NESHAP Initial Performance Test Report: One (1) Solar Vent Flare

Smith's Creek Landfill
Smith's Creek, Michigan

Prepared for:

Smith's Creek Landfill
6779 Smith's Creek Road
Smith's Creek, Michigan 48074

Prepared by:

Environmental Information Logistics, LLC
130 E. Main Street
Caledonia, MI 49316

January, 2023

TABLE OF CONTENTS

PAGE

1.0 INTRODUCTION 1

2.0 SUMMARY OF RESULTS 3

3.0 SOURCE DESCRIPTION 2

4.0 SAMPLING AND ANALYTICAL PROCEDURES 4
- 4.1 Stack Gas Velocity (Anemometer) 2
- 4.2 Determination of CO_2, CH_4, N_2 and O_2 (Field Instrument & Method 3C) 3
- 4.3 Visual Determination of Smoke Emissions from Flares (Method 22) 3

5.0 TEST RESULTS AND DISCUSSION 6

6.0 ADDITIONAL INFORMATION REQUIRED BY THE NSPS 6

TABLES

1 BTU Determination from Field & Laboratory Testing
2 Allowable Exit Velocity Calculations for Solar Passive Flare
3 Solar Passive Flare Landfill Gas Quality Data
4 Measured Solar Flare Gas Velocities Using Anemometer

FIGURES

1 Solar Vent Flare Location Map
2 Typical Solar Vent Flare Diagram
3 Method 3C Sample Train

APPENDICES

A EGLE Test Protocol Approval
B Field Data Sheets and Logs (Anemometer readings, gas quality readings, VE testing logs)
C Equipment Calibration Sheets
D Enthalpy Analytical Test Report

1.0 INTRODUCTION

Environmental Information Logistics, LLC (EIL) was retained by the Smiths Creek Landfill (Smiths Creek) to conduct NESHAP Initial Performance Testing of one (1) solar landfill gas vent flare at the site, which is located in Smiths Creek, Michigan. EIL was also retained by Smith' Creek to prepare the NESHAP Initial Performance Test Report. The testing was conducted by EIL on November 16 & November 17, 2022.

The testing was performed to demonstrate conformance of the solar vent flare with the general requirements of 40 CFR 63.11 and 40 CFR 60.18 and thus to also demonstrate that the flare is in compliance with 40 CFR 63, Subpart AAAA. The requirements of §63.11 include the following:

- The determination of visible emissions at the solar vent flare using United States Environmental Protection Agency (USEPA) Method 22, as per 40 CFR 63.11(b)(4).
- The determination of net heating value of the landfill gas that is combusted in the passive flare per 40 CFR. 63.11(b)(6)(ii)
- The determination of exit velocity, per 40 CFR 63.11(b)(6)(i) and the variance requested to use an Anemometer.

EIL submitted a Test Protocol to EGLE on October 17, 2022. EGLE approved the Test Protocol on November 4, 2022 (see Appendix A).

The active Smith's Creek Landfill is subject to the Landfill NESHAP – 40 CFR 63, Subpart AAAA. The site recently installed a solar vent flare on a leachate sump in order to address a surface emissions monitoring (SEM) exceedance measured three times in one quarter. The NESHAP and the facility's Renewable Operating Permit (ROP) require that the site conduct an Initial Performance Test on the new solar flare, pursuant to 40 CFR 63.1959(e) and 40 CFR 63.11.

Names, addresses and telephone numbers of the persons and companies involved in the testing are as follows:

Facility Contacts:	Matt Williams 6779 Smith's Creek Rd Smith's Creek, MI 48074 (810) 989-6979

Test Personnel:	Laura Niemann (Contact) – (616) 891-2592
	Andrew Medaugh (Testing Personnel) – (586) 804-8714
	EIL, LLC
	130 E. Main Street
	Caledonia, MI 49316

2.0 SUMMARY OF RESULTS

Operating data for the solar vent flare is provided in the field data and calculated data sheets in Appendix B. The flare combusts landfill gas produced by the decomposing municipal solid waste landfill disposed of within the Smiths Creek Landfill. The solar vent flare location is provided on Figure 1.

The facility's SRN number is N6207. The Smith's Creek Landfill, located at 6779 Smiths Creek Rd, Smiths Creek, MI 48074, was issued a Renewable Operating Permit (No. MI-ROP-N6207-2018) on June 7, 2018. A permit renewal application was submitted to EGLE on November 16, 2022. The Emissions Unit ID for the source being tested is EU-VENTFLARE-SCL1.

The following table summarizes the results of the performance testing at the solar vent flare:

Device Name	Results of VE Testing (minutes: seconds of accumulated total visible emissions)	Net Heating Value (BTU/SCF) – HHV Basis		Average Net Heating Value (BTU/SCF)	Actual Exit Velocity (feet/second)
		Field Measurement (average of 4 measurements)	Laboratory Analyses (average of 3 samples)		
Solar Flare	0 min: 0 sec	548.5	556.3	552.4	0.04

Note: The solar flare was not operational (lit) the morning of 11/16/2022. However, landfill gas was present in the leachate sump after field measurements. Therefore, the technician assembled the sample train and collected the Method 3C samples. Since insufficient gas was present to keep the flare lit, the technician did not collect flow readings with the anemometer the morning of 11/16/2022. The flare re-lit itself in the afternoon and the technician was able to conduct the two hour Method 22 VE test. Flow readings were taken the following day on 11/17/2022 since the flare remained operational.

This type of intermittent operation is very typical for passive gas solar flares, which rely on internal gas generation in a localized area to supply the fuel. Barometric pressure may also play a role in flare operations, with emissions rates changing based on high or low pressure conditions. It is therefore not possible for this type of control device to operate at a "maximum" gas flow rate upon command, since the flow of gas depends on biological activity within the landfill and barometric pressure conditions, which are beyond human control.

3.0 SOURCE DESCRIPTION

The Smith's Creek Landfill is an active municipal solid waste (MSW) landfill. Municipal, commercial, industrial, construction and demolition debris are all permitted for disposal at the facility. Complex microbial and biochemical reactions occur within the landfill's interior after the waste has been deposited for a period of time. Initial decomposition of the waste is rapid and continues until the entrained oxygen within the refuse is depleted.

The second stage of refuse decomposition is anaerobic, and can be divided into two separate and independent processes: non-methanogenic and methanogenic. Carbon dioxide (CO_2) is a byproduct of the non-methanogenic process and methane (CH_4) is a byproduct of the methanogenic process. These two compounds are the primary constituents of landfill gas; CO_2 content can range from 30% to 50% and CH_4 ranges from 50% to 60%. The production of landfill gas is a continuous process. It begins a few months after initial waste placement and continues until the microbial reactions are limited by substrate or moisture availability.

Multiple control devices are installed at this facility and have already undergone performance testing. The new solar vent flare was installed to control landfill gas emissions at a leachate sump since the perimeter location of the sump is too far to connect to the active gas extraction system. The solar vent flare is self-igniting: a solar powered battery provides a spark which should allow the flare to re-ignite as long as landfill gas of sufficient quality and quantity is present to sustain combustion. The landfill currently operates six (6) identical solar vent flares at closed areas of the facility. These flares were previously performance tested in 2003.

The solar flare is designed to meet the requirements of 40 CFR 60.18 and 40 CFR 63.11 at a flow rate of up to 140 standard cubic feet per minute (scfm). Flares designed and operated in accordance with 40 CFR 60.18 and 40 CFR 63.11 are assumed to have a destruction efficiency for NMOC of 98%.

The measured landfill gas flow at the solar flare was 0.033 SCFM. The average gas quality measured in the field was 54.2% methane, 36.0% CO_2, 1.9% oxygen, and 7.9% balance gas. This is considered typical for landfill gas.

The solar flare is equipped with a thermocouple to monitor for the presence of a flame.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

EIL conducted testing in accordance with USEPA Reference Test Methods in 40 CFR 60. Additionally, EIL followed a testing variance approved by EGLE as outlined below. Sample collection and analysis methods included:

PARAMETER	METHOD	Analytical Method
Landfill Gas Velocity/Flow Rate; Flare Exit Velocity	Hand-held anemometer (per 11/04/2022 EGLE test protocol approval)	Anemometer/field data
Gas Composition and Moisture Content; Net Heating Value	Three (3) 30-minute samples per USEPA Method 3C and 40 CFR 63.1959(e).	Gas Chromatography (GC/TCD)
Visible Emissions	USEPA Method 22	Observation – two hours

4.1 Stack Gas Velocity (Anemometer)

The construction of the solar vent flare was not conducive for traditional stack gas flow measurements using USEPA Methods 1 & 2 (i.e. traverses and pitot tubes). The available sample ports for conducting measurements were located directly on the steel flare stack itself, which was only 1 ½ inch in diameter. Traditional pitot tubes manufactured by Dwyer cannot fit into a pipe diameter as small as this.

EIL proposed an addendum for measuring stack velocity to EGLE on October 17, 2022. Specifically, an instrument called an "anemometer" was proposed to measure stack velocity and flow. The anemometer device measures flow, velocity and temperature for pipe sizes from a half inch to 100 inches. EGLE approved the protocol on November 4, 2022.

During the testing, the EIL technician placed the probe tip of the anemometer in the center of the 1 ½ inch flare stack using the existing sampling port. Velocity data from the instrument was recorded once the readings stabilized. EIL took three sets of readings at the flare. The existing sample port at the flare was located approximately 18 inches above the flange that connects the vent flare to the HDPE pipe, and was approximately two feet below a ball valve located on the flare stack.

Since the anemometer measured velocity directly and since the flare tip is the same diameter as the stack where the velocity was measured, no calculation was required to determine exit velocity since it is the same as the measured velocity.

Figure 2 depicts a typical solar flare diagram with the location of the sample port depicted. Calibration information for the anemometer used is provided in Appendix C. Field notes for the velocity data collected are included in Appendix B.

4.2 Determination of CO_2, CH_4, N_2 and O_2 (Field Instrument & USEPA Method 3C)

The determination of fixed gases (for calculation of net heating value) was conducted using USEPA Method 3C. The site utilized a GEM meter to collect and analyze a gas quality sample from the flare's sample port on the stack. Data collected at the solar flare was recorded on data sheets included in Appendix B.

Four 30-minute integrated samples of landfill gas from the sample port on the flare stack was collected by EIL for laboratory analyses using Method 3C. EIL contracted with Enthalpy Analytical to analyze each sample for carbon dioxide, (CO_2), methane (CH_4), nitrogen (N_2), and oxygen (O_2) concentration and moisture fraction using Method 3C. Figure 3 details the Method 3C sample train.

Enthalpy Analytical followed the analytical procedures of Method 3C using a gas chromatograph (GC), with appropriate separation column for the expected parameters, equipped with a thermal conductivity detector (TCD). The Enthalpy laboratory analytical report is provided in Appendix D.

EIL used the combined measured field and Method 3C analytical results to calculate stack gas molecular weight (for use in the allowable stack gas exit velocity calculation), and to calculate the net heating value of the gas being combusted per §63.11(b)(6). The reported net heating value is the arithmetic average of the four field samples and the three analytical samples.

4.3 Visual Determination of Smoke Emissions from Flares (USEPA Method 22)

EIL used Method 22, *"Visual Determination of Fugitive Emissions from Material Sources and Smoke Emissions from Flares,"* to determine the presence and duration of visible emissions.

EIL observed the solar flare continuously for 20 minutes, took a break of 5 minutes, and repeated this process until a 2-hours of observation time had been accrued. Data for the observation was recorded on the Method 22 data sheets provided in Appendix B.

5.0 RESULTS

EIL did not observe any visible emissions from the solar flare during the 2 hour observation.

The average net heating value of the gas being combusted at the solar flare was 556.3 BTU/SCF (HHV basis), or 17.23 MJ/scm. The requirement for net heating value is that the landfill gas quality for a non-assisted flare be greater than 200 BTU/SCF, which equates to 7.45 MJ/scm 40 CFR [63.11(b)(6)(ii)]. The average net heating values in BTU/scm and MJ/scm are provided in Tables 1 & 2. Table 3 provides a summary of the major constituents of the landfill gas quality at each flare (CH_4, CO_2, O_2 and N_2) measured in the field using a hand-held combustible gas meter, and via laboratory analyses using Method 3C.

Additionally, open flares are required by 40 CFR 60.18 and 40 CFR 63.11 to determine an exit velocity and demonstrate that it is less than Vmax (per 40 CFR 60.18(f)(5)) and 40 CFR 63.11(b)(7)).

$Log_{10}(V_{max})=(H_T+28.8)/31.7$

V_{max}=Maximum permitted velocity, M/sec

28.8=Constant

31.7=Constant

H_T=The net heating value as determined in paragraph (b)(6).

The permitted exit velocity calculations are provided in Table 2. Actual average velocities measured by the anemometer are provided in Table 4. The permitted stack gas exit velocity was 92.85 feet/second. The average measured velocity was 0.04 feet/second.

The average measured flow rate was .0327 scfm, which is significantly less than the flare's rated capacity of 140 scfm. EIL concludes that the flow rates at the flare are variable depending on landfill gas production rates. Although the landfill gas flows observed during the testing did not approach the flare's maximum rated capacity, it is unlikely that the flows will suddenly increase much more beyond what is currently measured. The gas flows are therefore believed to be representative of typical operating conditions.

The results demonstrate that the solar flare tested meet the performance requirements of §60.18 and §63.11, and thus satisfy 40 CFR 60.752(b)(2)(iii) and 40 CFR 63.1959(e).

EIL did not note any variations and/or anomalies in normal sample collection procedures.

EIL quality assurance (QA) procedures included:

1. Verification of sufficient evacuation of each Method 3C canister prior to initiation of each sample collection.

Again, EGLE's approval letter for the flow test method change is provided in Appendix A. Field and calculated data used in the determination of the utility flare allowable exit velocity and net heating value and visible emissions observation data are presented in Appendix B. Appendix C includes equipment calibration sheets. The Method 3C laboratory analytical results and chain-of-custody forms are provided in Appendix D.

This report prepared by: Andrew Medaugh

Andrew Medaugh
Environmental EIT
EIL, LLC

December 21, 2022

TABLES

Table 1: BTU Determination from Field & Laboratory Testing
Smith's Creek Landfill

Device	Sample Date	Field Testing (GEM meter)							Average Laboratory Analysis CH_4 (%)[3]	Average Laboratory BTU/SCF Analyses (HHV)[4]	Average of Field and Lab Data (BTU/SCF) HHV Basis	Average CH4 Concentration (%) from Field and Lab Data
		Run #1 CH_4 (%)	Run #2 CH_4 (%)	Run #3 CH_4 (%)	Run #4 CH_4 (%)	Average CH_4 (%)	BTU/SCF (LHV)[1]	BTU/SCF (HHV)[2]				
Solar Flare 7	11/16/2022	55.60%	52.10%	54.10%	55.00%	54.20%	492.7	548.5	54.07%	556.3	552.4	54.17%
										Average:	**552.4**	**BTU/SCF (HHV)**

[1]BTU Constant (LHV) = 909 BTU/scf. Landfill Gas BTU/ SCF (LHV) = % CH_4 x 909 BTU/SCF

[2]BTU Constant (HHV) = 1012 BTU/scf. Landfill Gas BTU/ SCF (HHV) = % CH4 x 1012 BTU/SCF

[3]Sample SC-2 = 57.1%, SC-3 = 48.6% and SC-4 = 56.5%

[4]Sample SC-2 = 586 BTU/ft^3, SC-3 = 499 BTU/ft^3 and SC-4 = 584 BTU/ft_3

Table 2
Allowable Exit Velocity Calculations for Solar Passive Flare
Smith's Creek Landfill

Device Name	Average Flare CH4 %	Ambient Temperature (°F)	Temperature Correction Factor to 25°C	H_i kcal/gm-mole	H_T MJ/scm	$Log_{10}V_{max}$ m/sec	Allowable V_{max} m/sec	Allowable V_{max} ft/sec	Actual Velocity ft/sec
Solar Flare	54.17%	35	0.952	182.76	17.23	1.45	28.31	92.85	0.04

Table 3: Solar Passive Flare Landfill Gas Quality Data
Smith's Creek Landfill
Smith's Creek, MI

Sample ID	Sample Date	Analytical Date	Sample Time Start	Sample Time End	Ambient Temp (°F)	Initial Tank Pressure ("W.C.)	FinalTank Pressure ("W.C.)	Field Data (%)				Lab Data (ppm)			
								CH_4	CO_2	O_2	Balance Gas	CH_4	CO_2	O_2	N_2
SC-1	11/6/2022	N/A	11:04	11:34	35	-18.0	-2.50	55.6%	36.6%	1.5%	6.2%	Spare Cannister Not Analyzed			
SC-2	11/6/2022	12/2/2022	11:45	12:15	35	-19.5	-2.50	52.1%	34.9%	2.4%	10.5%	571000	411000	ND	ND
SC-3	11/6/2022	12/2/2022	12:24	12:54	35	-18.0	-2.50	54.1%	36.0%	1.9%	8.0%	486000	351000	31300	112000
SC-4	11/6/2022	12/2/2022	13:02	13:32	35	-20.0	-2.50	55.0%	36.4%	1.9%	6.8%	565000	408000	ND	ND
							Averages:	**54.2%**	**36.0%**	**1.9%**	**7.9%**				

Table 4: Measured Solar Flare Gas Velocities Using Anemometer

Device Name	Date	Measured Anemometer Velocity (feet/min)	Average Measured Velocity (feet/min)	Average Measured Velocity (feet/sec)	Average Flow (SCFM) (based on ID of 1.50 in)
Solar Flare 7	11/17/2022	3	2.67	0.04	0.0327
		2			
		3			

FIGURES

Figure 1
Solar Vent Flare Location

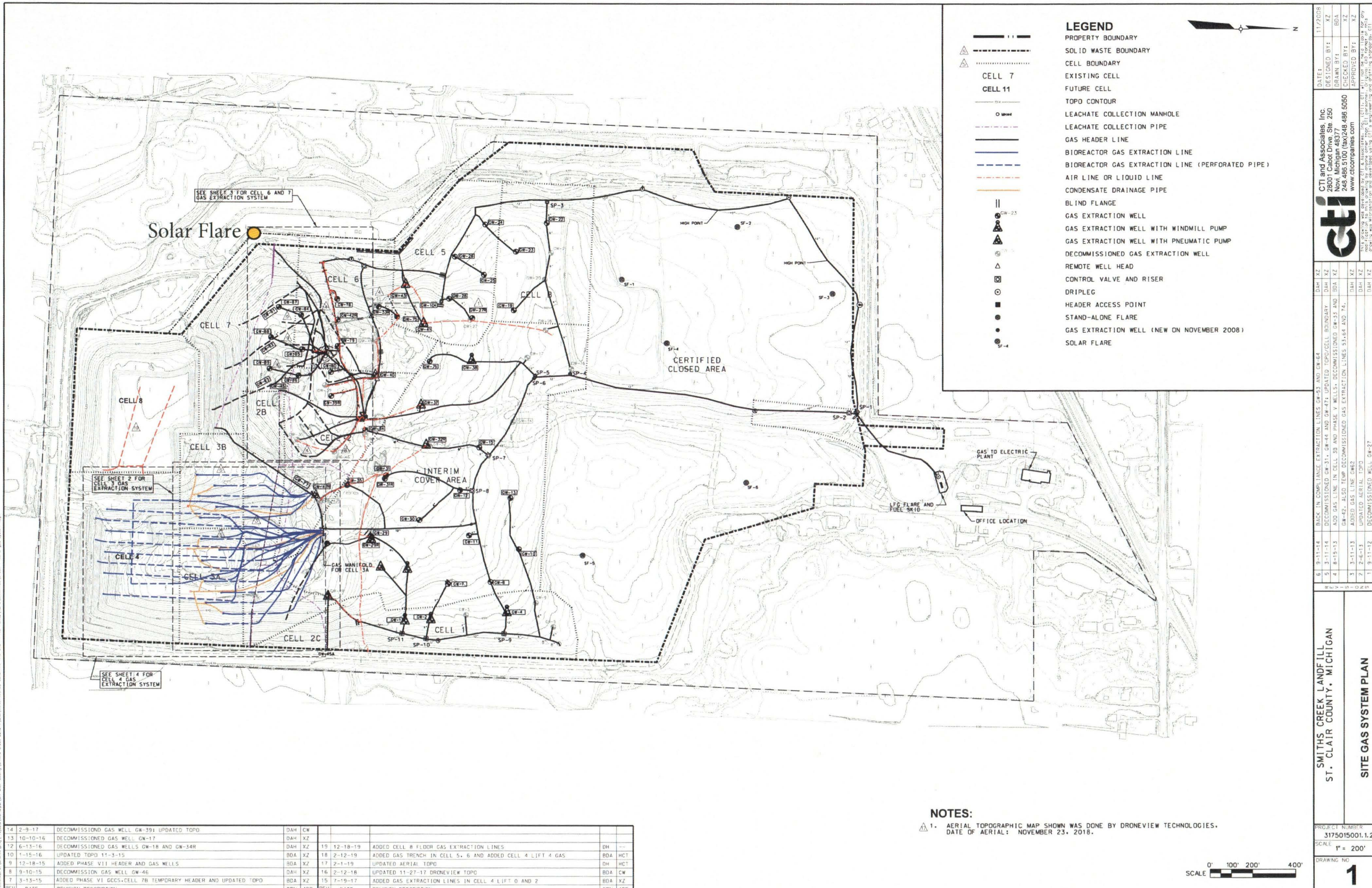
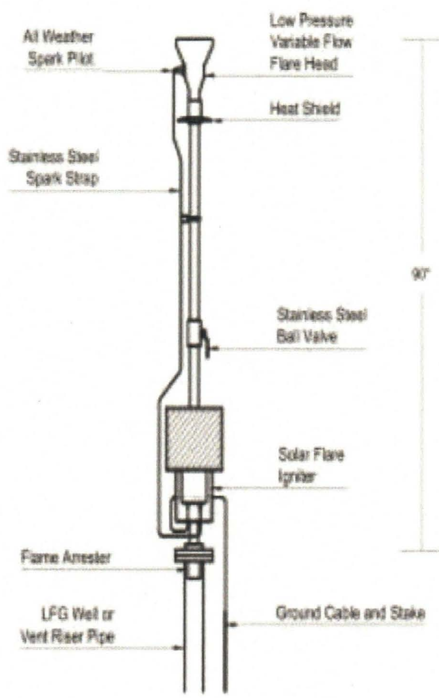


Figure 2
Solar Vent Flare Diagram

Solar Spark Technical Information:

Landfill Gas Vent Flare Diagram

TYPICAL INSTALLATION
CF-5 / CF-10

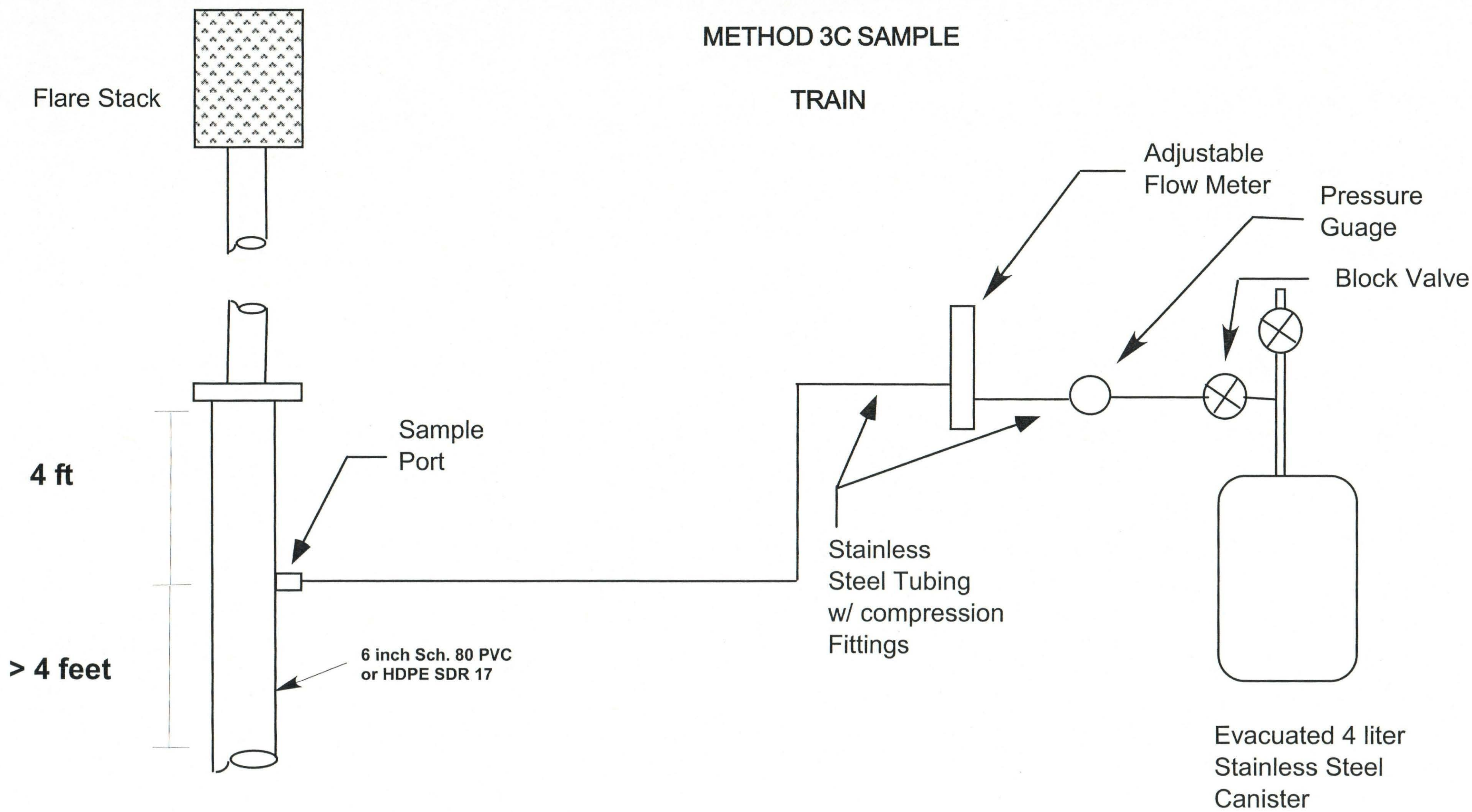


LSC
ENVIRONMENTAL PRODUCTS, LLC

Figure 3

METHOD 3C SAMPLE

TRAIN



Note: Sample train based on Method 25C section 2.2.1 - 2.2.4, as allowed for in the Method.

NTS