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APEX COMPANIES, LLC

Air Emissions Test Report
Fluidized Bed Sewage Sludge Incinerator Compliance Test
Ypsilanti Community Utilities Authority
Ypsilanti, Michigan

PREPARED FOR:
Ypsilanti Community Utilities Authority
2777 State Street
Ypsilanti, Michigan 48198
State Registration No. B6237

Apex Project No. YPS001-0202012-21000973

January 20, 2022

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Executive Summary

Ypsilanti Community Utilities Authority (YCUA) retained Apex Companies, LLC (Apex) to conduct air emissions testing at the YCUA facility in Ypsilanti, Michigan.

The purpose of the air emission testing was to evaluate compliance with certain emission limits in Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-B6237-2020, effective August 14, 2020. The emission unit tested was the fluidized bed sewage sludge incinerator (EU-FBSSI). Testing was conducted as a retest following inconclusive results from a sampling event performed by Gammie Air Monitoring, LLC on May 26, 2021.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1, 2, 3, 4, 23, and 1668C.

Detailed results are presented in Table 1 after the Tables Tab of this report. The following table summarizes the results of testing conducted on November 22 and 23, 2021.

EU-FBSSI Emissions Results

Parameter	Unit	Average Result	Permit Limit
PCB	lb/ton sludge	1.5×10^{-6}	1.2×10^{-6}

PCB: polychlorinated biphenyl
lb/ ton sludge: pound per dry ton of sewage sludge

1.0 Introduction

1.1 Summary of Test Program

Ypsilanti Community Utilities Authority (YCUA) retained Apex Companies, LLC (Apex) to conduct air emissions testing at the YCUA facility in Ypsilanti, Michigan.

The purpose of the air emission testing was to evaluate compliance with certain emission limits in Michigan Department of Environment, Great Lakes, and Energy (EGLE) Renewable Operating Permit (ROP) MI-ROP-B6237-2020, effective August 14, 2020. The emission unit tested was the fluidized bed sewage sludge incinerator (EU-FBSSI). Testing was conducted as a retest following inconclusive results from a sampling event performed by Gammie Air Monitoring, LLC on May 26, 2021.

The testing followed United States Environmental Protection Agency (USEPA) Reference Methods 1, 2, 3, 4, 23, and 1668C.

Table 1-1 lists the emission source tested, parameter, and test dates.

Table 1-1
Source Tested, Parameter, and Test Dates

Source	Test Parameter	Test Date(s)
EU-FBSSI	PCB	November 22 and 23, 2021

1.2 Key Personnel

The key personnel involved in this test program are listed in Table 1-2. Mr. David Kawasaki, Senior Engineer with Apex, led the emission testing program. Mr. Sree Mullapudi, Director of Wastewater Operations/Compliance with YCUA, provided process coordination and recorded operating parameters. Ms. Diane Kavanaugh Vetort and Ms. Regina Angellotti, with EGLE, witnessed the testing and verified production parameters were recorded.

Table 1-2
Key Contact Information

Client	Apex
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2.0 Source and Sampling Locations

2.1 Process Description

YCUA operates a wastewater treatment plant that processes over 8 billion gallons of residential and industrial wastewater per year. As part of the wastewater treatment, biosolids are accumulated and collected prior to discharge of the treated water into the Lower Rouge River. Biosolids are a sludge that is typically brown to black in color, malodorous, and consists of residual organic matter and microbes containing bacteria and pathogens.

Biosolid sludge accumulated at the YCUA wastewater treatment plant is treated using a fluidized bed sewage sludge incinerator. Air emissions from the fluidized bed sewage sludge incinerator are controlled by four pollution control devices: a scrubber, impingement tray, electrostatic precipitator, and carbon bed; the final discharge to the atmosphere is through Stack SV-001. Emissions testing were performed at Exhaust Stack SV-001.

The facility processes residential and industrial wastewater. Biosolids are accumulated as part of the treatment process. These biosolids are treated in the fluidized bed sewage sludge incinerator.

The incinerator is designed to operate continuously. Depending on the amount of available biosolids, the incinerator is operated on an average of three to four days a week. During the testing, the incinerator was operated at the maximum routine operating feed rate based on the previous 12 months of operation.

Two dewatered sewage sludge feed bins are located in the solids building. Dewatered cake from nine belt filter presses is stored in the feed bins before being pumped to the incinerator. Two dewatered biosolid pumps are connected to each of the feed bins. The feed bin extraction screw conveyors feed the pumps, and the pumps transfer dewatered sludge to the incinerator. Sludge is transferred, via high-pressure schedule 80 steel pipe, from the feed bins to the incinerator. High-pressure ball valves installed in the piping system control the flow of sludge to the incinerator.

2.2 Control Equipment Description

The fluidized bed sewage sludge incinerator uses four pollution control devices prior to exhausting emissions to the atmosphere through Exhaust Stack SV-001. These pollution control devices include: a venturi scrubber, a multi-stage impingement tray scrubber, a wet electrostatic precipitator, and a granular activated carbon bed.

The main component of the incinerator is the fluid bed reactor. During static conditions, the fluid bed reactor consists of an inert sand bed supported on an air distributor dome. As air is forced up through the dome and sand bed, the individual particles of the bed will fluidize. At a certain air velocity, the sand becomes suspended in the fluidizing air stream. The fluidized state promotes an intensive mixing of the individual sand particles with the fluidizing air that is used as combustion air for the incineration process.

The fluid bed reactor vessel has three main sections of which two sections are physically separated. The bottom of the reactor is the windbox, which is used to distribute the air evenly to the sand and has a burner for preheating. In the middle sand bed section, natural gas and sludge are injected into the fluidized sand media where most of the combustion takes place. The upper section is the freeboard, which allows additional residence time to completely combust the natural gas and sludge.

Hot gases, containing ash from the incineration process, exit the top of the fluidized bed incinerator and pass through two shell-and-tube heat exchangers. After the heat exchangers, the gases pass through a venturi scrubber that removes particulate matter from the gases due to water injection and gas velocity increases at the venturi throat.

Next, the gases pass through a tray scrubber to remove condensable gas byproducts and lower the exit temperature of the gases.

The gas from the tray scrubber is passed through a wet electrostatic precipitator to remove very fine particulate matter. The final air pollution control device is the granular activated carbon system that contains (1) a conditioner to remove water droplets and heat the gas, and (2) an absorber to remove trace mercury in the gas stream. The absorber removes mercury by passing the gas through one column of porous filter media pellets and two columns of more porous carbon pellets.

Operating parameters for the fluidized bed sewage sludge incinerator pollution control equipment are controlled by programmable logic controller monitoring systems.

Operating parameters for EU-FBSSI include the following:

- Maintain a temperature of 1,200°F within the fluidized sand bed during start-up.
- Maintain temperatures above 1,500°F during shutdown while any sludge is still burning.
- Maintain the oxygen content of the exhaust stack gas to be greater than 2% wet or 3% dry based on 15-minute average.
- Ensure the total volumetric flowrate at the fluidized air blower does not exceed 13,061 standard cubic feet per minute (scfm), based on an hourly average.
- Maintain a minimum operating temperature of 1,150°F, based on a 15-minute average, within the fluidized sand bed while in operation.
- Maintain a minimum 2-second retention time while the sewage is in the fluidized sand bed.
- Maintain a temperature of 1,500°F, based on a 15-minute average, at the freeboard.
- Maintain a 6-second retention time while sewage is in the freeboard.
- Maintain a sewage sludge input feed rate of less than 6,300 pounds of dry sewage sludge per hour based on a 24-hour average and less than 16,380 tons of dry sewage sludge per 12-month rolling period.
- Maintain venturi scrubber water flow at a minimum of 300 gallons per minute (gpm).
- Maintain an impingement tray scrubber water flowrate at a minimum of 350 gpm.
- Maintain a venturi scrubber pressure differential between 30 to 40 inches of water (20 to 40 inches of water during startup).
- Maintain an impingement tray scrubber pressure differential of 5 to 15 inches of water.
- Maintain a granular activated carbon bed pressure differential from 1 to 10 inches of water.

The permitted capacity of the EU-FBSSI is 6,300 dry pounds of solids per hour. The rated air pollutant removal efficiency is a minimum of 95%.

Operating parameters were measured and recorded by YCUA personnel during testing. Table 2-1 summarizes the operating conditions during testing of EU-FBSSI. Additional operating parameter data are included in Appendix F.

Table 2-1
Summary of EU-FBSSI Operating Data

Parameter	Unit	Run 1	Run 2	Run 3	Average
Biosolids feed rate	lb/hr, dry	4,258.0	4,614.4	5,101.6	4,658.0

2.3 Flue Gas Sampling Location

Two sampling ports oriented at 90° to one another are located in a straight section of a 42 inch-internal-diameter duct. The sampling ports are located:

- Approximately 216 inches (5.1 duct diameters) from the nearest downstream disturbance.
- Approximately 672 inches (16 duct diameters) from the nearest upstream disturbance.

The sampling ports are accessible from the third floor of the building. A photograph of the EU-FBSSI sampling location is presented in Figure 2-1. Figure 1 in the Appendix depicts the EU-FBSSI sampling ports and traverse point locations.

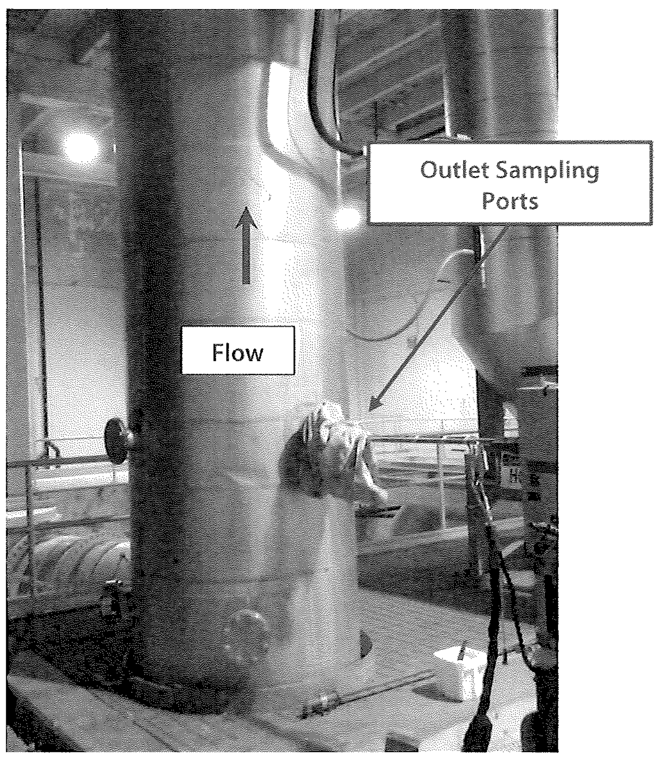

Figure 2-1. EU-FBSSI Sampling Location

2.4 Process Sampling Locations

Process sampling was not required during this test program. A process sample is a sample that is analyzed for operational parameters, such as calorific value of a fuel (e.g., natural gas, coal), organic compound content (e.g., paint coatings), or composition (e.g., polymers).

3.0 Summary and Discussion of Results

3.1 Objectives and Test Matrix

The objective of the air emission testing was to evaluate compliance with certain emission limits in EGLE ROP MI-ROP-B6237-2020, effective August 14, 2020.

Table 3-1 summarizes the sampling and analytical matrix.

Table 3-1
Sampling and Analytical Matrix

Sampling Location	Sample/Type of Pollutant	Sample Method	Date (2021)	Run	Start Time	End Time	Analytical Laboratory
EU-FBSSI	Flowrate, molecular weight, moisture content, PCB	USEPA 1, 2, 3, 4, 23, 1668C	Nov. 22	1	12:30	14:32	ALS Global
			Nov. 23	2	09:35	11:37	
			Nov. 23	3	12:45	14:46	

3.2 Field Test Changes and Issues

Communication between YCUA, Apex, and EGLE allowed the testing to be completed as proposed in the October 22, 2021, Intent-to-Test Plan.

3.3 Summary of Results

The results of testing are presented in Table 3-2. Detailed results are presented in the Appendix Table 1 after the Tables Tab of this report. Sample calculations are presented in Appendix B.

Table 3-2
EU-FBSSI Emissions Results

Parameter	Unit	Run 1	Run 2	Run 3	Average Result	Permit Limit
PCB	lb/ton sludge	2.6×10^{-6}	1.1×10^{-6}	9.7×10^{-7}	1.5×10^{-6}	1.2×10^{-6}

PCB: polychlorinated biphenyl
lb/ ton sludge: pound per dry ton of sewage sludge

4.0 Sampling and Analytical Procedures

Apex measured emissions in accordance with USEPA sampling methods. Table 4-1 presents the emissions test parameters and sampling methods.

Table 4-1
Emission Testing Methods

Parameter	EU-FBSSI	USEPA Reference	
		Method	Title
Sampling ports and traverse points	•	1	Sample and Velocity Traverses for Stationary Sources
Velocity and flowrate	•	2	Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)
Molecular weight	•	3	Gas Analysis for the Determination of Dry Molecular Weight
Moisture content	•	4	Determination of Moisture Content in Stack Gases
Polychlorinated biphenyls (PCBs) (Sample Collection)	•	23	Determination of Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans from Stationary Sources
Polychlorinated biphenyls (PCBs) (Laboratory Analysis)	•	1668C	Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS

4.1 Emission Test Methods

4.1.1 Volumetric Flowrate (USEPA Methods 1 and 2)

USEPA Method 1, "Sample and Velocity Traverses for Stationary Sources," was used to evaluate the sampling locations and the number of traverse points for sampling and the measurement of velocity profiles. Figure 1 in the Appendix depicts the source locations and traverse points.

USEPA Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)," was used to measure flue gas velocity and calculate volumetric flowrates. S-type Pitot tubes and thermocouple assemblies, calibrated in accordance with Method 2, Section 10.0, were used during testing. Because the dimensions of the Pitot tubes met the requirements outlined in Method 2, Section 10.1, and are within the specified limits, the baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned. The digital manometer and thermometer are calibrated using calibration standards that are traceable to National Institute of Standards and Technology (NIST). Pitot tube inspection sheets are included in Appendix A.

Cyclonic Flow Check. Apex evaluated whether cyclonic flow was present at the sampling locations. Cyclonic flow is defined as a flow condition with an average null angle greater than 20°. The direction of flow can be determined by aligning the Pitot tube to obtain zero (null) velocity head reading—the direction would be parallel to the Pitot tube face openings or perpendicular to the null position. By measuring the angle of the Pitot tube face openings in relation to the stack walls when a null angle is obtained, the direction of flow is measured. If the absolute average of the flow direction angles is greater than 20°, the flue gas is considered to be cyclonic at that sampling location and an alternative location should be selected.

The average of the measured traverse point flue gas velocity null angles were less than 20° at the sampling location. The measurements indicate the absence of cyclonic flow.

Field data sheets are included in Appendix C. Computer-generated field data sheets are included in Appendix D.

4.1.2 Molecular Weight (USEPA Method 3)

USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight," was used to determine the molecular weight of the flue gas. Flue gas was extracted from the stack through a probe and directed into a Fyrite® gas analyzer. The concentrations of carbon dioxide (CO_2) and oxygen (O_2) were measured by chemical absorption to within ±0.5%. The average CO_2 and O_2 results of the grab samples were used to calculate molecular weight.

4.1.3 Moisture Content (USEPA Method 4)

USEPA Method 4, "Determination of Moisture Content in Stack Gases" was used to determine the moisture content of the flue gas. Prior to testing, the moisture content was estimated using measurements from previous testing, psychrometric charts and/or water saturation vapor pressure tables. These data were used in conjunction with preliminary velocity head pressure and temperature data to calculate flue gas velocity, nozzle size, and to establish the isokinetic sampling rate for the USEPA Method 23 sampling. For each sampling run, moisture content of the flue gases was measured using the reference method outlined in Section 2 of USEPA Method 4 in conjunction with the performance of USEPA Method 23.

4.1.4 Polychlorinated Biphenyls (USEPA Methods 23 and 1668C)

USEPA Method 23, "Determination of Polychlorinated Dibenzo-p-dioxins and Polychlorinated Dibenzofurans from Municipal Waste Combustors," was used to sample polychlorinated biphenyls. USEPA Method 1668C, "Chlorinated Biphenyl Congeners in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS," was used for laboratory analytical.

Apex's modular isokinetic stack sampling system consists of:

- A borosilicate glass button-hook nozzle.
- A heated (248±25°F) borosilicate glass-lined probe.
- A pre-cleaned glass fiber filter (manufactured to at least 99.95% efficiency (<0.05 % penetration) for 0.3-micron dioctyl phthalate smoke particles) in a heated (248±25°F) filter box.
- A glass recirculating ice water condenser system.
- A XAD-2 sorbent trap.
- A set of five pre-cleaned impingers with the configuration shown in Table 4-2.
- A sampling line.
- An Environmental Supply® control case equipped with a pump, dry-gas meter, and calibrated orifice.

Table 4-2
USEPA Method 23 Impinger Configuration

Impinger Order (Upstream to Downstream)	Impinger Type	Impinger Contents	Contents
1	Modified - knockout	Empty	0 ml
2	Greenburg Smith	HPLC water	100 ml
3	Modified	HPLC water	100 ml
4	Modified	Empty	0 ml
5	Modified	Silica gel desiccant	~300 grams

Before testing, a preliminary velocity traverse was performed and a nozzle size was calculated that allowed isokinetic sampling at an average rate of 0.7 cfm. Apex selected a pre-cleaned borosilicate glass nozzle that had an inner diameter that approximated the calculated ideal value. The nozzle diameter was measured with calipers across three cross-sectional chords to evaluate the inside diameter; rinsed and brushed with acetone, methylene chloride, and toluene; and connected to the borosilicate glass-lined sample probe.

The impact and static pressure openings of the Pitot tube were leak-checked at or above a velocity head of 3.0 inches of water for more than 15 seconds. The sampling train was leak-checked by capping the nozzle tip and applying a vacuum of approximately 10 inches of mercury to the sampling train. The dry-gas meter was monitored for approximately 1 minute to measure that the sample train leakage rate was less than 0.02 cfm. The sampling probe was then inserted into the sampling port to begin sampling.

Ice was placed around the impingers and the probe, and filter temperatures were allowed to stabilize at 248±25 °F before each sample run. After the desired operating conditions were coordinated with the facility, testing was initiated.

Stack parameters (e.g., flue velocity, temperature) were monitored to establish the isokinetic sampling rate within ±10% for the duration of the test.

At the conclusion of a test run and the post-test leak check, the sampling train was disassembled and the condenser, XAD-2 Trap, impingers, and filter were transported to the recovery area. The XAD-2 Trap was removed from the sampling train, tightly capped at both ends, labeled, covered with aluminum foil, and stored in an iced cooler to be transported to the laboratory. The filter was recovered using Teflon-lined tweezers and placed in a Petri dish. The Petri dish was immediately labeled and sealed. The nozzle, probe, filter housing, and condenser were brushed and triple rinsed with acetone and then toluene, which were collected in a pre-cleaned sample container. As allowed by USEPA Alternative Method ALT-052, methylene chloride was not used in sample recovery.

At the end of the test run, the liquid volume collected in each impinger, including the silica gel, were weighed. These volumes were used to calculate moisture content of the flue gas. The sample containers were transported to ALS Global Laboratory in Burlington, Ontario, Canada for analysis. The laboratory analytical results are included in Appendix E.

Figure 4-1 depicts the USEPA Method 23 sampling train.

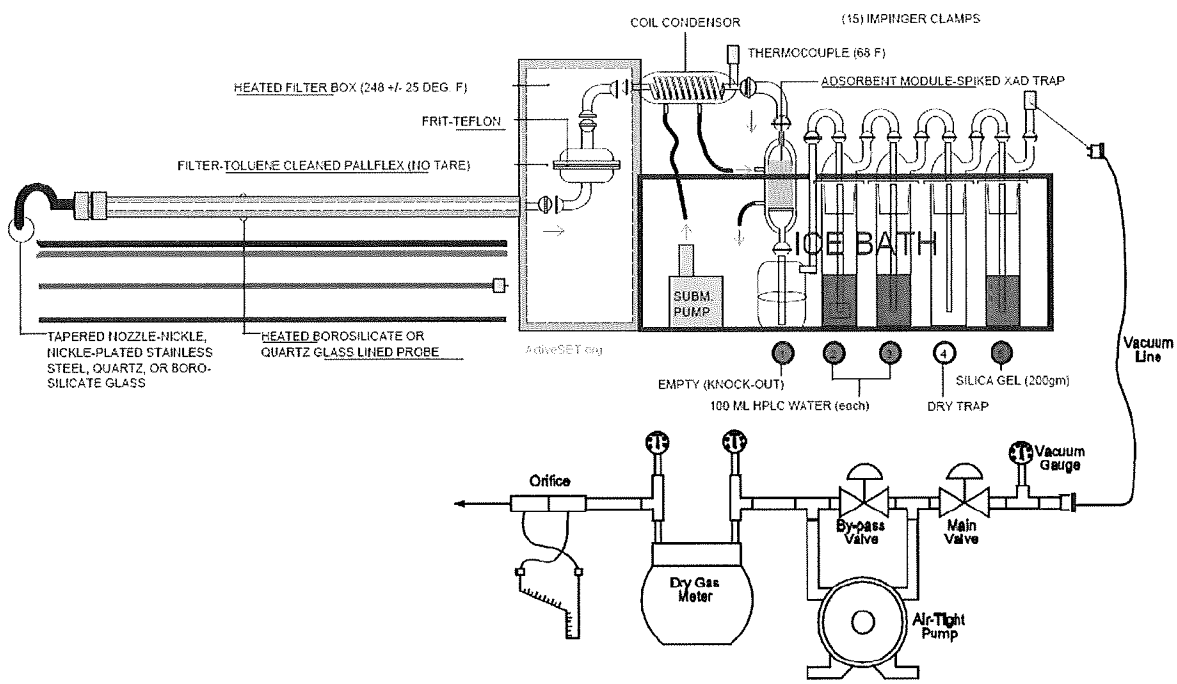

Figure 4-1. USEPA Method 23 Sampling Train

4.2 Process Data

YCUA recorded process data during testing. EGLE personnel verified the requested operating and process data were recorded. Process data are included in Appendix F.

4.3 Sample Identification and Custody

Recovery and analytical procedures were applicable to the sampling methods used in this test program. Applicable chain-of-custody procedures followed guidelines outlined in ASTM D4840-99 (Reapproved 2010), "Standard Guide for Sample Chain-of-Custody Procedures." Detailed sampling and recovery procedures are described in Section 4.1. For each sample collected (i.e., filter, probe rinse, impinger contents), sample identification and custody procedures were completed as follows:

- Containers were sealed to prevent contamination.
- Containers were labeled with test number, location, and test date.
- The level of fluid was marked on the outside of the sample containers to indicate if leakage occurred prior to receipt of the samples by the laboratory.
- Containers were placed in a cooler for storage, if necessary.
- Samples were logged using guidelines outlined in ASTM D4840-99 (Reapproved 2010).
- Samples were transported to the laboratory under chain of custody.

Chain of custody and laboratory analytical results are included in Appendix E.

5.0 Quality Assurance and Quality Control

5.1 QA/QC Procedures

Equipment used in this emissions test program passed Quality Assurance (QA) and Quality Control (QC) procedures. Refer to Appendix A for equipment calibrations. Before testing, the sampling equipment was cleaned, inspected, and calibrated according to procedures outlined in the applicable USEPA sampling method and USEPA's "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III, Stationary Source-Specific Methods."

5.2 QA/QC Audits

Onsite QA/QC procedures (i.e., Pitot tube inspections, nozzle size verifications, leak check, calculation of isokinetic sampling rates, calibrations) were performed in accordance with the respective USEPA sampling methods. Equipment inspection and calibration measurements are presented in Appendix A.

Offsite QA audits include dry-gas meter and thermocouple calibrations.

5.2.1 Audit Sample Results QA/QC

QA audit samples were not proposed during this test program. Currently, audit samples for the parameters to be measured are not available from the USEPA Stationary Source Audit Program.

5.2.2 Sampling Train QA/QC

The sampling trains described in Section 4.1 were audited for measurement accuracy and data reliability. Table 5-1 summarizes the QA/QC audits conducted on each sampling train.

Table 5-1
USEPA Method 23 Sampling Train QA/QC

Parameter	Run 1	Run 2	Run 3	Method Requirement	Comment
Average velocity pressure head (in H_2O)	0.23	0.24	0.24	>0.05 in H_2O	Valid
Sampling train post-test leak check	0.003 ft^3 for 1 min at 8 in Hg	0 ft^3 for 1 min at 5 in Hg	0.005 ft^3 for 1 min at 6 in Hg	<0.020 ft^3 for 1 minute at a vacuum ≥ recorded during test	Valid
Sampling vacuum (in Hg)	5 to 7	2 to 3	3 to 4		

5.2.3 Dry-Gas Meter QA/QC

Table 5-2 summarizes the dry-gas meter calibration checks in comparison to the acceptable USEPA tolerance. Complete dry-gas meter calibrations are included in Appendix A.

Table 5-2
Dry-Gas Meter Calibration QA/QC

Dry-Gas Meter	Pre-test DGM Calibration Factor	Post-test DGM Calibration Factor	Difference Between Pre- and Post-test Calibrations	Acceptable Tolerance	Comment
2	1.008 (11/5/2021)	1.006 (1/3/2022)	-0.002	±0.05	Valid

5.2.4 Thermocouple QA/QC

Temperature measurements using thermocouples and digital pyrometers were compared to a reference temperature prior to testing to evaluate accuracy of the equipment. The thermocouples and pyrometers measured temperature within ±1.5% of the reference temperatures and were within USEPA acceptance criteria. Thermocouple calibration sheets are included in Appendix A.

5.2.5 Laboratory Blanks QA/QC

QA/QC blanks were analyzed for the parameters of interest. The results are presented in Table 5-3. Blank corrections were not applied to the sample results. Blank and sample laboratory results are included in Appendix E.

Table 5-3
Laboratory Blanks QA/QC

Sample Identification	Result (ng)	Comment
Method 23 Reagent Blank - Total PCB	0.258	N/A

5.3 Data Reduction and Validation

The emissions testing Project Manager and/or the QA/QC Officer validated computer spreadsheets. The computer spreadsheets were used to ensure that field calculations were accurate. Random inspection of the field data sheets were conducted to verify data have been recorded appropriately. At the completion of a test, the raw field data were entered into computer spreadsheets to provide applicable onsite emissions calculations. The computer data were checked against the raw field sheets for accuracy during review of the report.

5.4 QA/QC Problems

Equipment audits and QA/QC procedures demonstrate sample collection accuracy and compliance for the test runs.

6.0 Limitations

The information and opinions rendered in this report are exclusively for use by Ypsilanti Community Utilities Authority. Apex Companies, LLC will not distribute or publish this report without consent of Ypsilanti Community Utilities Authority except as required by law or court order. The information and opinions are given in response to a limited assignment and should be implemented only in light of that assignment. Apex Companies, LLC accepts responsibility for the competent performance of its duties in executing the assignment and preparing reports in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

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Table

APEX

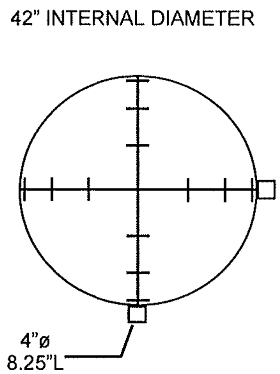
Table 1 - EU-FBSSI PCB Results

Facility		**Ypsilanti Community Utilities Authority**			
Source Designation		**EU-FBSSI**			
Test Date		**Nov 22, 2021**	**Nov 23, 2021**	**Nov 23, 2021**	
Meter/Nozzle Information		**Run 1**	**Run 2**	**Run 3**	**Average**
Meter Temperature, T_m	°F	96	98	102	99
Meter Pressure, P_m	in Hg	29.30	30.21	30.21	29.91
Measured Sample Volume, V_m	ft^3	82.37	84.07	84.47	83.64
Sample Volume, V_m	std ft^3	77.20	80.89	80.72	79.60
Sample Volume, V_m	std m^3	2.19	2.29	2.29	2.25
Condensate Volume, V_w	std ft^3	2.00	2.22	3.52	2.58
Gas Density, ρ_s	std lb/ft^3	0.0776	0.0775	0.0771	0.0774
Total weight of sampled gas	lb	6.146	6.445	6.397	6.329
Nozzle Size, A_n	ft^2	0.0004430	0.0004430	0.0004430	0.0004430
Isokinetic Variation, I	%	102	102	102	102
Stack Data					
Average Stack Temperature, T_s	°F	137	126	129	130
Molecular Weight Stack Gas-dry, M_d	lb/lb-mole	30.20	30.20	30.20	30.20
Molecular Weight Stack Gas-wet, M_s	lb/lb-mole	29.89	29.87	29.69	29.82
Stack Gas Specific Gravity, G_s		1.03	1.03	1.03	1.03
Percent Moisture, B_{ws}	%	2.53	2.67	4.18	3.13
Water Vapor Volume (fraction)		0.025	0.027	0.042	0.031
Pressure, P_s	in Hg	29.22	30.12	30.12	29.82
Average Stack Velocity, V_s	ft/sec	28.20	28.31	28.72	28.41
Area of Stack	ft^2	9.62	9.62	9.62	9.62
Exhaust Gas Flowrate					
Flowrate	ft^3/min, actual	16,280	16,342	16,577	16,400
Flowrate	ft^3/min, standard wet	14,073	14,816	14,971	14,620
Flowrate	ft^3/min, standard dry	13,717	14,420	14,345	14,160
Flowrate	m^3/min, standard dry	388	408	406	401
Collected Mass					
PCBs					
Monochlorobiphenyl	ng	1.50	0.643	0.634	0.926
Dichlorobiphenyl	ng	95.7	23.5	21.4	46.9
Trichlorobiphenyl	ng	24.0	12.5	14.7	17.1
Tetrachlorobiphenyl	ng	41.4	25.9	25.7	31.0
Pentachlorobiphenyl	ng	54.6	32.7	35.1	40.8
Hexachlorobiphenyl	ng	14.0	7.97	7.24	9.74
Heptachlorobiphenyl	ng	1.51	0.460	0.392	0.787
Octachlorobiphenyl	ng	0.331	0.0513	0.0351	0.139
Nonachlorobiphenyl	ng	0.0580	<0.0023	0.00320	0.0212
Decachlorobiphenyl	ng	0.0137	0.00550	0.00620	0.00847
Total PCBs	ng	233	104	105	147
Monochlorobiphenyl	mg/dscf	1.9E-08	7.9E-09	7.9E-09	1.2E-08
Dichlorobiphenyl	mg/dscf	1.2E-06	2.9E-07	2.7E-07	6.0E-07
Trichlorobiphenyl	mg/dscf	3.1E-07	1.5E-07	1.8E-07	2.2E-07
Tetrachlorobiphenyl	mg/dscf	5.4E-07	3.2E-07	3.2E-07	3.9E-07
Pentachlorobiphenyl	mg/dscf	7.1E-07	4.0E-07	4.3E-07	5.2E-07
Hexachlorobiphenyl	mg/dscf	1.8E-07	9.9E-08	9.0E-08	1.2E-07
Heptachlorobiphenyl	mg/dscf	2.0E-08	5.7E-09	4.9E-09	1.0E-08
Octachlorobiphenyl	mg/dscf	4.3E-09	6.6E-10	4.5E-10	1.8E-09
Nonachlorobiphenyl	mg/dscf	7.5E-10	<3.0E-11	4.1E-11	2.7E-10
Decachlorobiphenyl	mg/dscf	1.8E-10	7.1E-11	8.0E-11	1.1E-10
Total PCBs	mg/dscf	3.0E-06	1.3E-06	1.3E-06	1.9E-06

APEX

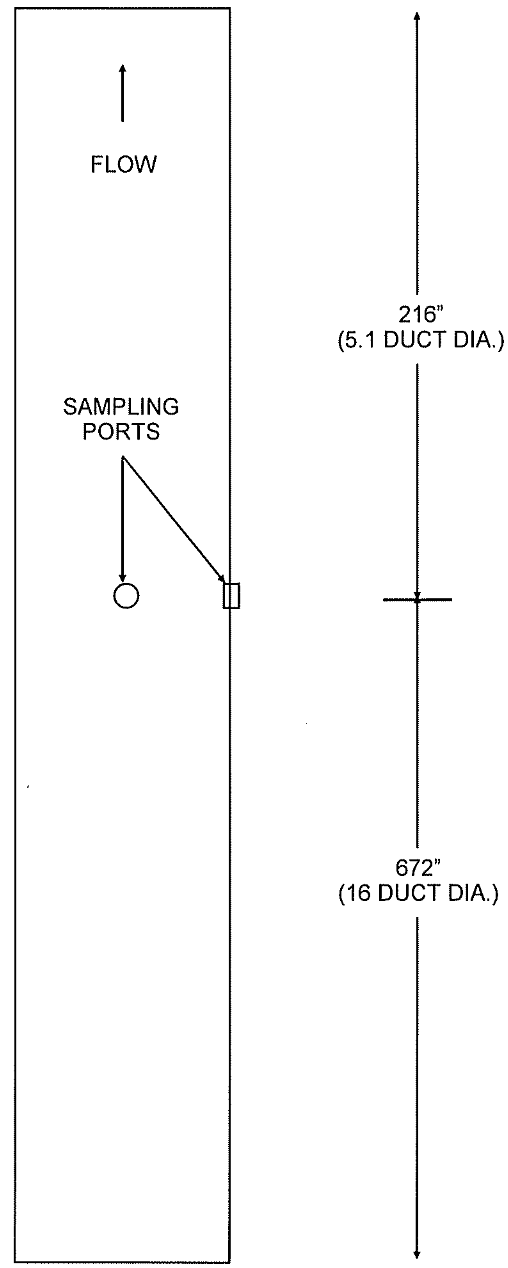
Table 1 - EU-FBSSI PCB Results (continued)					
Facility		**Ypsilanti Community Utilities Authority**			
Source Designation		**EU-FBSSI**			
Test Date		**Nov 22, 2021**	**Nov 23, 2021**	**Nov 23, 2021**	
Run		**Run 1**	**Run 2**	**Run 3**	**Average**
Mass Emission Rate					
Dry Sewage Sludge Feedrate	lb/hr	4,258.0	4,614.4	5,101.6	4658.0
Dry Sewage Sludge Feedrate	ton/hr	2.1	2.3	2.6	2.3
PCBs					
Monochlorobiphenyl	lb/hr	3.5E-08	1.5E-08	1.5E-08	2.2E-08
Dichlorobiphenyl	lb/hr	2.2E-06	5.5E-07	5.0E-07	1.1E-06
Trichlorobiphenyl	lb/hr	5.6E-07	2.9E-07	3.5E-07	4.0E-07
Tetrachlorobiphenyl	lb/hr	9.7E-07	6.1E-07	6.0E-07	7.3E-07
Pentachlorobiphenyl	lb/hr	1.3E-06	7.7E-07	8.3E-07	9.6E-07
Hexachlorobiphenyl	lb/hr	3.3E-07	1.9E-07	1.7E-07	2.3E-07
Heptachlorobiphenyl	lb/hr	3.5E-08	1.1E-08	9.2E-09	1.9E-08
Octachlorobiphenyl	lb/hr	7.8E-09	1.2E-09	8.2E-10	3.3E-09
Nonachlorobiphenyl	lb/hr	1.4E-09	<5.4E-11	7.5E-11	5.0E-10
Decachlorobiphenyl	lb/hr	3.2E-10	1.3E-10	1.5E-10	2.0E-10
Total PCBs	lb/hr	5.5E-06	2.5E-06	2.5E-06	3.5E-06
Monochlorobiphenyl	lb/ton of dry sewage sludge	1.7E-08	6.6E-09	5.8E-09	9.7E-09
Dichlorobiphenyl	lb/ton of dry sewage sludge	1.1E-06	2.4E-07	2.0E-07	5.0E-07
Trichlorobiphenyl	lb/ton of dry sewage sludge	2.6E-07	1.3E-07	1.4E-07	1.8E-07
Tetrachlorobiphenyl	lb/ton of dry sewage sludge	4.6E-07	2.6E-07	2.4E-07	3.2E-07
Pentachlorobiphenyl	lb/ton of dry sewage sludge	6.0E-07	3.3E-07	3.2E-07	4.2E-07
Hexachlorobiphenyl	lb/ton of dry sewage sludge	1.5E-07	8.1E-08	6.7E-08	1.0E-07
Heptachlorobiphenyl	lb/ton of dry sewage sludge	1.7E-08	5.1E-09	4.3E-09	8.7E-09
Octachlorobiphenyl	lb/ton of dry sewage sludge	3.7E-09	5.7E-10	3.9E-10	1.5E-09
Nonachlorobiphenyl	lb/ton of dry sewage sludge	6.4E-10	<2.5E-11	3.5E-11	2.3E-10
Decachlorobiphenyl	lb/ton of dry sewage sludge	1.5E-10	6.1E-11	6.8E-11	9.3E-11
Total PCBs	lb/ton of dry sewage sludge	2.6E-06	1.1E-06	9.7E-07	1.5E-06

Figure



TRAVERSE POINT	DISTANCE FROM STACK WALL (INCHES)
1	1.8
2	6.1
3	12.4
4	29.6
5	35.9
6	40.2

	DISTANCE FROM PORTS TO NEAREST UPSTREAM BEND/ DISTURBANCE	DISTANCE FROM PORTS TO NEAREST DOWNSTREAM BEND/DISTURBANCE
EU-FBSSI Exhaust Stack	672" 16 DIAMETERS	216" 5.1 DIAMETERS



SCALE	NOT TO SCALE
DATE	December 21, 2021
PRJ NO.	YPS001-0202012-21000973

EU-FBSSI
Sampling Ports and Traverse Point Locations
Ypsilanti Community Utilities Authority
Ypsilanti, Michigan

APEX

FIGURE 1