NTH Consultants, Ltd.

Infrastructure Engineering
and Environmental Services

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Mr. Hosam Hassanien, PG, CPG
City of Detroit
Environmental Affairs
2 Woodward Avenue – CAYMC, Suite 401
Detroit, MI 48226

July 26, 2021
NTH Project No. 74-200457-05

RE: Ambient Air Quality Monitoring – 2nd Construction Phase Monitoring Report
Proposed Amazon Distribution Center
Detroit, Michigan

Dear Mr. Hassanien:

The City of Detroit (City) recently completed a property transaction for a new Amazon Distribution Center to be constructed on a 137-acre parcel at the former State Fairgrounds property located at 1120 W. State Fair Avenue in Detroit, Michigan. The City contracted NTH Consultants, Ltd. (NTH) to conduct ambient air quality monitoring at the proposed Amazon Distribution Center site (Site).

The monitoring program consists of siting localized monitors at an upwind and downwind locations to measure concentrations of particulate matter (PM_{10} and $PM_{2.5}$), nitrogen oxide (NO_x, as NO_2), and volatile organic compounds (VOCs), and evaluate air quality from the Site during three (3) distinct phases:

- Pre-development baseline period
- Construction phase
- Post-construction facility operation

Pre-Development Baseline Period (Completed)

NTH's Baseline Monitoring Report, dated May 7, 2021, presented ambient concentrations prior to significant construction activities at the Site. The baseline period included monitoring data collected by Montrose Air Quality Services, LLC (MAQS), from January 22, 2021 through March 5, 2021, and was supplemented with monitoring data collected by the Site developer's consultant (Langan) from November 13, 2020 through December 2, 2020. The purpose of the Baseline Monitoring Report was to establish an ambient background concentration for each pollutant and use that concentration as a baseline whereas concentrations measured above these levels during construction would trigger the contractor to employ additional mitigation efforts to reduce pollutant concentrations.

The concentrations in Table 1 were published in the Baseline Monitoring Report and represent pollutant concentrations prior to start of significant construction activities. Each concentration is also compared to the applicable National Ambient Air Quality Standards (NAAQS) protective of public health and the environment.

Table 1 – Site-Specific Baseline Concentrations from Pre-Development Baseline Period

Pollutant	Operator	Monitor [1]	Baseline Concentration	Date of Baseline Concentration	NAAQS	Units
PM_{10}	Langan	ML2	47	11/25/2020	150	$\mu g/m^3$
$PM_{2.5}$	Langan	ML2	22	11/25/2020	35	$\mu g/m^3$
NO_2	MAQS	Unit 1480	52	1/30/2021	100	ppb
VOC	Langan	ML1	0.11	11/14/2020	NA[2]	ppm

[1] Baseline Monitoring included two (2) Site monitors operated by MAQS for NTH from January 22 through March 5, 2021 and identified as Unit 1479 (upwind location) and Unit 1480 (downwind location), as well as monitoring data provided by Hillwood Development Company (HDC), the project developers, for the period November 13, 2020 through December 2, 2020 from five (5) monitoring locations at the project Site and identified as ML1, ML2, ML3, ML4 and ML5.

[2] NAAQS have not been established for VOC. VOCs are considered precursors to the formation of ozone. Ozone is formed downwind by photochemical reaction of NO_x and VOCs in certain ambient conditions (typically hot, sunny weather)

Construction Phase Monitoring

The enclosed report presents the results of the 2nd construction phase monitoring event that was conducted for the one (1)-week period of June 20 through 27, 2021. The goal of construction phase monitoring is to collect concentration data of target air pollutants during construction activities consisting of paving, concrete work, steel construction, interior buildout, electrical work, and plumbing to assess whether additional mitigation efforts are warranted to reduce pollutant concentrations to below baseline levels.

The enclosed 2nd Construction Phase Monitoring Report describes the monitoring program, objectives, Site overview, monitor locations and equipment, monitoring results, and an overview of data quality assurance.

The report includes monitoring data from two (2) available sources, including:

- Two (2) Site monitors operated by MAQS for NTH during the monitoring period (June 20 through 27, 2021) and identified as Unit 1479 (upwind location) and Unit 1480 (downwind location).

- Nearby off-site monitors operated by Michigan Department of Environment, Great Lakes, and Energy (EGLE) during the MAQS monitoring period.

As part of this air monitoring program, MAQS collected one (1) week of air monitoring data for NO_x (as NO_2), PM_{10} and $PM_{2.5}$, and VOCs at two (2) monitors, along with prevailing wind directions and speeds (vectors).

The City anticipates that development of the proposed Amazon Distribution Center may result in direct and fugitive air emissions from construction activities, as well as future operations. Sources of NO_x and VOC emissions related to construction may include vehicular traffic and diesel engines (over-the-road and non-road heavy duty construction). Potential emissions of PM_{10} and $PM_{2.5}$ related to construction may include fugitive dust associated with vehicular traffic, soil handling, material storage piles, concrete batching, and abrasives blasting.

The monitors, designated as Unit 1479 and Unit 1480, were located on opposite sides of the Site and both stations collected meteorological data. The upwind monitor (Unit 1479) measures pollutant concentrations that have not blown across the Site and should be free from potential impacts of on-site development activity and is representative of local area background concentrations.

Results of Construction Phase Monitoring

As presented below and in the enclosed report, for monitoring conducted June 20 through 27, 2021, concentrations of PM_{10}, $PM_{2.5}$, NO_x (as NO_2) and VOC are less than their baseline concentrations, as summarized in Table 2. NO_x (as NO_2) concentrations are less than the 1-hour NAAQS of 100 ppb for NO_2.[1] Monitored concentrations of PM_{10}, $PM_{2.5}$ are also less than the 24-hour NAAQS of 150 µg/m^3 for PM_{10}, 35 µg/m^3 for $PM_{2.5}$.

Table 2 – Summary of Air Monitoring from June 20 through 27, 2021

Pollutant	Maximum Concentration	Monitor	Date of Maximum Concentration	Baseline Concentration	NAAQS	Units
PM_{10}	7.1	Unit 1480	6/25/2021	47	150	µg/m^3
$PM_{2.5}$	6.1	Unit 1480	6/1/2021	22	35	µg/m^3
NO_2	29.0	Unit 1480	6/23/2021	52	100	ppb
VOC	0.03	Unit 1479	6/25/2021	0.11	NA[1]	ppm

In summary, the data collected during this air monitoring event are not indicative of a threat to public health or unusual concentrations of the analyzed parameters.

We appreciate this opportunity to be of service to you. If you have questions or need additional information, please contact us at 248-662-2740.

Sincerely,

NTH Consultants, Ltd.

DocuSigned by:
Christopher O. Occhipinti
F72D85E12731430...
Christopher O. Occhipinti
Project Professional

DocuSigned by:
Bhushan C. Modi
9A8ED1C814C943E...
Bhushan C. Modi
Project Manager

COO/BCM/clm

Attachments

[1] NAAQS have not been established for VOC. VOCs are considered precursors to the formation of ozone. Ozone is formed downwind by photochemical reaction of NO_x and VOCs in certain ambient conditions (typically hot, sunny weather).

2nd CONSTRUCTION PHASE MONITORING REPORT
PROPOSED AMAZON DISTRIBUTION CENTER
(FORMER MICHIGAN STATE FAIRGROUNDS)
CITY OF DETROIT
DETROIT, MICHIGAN

Prepared For:
NTH Consultants, Ltd.
2990 W. Grand Blvd., Suite M-10
Detroit, MI 48202

Prepared By:
Montrose Air Quality Services, LLC
45 U.S. 46, Suite 601
Pine Brook, NJ 07058

Document Number:	**011AA-5509-RT-24**
NTH Project Number:	**74-200457-03**
Monitoring Period:	**June 20, 2021 through June 27, 2021**
Submittal Date:	**July 21, 2021**

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Project Overview

Background

NTH Consultants, Ltd. (NTH) contracted Montrose Air Quality Services, LLC (Montrose) to conduct an ambient air monitoring program on behalf of the City of Detroit at the proposed Amazon Distribution Center located at the former Michigan State Fairgrounds in Detroit, Michigan. The program is conducted to monitor for a mixture of pollutants that may originate from construction activities as well as future Site operations including vehicular traffic, surface attrition, and dust emissions.

The Baseline Monitoring Report presented ambient concentrations prior to significant Site construction activities. The baseline period included monitoring data collected by Montrose for the period January 22, 2021 through March 5, 2021 and was supplemented with monitoring data collected by the Site developer during the period November 13, 2020 through December 2, 2020. The purpose of the Baseline Monitoring report was to establish an ambient background concentration for each pollutant and use that concentration as a baseline whereas concentrations measured above these levels during construction would trigger the contractor to employ additional mitigation efforts to reduce pollutant concentrations to below baseline.

The 1st Construction Phase Report, dated June 8, 2021 presented monitoring data collected April 14 through April 21, 2021.

This 2nd Construction Phase Monitoring Report includes data from monitors operated by Montrose and Michigan Department of Environment, Great Lakes, and Energy (EGLE) during the monitoring period commencing on June 20 and concluding on June 27, 2021.

Objectives

The specific objectives are to measure ambient concentrations of the following parameters at two (2) monitoring locations:

- Particulate Matter (PM_{10}) of diameter equal to or less than 10 microns
- Particulate Matter ($PM_{2.5}$) of diameter equal to or less than 2.5 microns
- Nitrogen Dioxide (NO_2)
- Volatile Organic Compounds (VOC)
- Meteorological parameters (i.e., wind speed, wind direction, temperature, relative humidity, and barometric pressure)

Potential Sources

Sources of NO_2 and VOC emissions related to construction include vehicular traffic and diesel engines (over-the-road and non-road, heavy-duty construction). Potential emissions of PM_{10} and $PM_{2.5}$ related to construction may include the sources identified above for NO_x and VOC emissions and also fugitive dust associated with vehicular traffic, soil handling, material storage piles, concrete batching, and abrasives blasting.

Operational Staff and Contacts

Facility Information

Monitoring Location: Proposed Amazon Distribution Facility
Former Michigan State Fairgrounds
1120 W. State Fair Avenue
Detroit, MI 48203

Monitoring Program Coordinator

NTH Consultants, Ltd.
2990 W. Grand Blvd., Suite M-10
Detroit, MI 48202

Project Contacts: Mr. Bhushan Modi
Role: Project Manager
Company: NTH Consultants, Ltd.
Telephone: 248-662-2740
Email: bmodi@nthconsultants.com

Monitoring Team Contact Information

Testing Firm: Montrose Air Quality Services, LLC (Montrose)

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Email: dcummings@montrose-env.com

Contact: Kevin Ruggiero
Title: Project Manager
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Contact: Jeffrey Peitzsch
Title: Shop Coordinator
Telephone: 313-213-4816
Email: jbpeitzsch@montrose-env.com

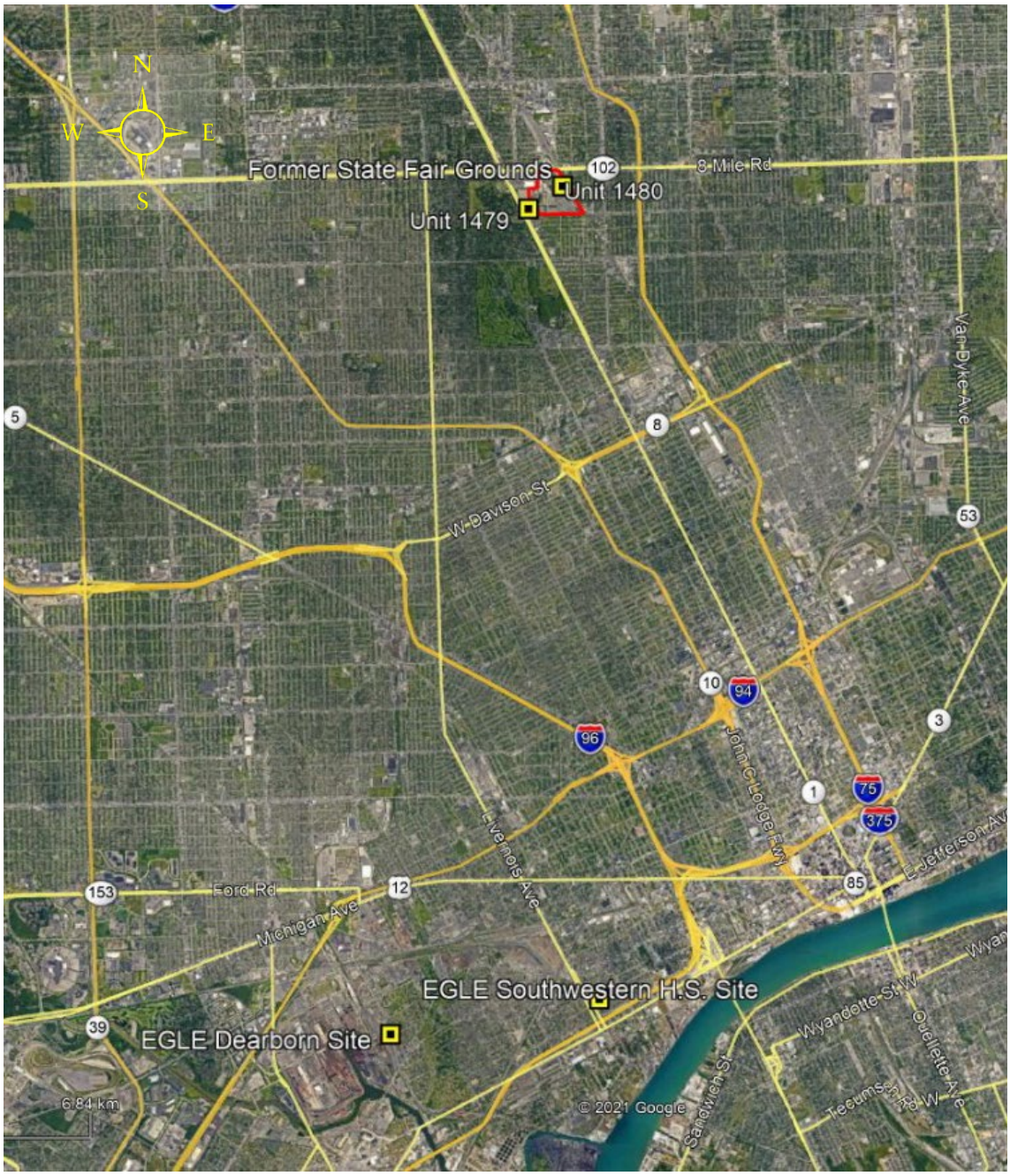
Site Overview

The Site air quality monitoring was performed at the proposed Amazon Distribution Center (former Michigan State Fairgrounds) property located at 1120 W State Fair Avenue in Detroit, MI. This area was purchased by Hillwood Development Company, LLC (Hillwood) who will be demolishing the existing structures onsite and building a large warehouse that will be occupied by an Amazon distribution center. The two (2) Site monitor locations are identified in Figure 1-A below.

Figure 1-A – Monitor Locations at the Proposed Amazon Distribution Center (Former Michigan State Fairgrounds) Property

Figure 1-B is an aerial view of the two monitoring Site locations at the proposed Amazon Distribution Center (former Michigan State Fairgrounds) property and two nearby air monitoring stations maintained by the Michigan Department of Environment, Great Lakes, and Energy (EGLE). Monitoring data available from the two nearby EGLE monitoring stations are intercompared in this report with corresponding monitoring data reported from the monitors operated at the former Michigan State Fairgrounds property.

Figure 1-B – Monitor Locations at the Proposed Amazon Distribution Center (Former Michigan State Fairgrounds) Property and Nearby MI EGLE Monitoring Stations



Monitoring Equipment

The air monitoring at the proposed Amazon Distribution Center (former Michigan State Fairgrounds) was performed using an AQS1 Urban Air Quality Monitor manufactured by Aeroqual. In the device, sampling occurs actively by pulling in ambient air via a pump and the air sample passing over the surface of each sensor. Each device used in this project is powered by deep-cycle batteries charged by solar photovoltaic panels and transmits data via cellular signal. Monitoring was conducted for the constituents listed in Table 1.

Table 1 - Pollutants Monitored

Air Pollutant/Parameter Category	Principle of Operation
PM_{10} and $PM_{2.5}$	Laser Scattering
NO_2	Electrochemical
VOC	Photoionization
Wind Speed, Wind Direction, Temperature, Relative Humidity, Barometric Pressure	Sonic Anemometer and Various

The sampled particles are measured by the physical principle of light scattering. Each single particle is illuminated by a defined laser light and each scattering signal is detected at an angle of 90° by a photo diode. In accordance with the Mie theory, each measured pulse height is directly proportional to the particle size, where each pulse is classified in an electronic register of 32 different size channels.

Electrochemical sensors measure the concentration of a specific gas within an external circuit via oxidation or reduction reactions. These reactions generate the positive or negative current flow through the external circuit. An electrochemical sensor is made up of a working counter and reference electrode. All of these components are situated inside of a sensor housing along with a liquid electrolyte that is specific to the compound of interest.

A Photoionization Detector (PID) sensor contains a lamp that produces photons that carry enough energy to break molecules into ions. The PID will only respond to molecules that have an ionization energy at or below the energy of the lamp; the PID used on this project employs a 10.6 electron-volt lamp. The produced ions then generate an electrical current that is measured as the output of the detector.

All operation and maintenance procedures contained in the monitoring plan dated January 10, 2021 were followed for the continuous monitoring equipment.

Discussion of Results

The results of PM_{10}, $PM_{2.5}$, NO_2, and VOC monitoring data are presented in Figures 3 through 6 in this report. These figures also include data for the same time period from nearby air monitoring stations maintained by the Michigan Department of Environment, Great Lakes, and Energy (EGLE). The EGLE data contained in this report are from monitors that are routinely subjected to calibration and maintenance. It should be noted that, as of the date of this report, the EGLE data have not yet been processed through EGLE final quality assurance procedures. The monitor locations for EGLE Sites can be found on the map provided in Appendix C (*State Monitor Map*).

The Clean Air Act requires EPA to establish National Ambient Air Quality Standards (NAAQS) for certain air pollutants considered harmful to public health and the environment. Air pollutants for which NAAQS are established include NO_2, $PM_{2.5}$ and PM_{10}. NAAQS have not been established for VOCs. VOCs are considered precursors to the formation of ozone. Ozone is formed downwind by photochemical reaction of NO_x and VOCs in certain ambient conditions.

The graphed data shown in Figures 3 through 5 present measured concentrations for these pollutants collected during the monitoring period relative to the Baseline concentration and NAAQS Standard. On June 25, 2021 during hour 2, transient signal interference occurred in monitor S/N 1480. This momentary interference resulted in elevated, non-representative readings for $PM_{2.5}$ and PM_{10}. Data validation review confirmed the transient interference affected only 2 minutes (02:50 and 02:51) of PM measurements. Accordingly, the affected two minutes of unrepresentative data were invalidated and removed from the database. The remaining 58 minutes of valid PM measurement data recorded during hour 2 from monitor S/N 1480 on June 25 were averaged to produce valid hourly averages for $PM_{2.5}$ and PM_{10}.

The NAAQS for NO_2, $PM_{2.5}$, and PM_{10} were not exceeded during these monitoring periods.

Electronic records of all data and calibrations have been uploaded to the Montrose Data Server, where they will be archived for a period of at least three (3) years.

Meteorological Data Collected

Figures 2-A and 2-B present wind roses derived from the meteorological data collected from each of the two monitors operated at the former State Fairgrounds over the course of the monitoring period of 6/20/21 to 6/27/21. The wind rose presented in Figure 2-A is derived from wind speed and wind direction data collected from monitor 1479. The wind rose presented in Figure 2-B is derived from wind speed and wind direction data collected from monitor 1480.

Figure 2-A – Wind Rose From 1479 Monitor

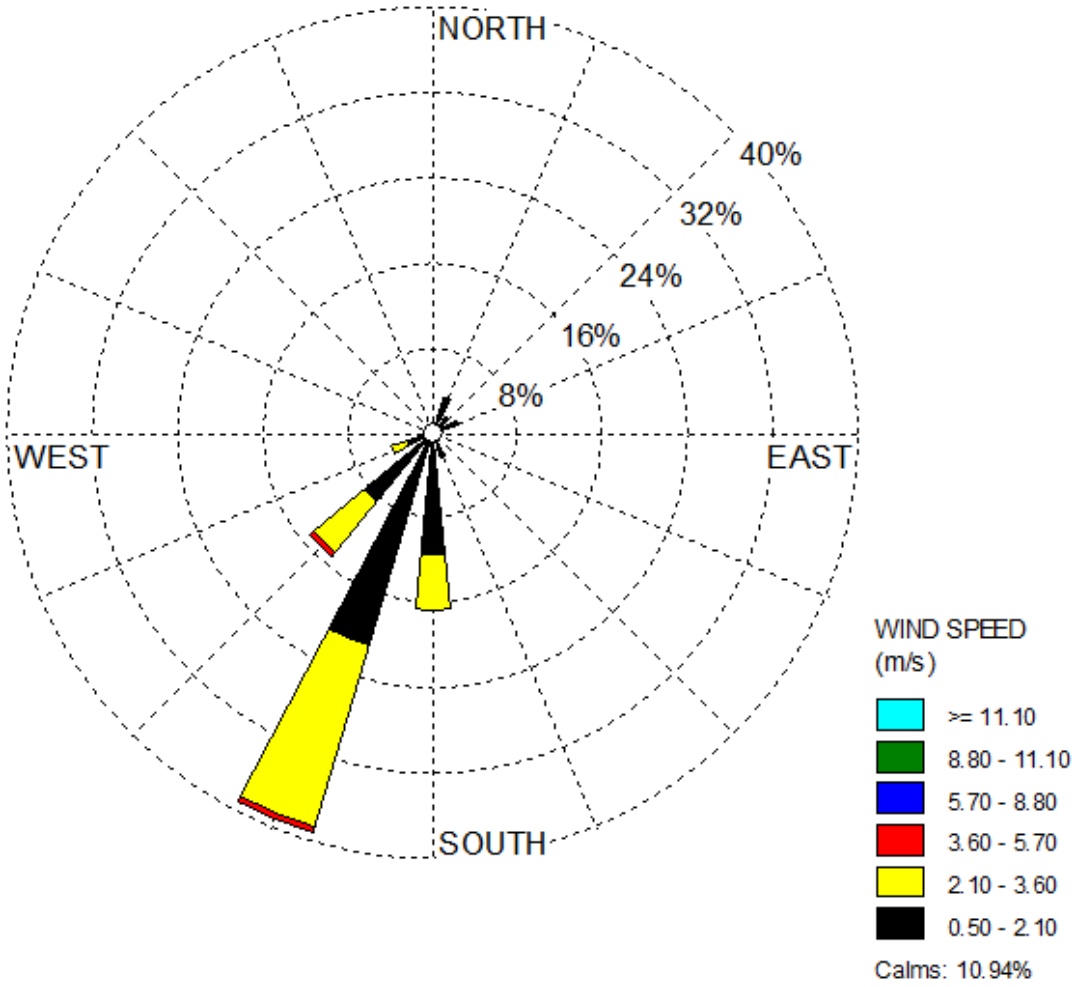
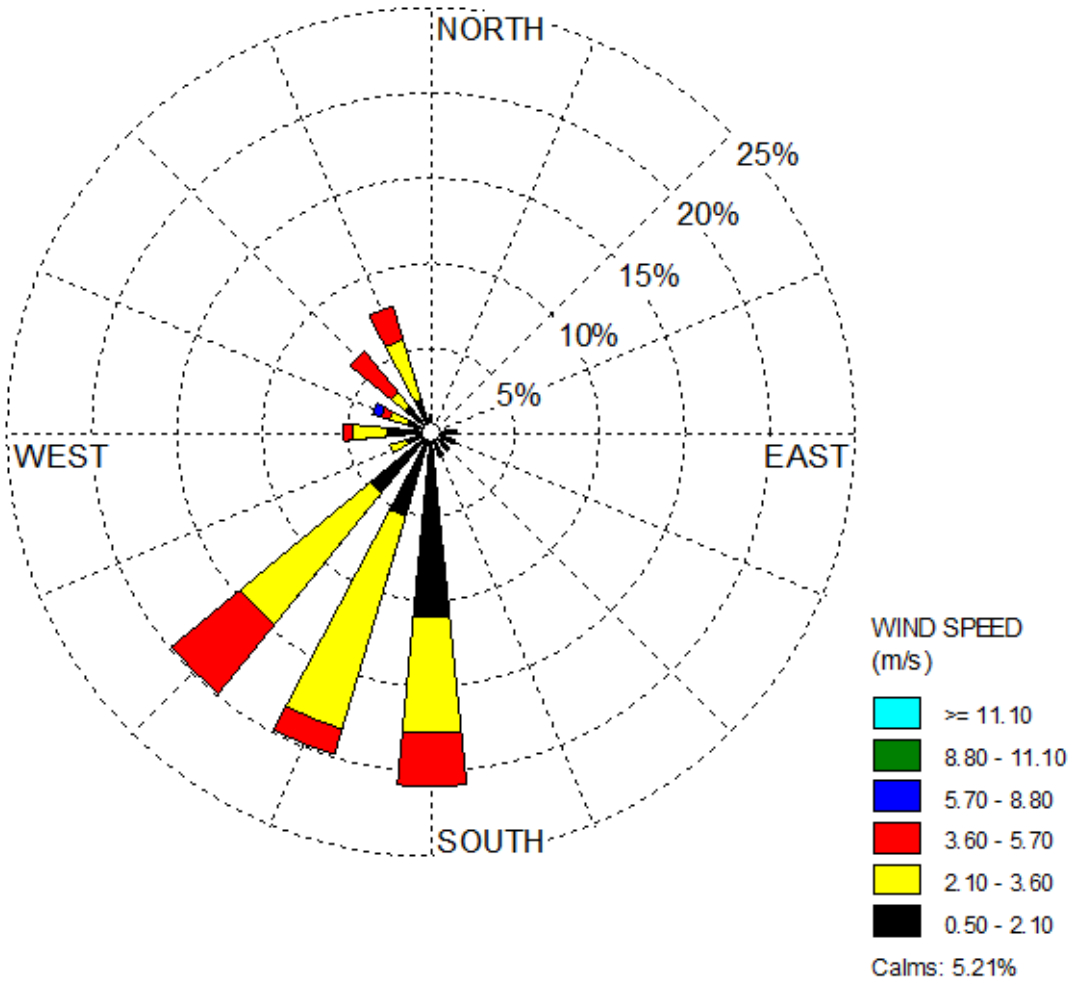


Figure 2-B – Wind Rose From 1480 Monitor



As is evident from the wind rose data, predominant winds were from the south and southwest during the monitoring period. Wind speeds recorded at monitor 1479 were generally very light; wind speeds recorded by monitor 1480 were generally light to moderate.

Pollutant Data Collected

Figure 3 – PM_{10} Data

The graph below represents the ambient PM_{10} measurement data collected at the former Michigan State Fairgrounds property during the monitoring period of 6/20/21 to 6/27/21. This graph is a plot of the PM_{10} measurement data as averaged over each daily monitoring period. The daily averaging interval for PM_{10} data is consistent with the associated EPA primary and secondary PM_{10} NAAQS; a 24-hour (daily) averaged value of 150 micrograms per cubic meter ($\mu g/m^3$) not to be exceeded more than once per year on average over 3 years.

The solid yellow line represents the 24-hour PM_{10} NAAQS of 150 $\mu g/m^3$. The solid red line represents the baseline concentration established in the 1st Baseline Report. The PM_{10} monitor at the EGLE Dearborn Site is the closest state-operated PM_{10} monitor relative to the former Michigan State Fairgrounds property. Therefore, the graph below presents the 24-hour averaged data from the EGLE Dearborn continuous PM_{10} monitor for comparison to corresponding PM_{10} measurement data reported from the on-site monitors. The EGLE Dearborn monitoring site experienced a power outage beginning June 25 which lasted several days. A sufficient number of hourly measurements were available from the Dearborn PM_{10} monitor to formulate and report a valid daily PM_{10} measurement value for 6/25/21, however, EGLE Dearborn PM_{10} data are unavailable for 6/26/21 and 6/27/21 and there are no other nearby daily EGLE PM_{10} monitors to supplement the missing data.

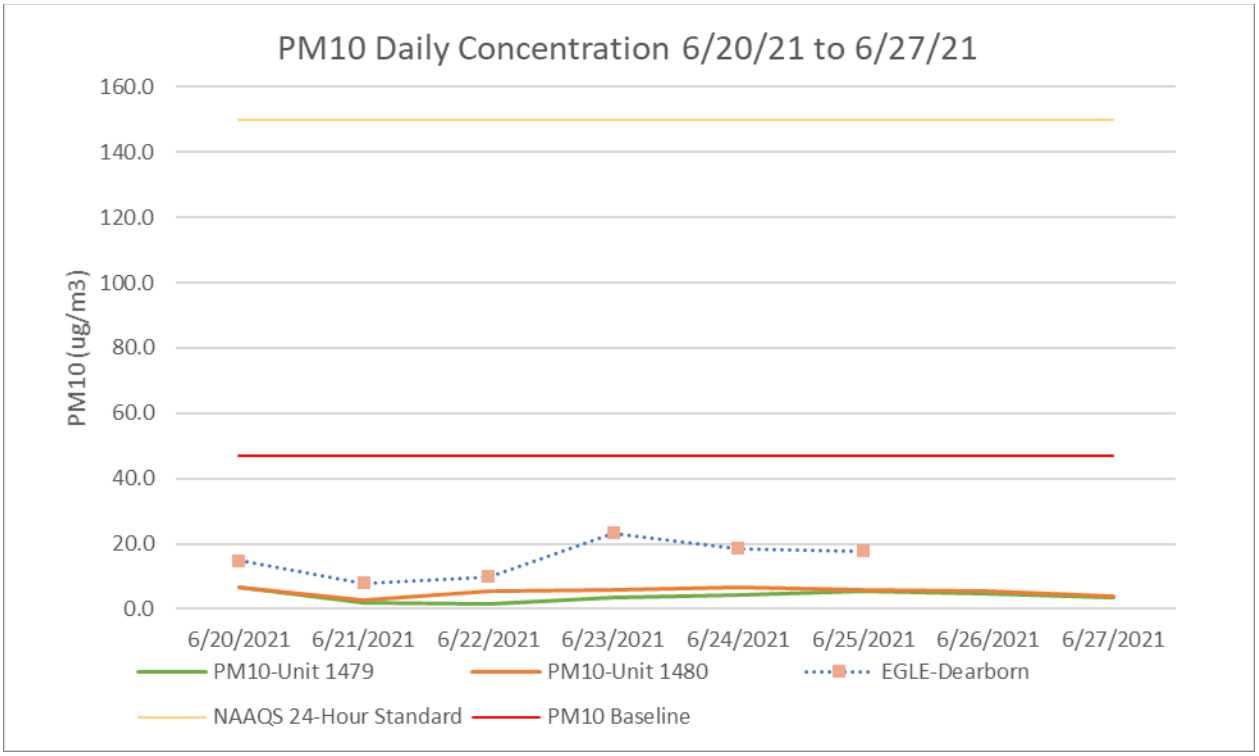


Figure 4 – $PM_{2.5}$ Data

The graph below represents the ambient $PM_{2.5}$ measurement data collected at the former Michigan State Fairgrounds property during the monitoring period of 6/20/21 to 6/27/21. This graph is a plot of the $PM_{2.5}$ measurement data as averaged over each daily monitoring period. The daily averaging interval for $PM_{2.5}$ data is consistent with the associated EPA primary and secondary $PM_{2.5}$ NAAQS: A 24-hour (daily) averaged value of 35 micrograms per cubic meter ($\mu g/m^3$) not to be exceeded more than once per year on average over 3 years.

The solid yellow line represents the 24-hour $PM_{2.5}$ NAAQS of 35 $\mu g/m^3$. The solid red line represents the baseline concentration established in the 1st Baseline Report. The EGLE Oak Park monitoring Site is the nearest state-operated $PM_{2.5}$ monitor relative to the former Michigan State Fairgrounds property. The EGLE Oak Park $PM_{2.5}$ monitor is a 24-hour, filter-based sampler that collects a sample at 3-day intervals. Filter-based PM samples require gravimetric analysis at a laboratory; EGLE estimates that analytical results for the Oak Park $PM_{2.5}$ filters are delayed on average by approximately three months. Therefore, the graph below presents the 24-hour averaged data from the EGLE Dearborn continuous $PM_{2.5}$ monitor for comparison to corresponding $PM_{2.5}$ measurement data reported from the on-site monitors. The EGLE Dearborn monitoring site experienced a power outage beginning June 25 and lasted until June 27. The blue dashed line represents $PM_{2.5}$ data from the nearby EGLE SWHS site to supplement the missing Dearborn data during the monitoring period.

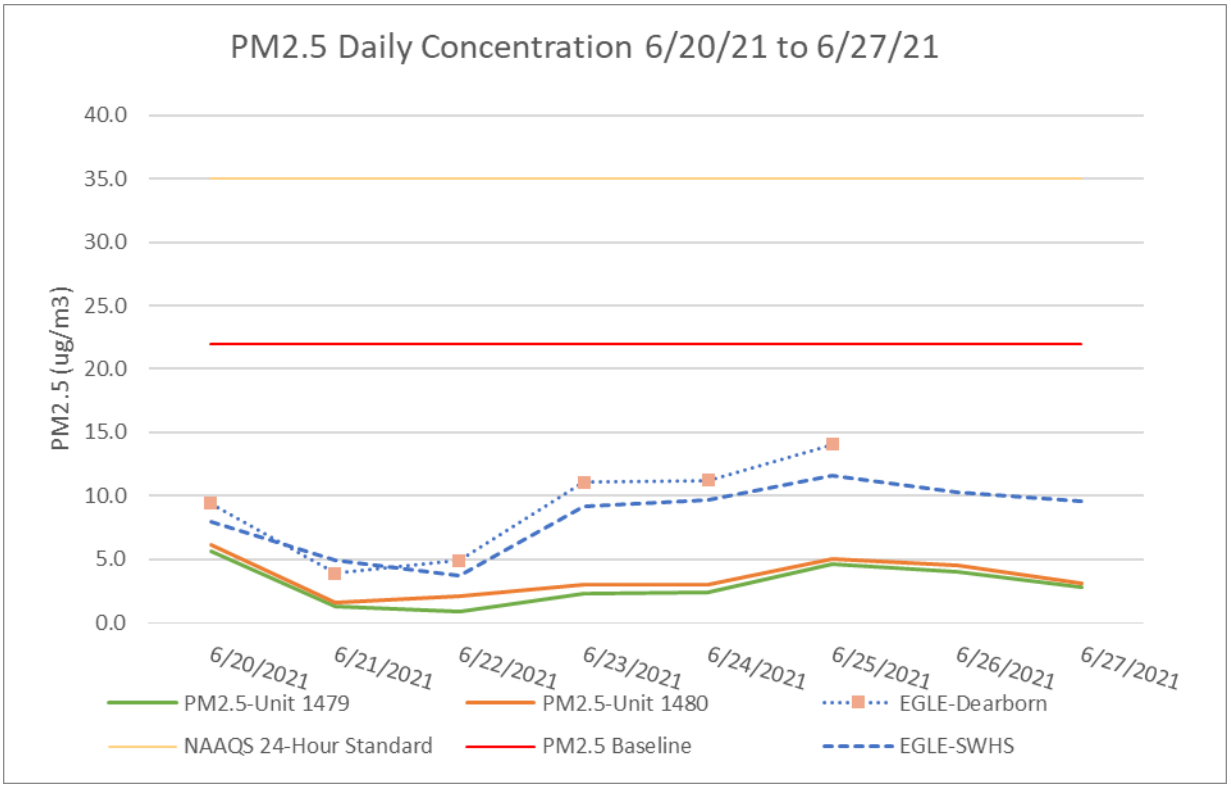


Figure 5 – NO_2 Data

The graph below represents the ambient NO_2 measurement data collected at the former Michigan State Fairgrounds property during the monitoring period of 6/20/21 to 6/27/21. This graph is a plot of the NO_2 measurement data as averaged over a period of one (1) hour. This is consistent with the associated EPA primary NO_2 NAAQS: A 1-hour averaged value of 100 parts-per-billion (ppb) not to be exceeded more than once per year on average over 3 years.

The solid yellow line represents the 1-hour NO_2 NAAQS of 100 ppb. The solid red line represents the baseline concentration established in the 1st Baseline Report. The NO_2 monitor at the EGLE Southwestern High School (SWHS) Site is the closest state-operated NO_2 monitor relative to the former Michigan State Fairgrounds property. Therefore, the graph below presents the 1-hour averaged data from the EGLE SWHS continuous NO_2 monitor for comparison to corresponding NO_2 measurement data reported from the on-site monitors.

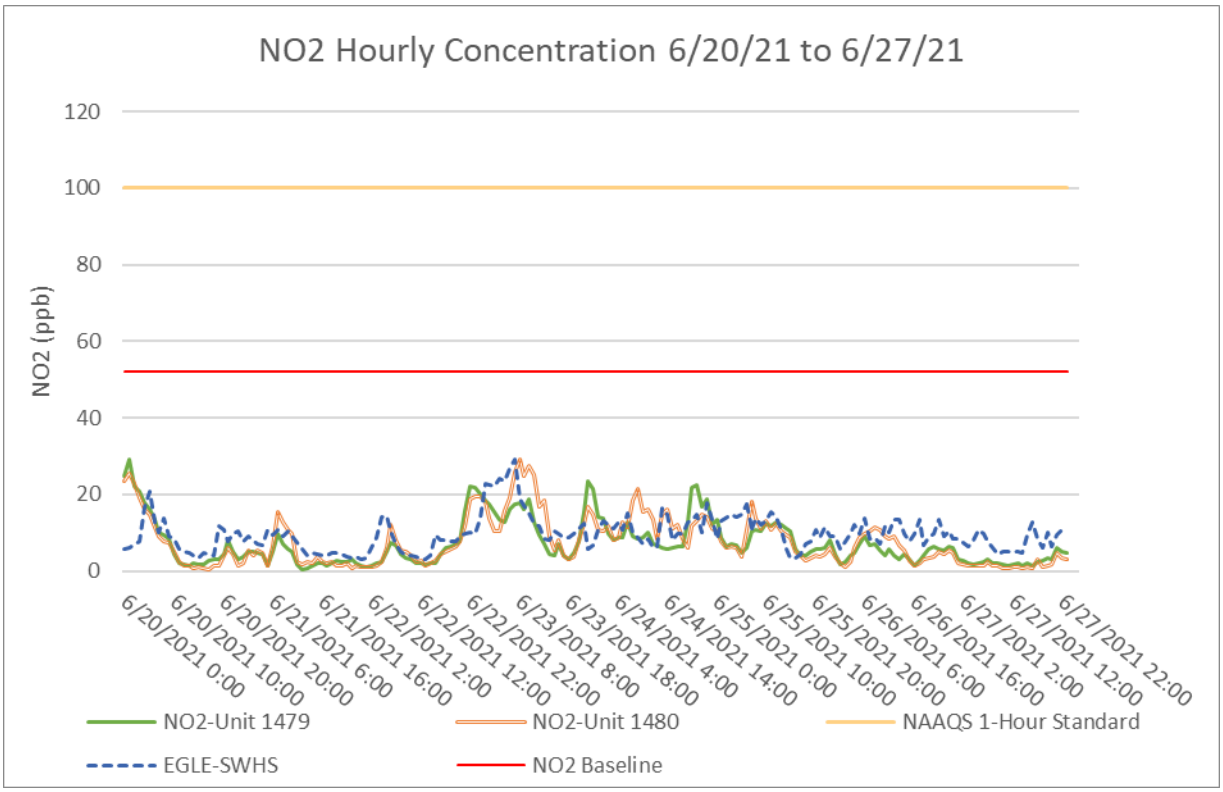
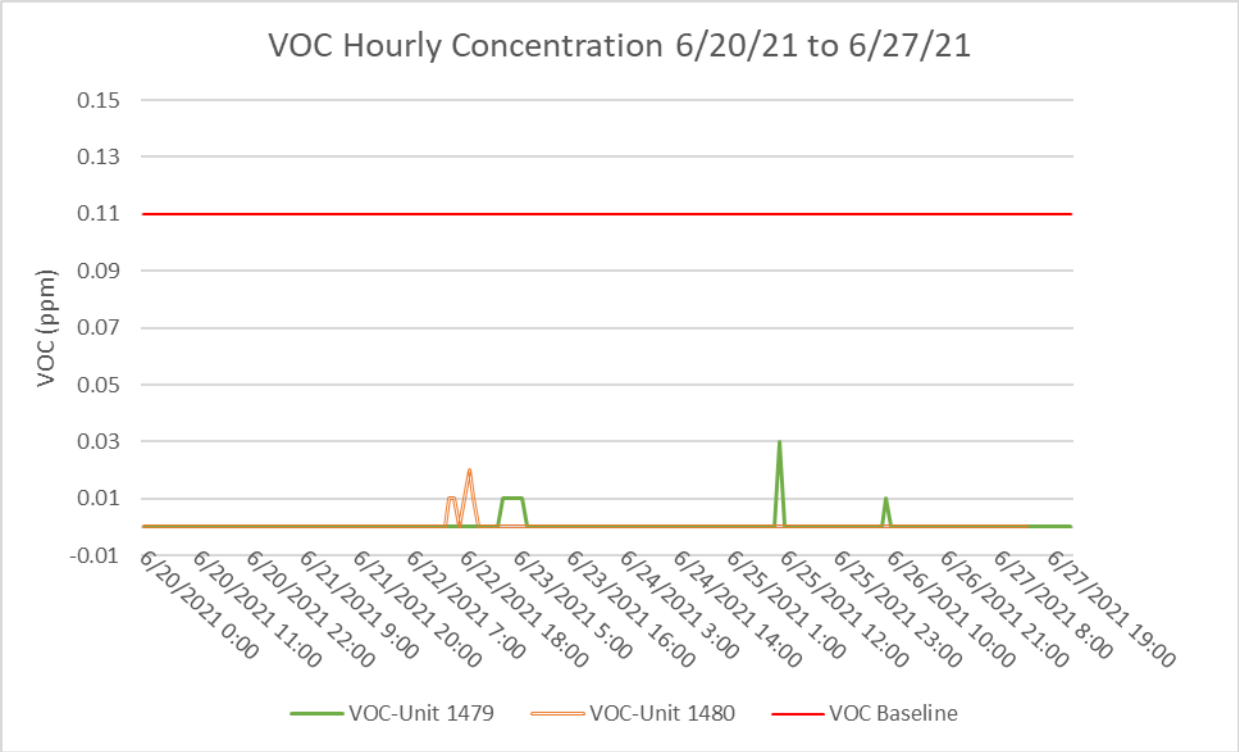


Figure 6 – VOC Data

The graph below presents the ambient VOC measurement data collected at the former Michigan State Fairgrounds property during the monitoring period of 6/20/21 to 6/27/21. This graph is a plot of the VOC measurement data as averaged over a period of one (1) hour. The solid red line represents the baseline concentration established in the 1st Baseline Report. The EPA has not established a NAAQS for VOC. VOC data are not available from nearby EGLE monitoring Sites.



Data Quality Assurance/Quality Control

Quality Assurance/Quality Control

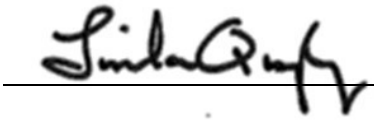
Quality assurance is a general term for the procedures used to ensure that a particular measurement meets the quality requirements for its intended use. Quality control of continuous analyzers consists of precision and span checks or flow verifications. Quality objectives were assessed via Site system audits.

All work performed by Montrose in support of this project follows the operating procedures described in the "Former Michigan State Fairgrounds Work Plan" dated 1/10/21.

All quality control data for the on-site monitors operated at the former Michigan State Fairgrounds property can be found in Appendix A to this report entitled *"Quality Assurance Logs"*. Certificates of traceability for the calibration standards and equipment used in support of quality assurance checks are presented in Appendix B to this report entitled *"Calibration Certification Sheets"*.

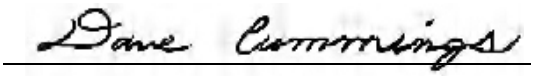
Signature Page

Prepared by:



Linda Quigley
Data Manager
Montrose Air Quality Services LLC

Reviewed by:



David Cummings
District Manager
Montrose Air Quality Services LLC

Appendix

A: Quality Assurance Logs

AEROQUAL AQS-1 VOC HIGH RANGE MODULE VERIFICATION/CALIBRATION FORM

Network:	City of Detroit	Site:	MTMS Lab	Date:	6/16/21
Time Off-Line:	09:00 EDT	Time On-Line:	10:20 EDT	Technician:	Dennis Weyburne

Calibration Equipment Info.	Analyzer Model:	Aeroqual AQS-1	S/N:	1479	Last Cal:	4/22/21
	Calibrator Model No:	Teledyne API	S/N:	69	Cal. Date:	12/29/20
	Zero Air Model No:	Teledyne API	S/N:	n/a	Cert Date:	n/a
	Gas Supplier:	GASCO #1-4	Cyl. Conc. (PPM):	0.99	Cyl. Pressure (PSIG)	550
	Gas Supplier:	GASCO #3-3	Cyl. Conc. (PPM):	3.10	Cyl. Pressure (PSIG)	150

VOC Sensor Module Calibration Settings	"As Found" (Before Any Adjustment)	"As Left" (After Adjustment)
OFFSET	0.00	0.00
GAIN	1.422	1.046

"AS FOUND" (UNADJUSTED) TEST DATA

Calibrator Flow and Test Gas Data					Observed VOC Response from AQS-1		Error (Δ%)
Calibrator Gas Channel		Calibrator Air Channel		Known VOC Input Gas Conc. (PPM)			
Display Setting (SLPM)	Actual Flow Rate (SLPM)	Display Setting (SLPM)	Actual Flow Rate (SLPM)		Response (PPM)	Std. Dev. (PPM)	

"AS LEFT" (ADJUSTED) TEST DATA

Calibrator Flow and Test Gas Data					Observed VOC Response from AQS-1		Error (Δ%)
Calibrator Gas Channel		Calibrator Air Channel		Known VOC Input Gas Conc. (PPM)			
Display Setting (SLPM)	Actual Flow Rate (SLPM)	Display Setting (SLPM)	Actual Flow Rate (SLPM)		Response (PPM)	Std. Dev. (PPM)	
OFF	OFF	5.0000	5.0130	0.00	-0.01	0.00	-
n/a	n/a	1.0000	n/a	0.99	1.01	0.00	2.0%
n/a	n/a	1.0000	n/a	3.10	3.13	0.01	1.0%

NOTES:

1. The VOC sensor zero response should be 0.0 ppm ± 0.2 ppm with a Std. Dev. < 0.2 ppm. If the sensor response error is greater than ± 0.2 ppm then an offset adjustment is required. If the Std. Dev. is greater than 0.2 ppm then the sensor is outside acceptable range and may need relacement.
2. The adjusted zero response NEW offset should be -1 < OFFSET < 1 and the sensor response 0.0 ppm ± 0.2 ppm.
3. The VOC sensor SPAN response should be ± 1 ppm (5% span of 20 ppm) with a Std. Dev. < 0.4 ppm (2% span of 20 ppm). If the sensor response error is greater than ± 1 ppm then a GAIN adjustment is required. If the Std. Dev. is greater than 0.4 ppm then the sensor is outside acceptable range and may need relacement.
4. The adjusted span response NEW gain should be 0.2 < GAIN < 5.0 and the sensor response 0.0 ppm ± 1 ppm.

Comments:

Adjusted to 1 ppm and ran calibration prior to field deployment.

Technician: *Dennis Weyburne*

QA Review:

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 NO2 MODULE MULTI-POINT CALIBRATION FORM

Calibration Data on This Form Are For:			Unadjusted Cal.		Adjusted Cal.	X
Network:	City of Detroit	Site:	MTMS Lab	Date:	6/16/21	
Time Off-Line:	10:08 EDT	Time On-Line:	10:53 EDT	Technician:	Kevin Ruggiero	

Calibration Equipment Info.	Analyzer Model:	Aeroqual AQS-1	S/N:	1479	Last Cal:	4/22/21
	Calibrator Model No.:	Teledyne API	S/N:	69	Cal. Date:	12/29/20
	Zero Air Model No.:	Teledyne API	S/N:	n/a	Cert Date:	n/a
	Gas Supplier:	Airgas	Cyl. Cert. Date:	1/26/21	Cyl. Pressure (PSIG)	2,000
	Gas Cylinder ID #:	D068357	Cyl. Conc. (PPM):	30.95	Gas Module Total Flow Rate	137 mL

Analyzer Calibration Settings	"As Found" (Before Any Adjustment)	"As Left" (After Adjustment)
OFFSET	0.5	0.1
GAIN	1.199	1.245

Calibrator Flow and Test Gas Data					NO_2 Response *Observed from AQS-1*		Δ% (Observed Response Vs. Known Conc.) 3	PASS/FAIL
Calibrator Gas Channel		**Calibrator Air Channel**						
Display Setting (SLPM)	**Actual Flow Rate** (SLPM)	Display Setting (SLPM)	**Actual Flow Rate** (SLPM)	**Known NO_2 Gas Conc. (PPB)**	Response (PPB)	Std. Dev. (PPB)		
0.0497	0.0498	3.8003	3.8206	398.2	404.1	1.1	1.5%	
0.0145	0.0146	4.4855	4.5085	99.9	96.7	1.0	-3.2%	
0.0081	0.0082	4.9919	5.0139	50.5	45.1	0.6	-10.7%	
0.0048	0.0050	4.9952	5.0163	30.8	27.0	0.3	-12.3%	
OFF	OFF	5.0000	5.0150	0.0	-1.5	0.7		
Linear Regression Analysis:								
Slope:	1.024471	Intercept:	-4.435656	Corr. Coefficient (r):	0.999931			

NOTES:

1. The NO2 sensor zero response should be 0.0 ppb ± 0.2 ppb with a Std. Dev. < 0.2 ppb. If the sensor response error is greater than ± 0.2 ppb then an offset adjustment is required. If the Std. Dev. is greater than 0.2 ppb then the sensor is outside acceptable range and may need relacement.
2. The adjusted zero response NEW offset should be -1 < OFFSET < 1 and the sensor response 0.0 ppb ± 0.2 ppb.
3. The NO2 sensor SPAN response should be 400 ppb ± 20 ppb (5% span of 400 ppb) with a Std. Dev. < 8 ppb (2% span of 400 ppb). If the sensor response error is greater than ±20 ppb then a GAIN adjustment is required. If the Std. Dev. is greater than 8.0 ppb then the sensor is outside acceptable range and may need relacement.
4. The adjusted span response NEW gain should be 0.2 < GAIN < 5.0 and the sensor response 400 ppb ± 20 ppb.

Comments:

Adjusted and calibrated NO2 module prior to field deployment.

Technician: *Dennis Weyburne*

QA Review: Kenneth Stein

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 FLOW and LEAK CHECK FORM

QC Checks are: X Scheduled _____ Unscheduled (If unscheduled, explain reason why in "Comments" Section)

Network:	City of Detroit (Amazon)	**Site:**	Fairgrounds	**Date of Checks:**	6/17/2021
Operator:	Rob Bienenstein			**Time Off-Line:**	12:03 EDT
AEROQUAL QS-1 S/N	1479			**Time On-Line:**	12:15 EDT

Reference Standards:

Flow Standard:	Aeroqual 0-5 LPM Rotometer	**S/N#**	n/a	**Cert Date:**	n/a

AS FOUND CHECK DATA

Checks are "as found" checks. Adjust profiler flow or resolve leak and complete "as left" section below if any acceptability limits are exceeded or if any adjustments to the monitor are to be made.

FLOW CHECK DATA:

AQS-1 Expected Flow Rate (A)	Reference Flow Rate (B)	Profiler Flow Rate Error LPM (A-B)	Profiler Flow Rate Error Δ% (A-B) ÷ A x 100
1.0 LPM	1.0 LPM	0.00	0.0%

Flow Check Procedure Link

Acceptability Limits: The expected AQS-1 Particle Profiler Flow Rate is 1.0 LPM ± 0.05 LPM (between 0.95 LPM and 1.05 LPM) or ≤±5%.

LEAK CHECK DATA:

PROFILER LEAKAGE RATE:	>30 seconds	(Must be >10 sec for 10 kPa pressure change)

Leak Check Procedure Link

AS LEFT CHECK DATA

FLOW CHECK DATA:

AQS-1 Expected Flow Rate (A)	Reference Flow Rate (B)	Profiler Flow Rate Error LPM	Profiler Flow Rate Error Δ%
LPM	LPM		

LEAK CHECK DATA:

PROFILER LEAKAGE RATE:	seconds	(Must be > 10 sec for 10 kPa pressure change)

Comments:

Technician: *Rob Bienenstein*

QA Review: Kenneth Rogers

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 VOC HIGH RANGE MODULE VERIFICATION/CALIBRATION FORM

Network:	City of Detroit	Site:	MTMS Lab	Date:	7/12/21
Time Off-Line:	13:05 EDT	Time On-Line:	13:58 EDT	Technician:	Dennis Weyburne

Calibration Equipment Info.	Analyzer Model:	Aeroqual AQS-1	S/N:	1479	Last Cal:	6/16/21
	Calibrator Model No:	Teledyne API	S/N:	69	Cal. Date:	12/29/20
	Zero Air Model No:	Teledyne API	S/N:	n/a	Cert Date:	n/a
	Gas Supplier:	AirGas	Cyl. Conc. (PPM):	49.33	Cyl. Pressure (PSIG)	2,000

VOC Sensor Module Calibration Settings	"As Found" (Before Any Adjustment)	"As Left" (After Adjustment)
OFFSET	0.00	0.00
GAIN	1.046	0.847

"AS FOUND" (UNADJUSTED) TEST DATA

Calibrator Flow and Test Gas Data					Observed VOC Response from AQS-1		Error (Δ%)
Calibrator Gas Channel		Calibrator Air Channel		Known VOC Input Gas Conc. (PPM)			
Display Setting (SLPM)	Actual Flow Rate (SLPM)	Display Setting (SLPM)	Actual Flow Rate (SLPM)		Response (PPM)	Std. Dev. (PPM)	
OFF	OFF	5.0000	5.0130	0.00	-0.01	0.00	-
0.0500	0.0501	4.9493	4.9660	0.49	0.59	0.20	19.7%
0.0500	0.0501	2.4493	2.4600	0.98	1.23	0.00	24.9%

"AS LEFT" (ADJUSTED) TEST DATA

Calibrator Flow and Test Gas Data					Observed VOC Response from AQS-1		Error (Δ%)
Calibrator Gas Channel		Calibrator Air Channel		Known VOC Input Gas Conc. (PPM)			
Display Setting (SLPM)	Actual Flow Rate (SLPM)	Display Setting (SLPM)	Actual Flow Rate (SLPM)		Response (PPM)	Std. Dev. (PPM)	
OFF	OFF	5.0000	5.0146	0.00	-0.01	0.0	-
0.0500	0.0501	4.9493	4.9716	0.49	0.48	0.0	-2.0%
0.05	0.0501	2.4493	2.4683	0.98	1.00	0.0	2.0%

NOTES:

1. The VOC sensor zero response should be 0.0 ppm ± 0.2 ppm with a Std. Dev. < 0.2 ppm. If the sensor response error is greater than ± 0.2 ppm then an offset adjustment is required. If the Std. Dev. is greater than 0.2 ppm then the sensor is outside acceptable range and may need relacement.
2. The adjusted zero response NEW offset should be -1 < OFFSET < 1 and the sensor response 0.0 ppm ± 0.2 ppm.
3. The VOC sensor SPAN response should be ± 1 ppm (5% span of 20 ppm) with a Std. Dev. < 0.4 ppm (2% span of 20 ppm). If the sensor response error is greater than ± 1 ppm then a GAIN adjustment is required. If the Std. Dev. is greater than 0.4 ppm then the sensor is outside acceptable range and may need relacement.
4. The adjusted span response NEW gain should be 0.2 < GAIN < 5.0 and the sensor response 0.0 ppm ± 1 ppm.

Comments:

Unadjusted calibration performed post-deployment of 6-20-21 to 6-26-21 field sampling.
Adjusted to 1 ppm and ran calibration for pre-deployment of 7-18-21 to 7-24-21 field sampling.

Technician: *Dennis Weyburne*

QA Review: Kenneth Rys

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 NO2 MODULE MULTI-POINT CALIBRATION FORM

Calibration Data on This Form Are For:			**Unadjusted Cal.**	X	**Adjusted Cal.**	
Network:	City of Detroit	Site:	MTMS Lab		Date:	7/14/21
Time Off-Line:	12:13 EDT	Time On-Line:	14:06 EDT		Technician:	Dennis Weyburne

Calibration Equipment Info.	Analyzer Model:	Aeroqual AQS-1	S/N:	1479	Last Cal:	6/16/21
	Calibrator Model No.:	Teledyne API	S/N:	69	Cal. Date:	12/29/20
	Zero Air Model No.:	Teledyne API	S/N:	n/a	Cert Date:	n/a
	Gas Supplier:	Airgas	Cyl. Cert. Date:	1/26/21	Cyl. Pressure (PSIG)	2,000
	Gas Cylinder ID #:	D068357	Cyl. Conc. (PPM):	30.95	Gas Module Total Flow Rate	137 mL

Analyzer Calibration Settings	**"As Found" (Before Any Adjustment)**	**"As Left" (After Adjustment)**
OFFSET	0.1	
GAIN	1.245	

Calibrator Flow and Test Gas Data					**NO_2 Response** ***Observed from AQS-1***		Δ% (Observed Response Vs. Known Conc.) 3	PASS/FAIL
Calibrator Gas Channel		**Calibrator Air Channel**						
Display Setting (SLPM)	**Actual Flow Rate** (SLPM)	Display Setting (SLPM)	**Actual Flow Rate** (SLPM)	**Known NO_2 Gas Conc. (PPB)**	Response (PPB)	Std. Dev. (PPB)		
0.0490	0.0491	3.7510	3.7651	398.4	412.5	0.5	3.5%	
0.0323	0.0324	4.9677	4.9887	199.7	204.0	0.8	2.2%	
0.0161	0.0162	4.9839	5.0053	99.8	100.5	0.4	0.7%	
0.0081	0.0082	4.9919	5.0139	50.5	48.1	0.3	-4.8%	
OFF	OFF	5.0000	5.0150	0.0	-0.1	0.2		
Linear Regression Analysis:								
Slope:	1.039762	Intercept:	-2.631590	Corr. Coefficient (r):	0.999945			

NOTES:

1. The NO2 sensor zero response should be 0.0 ppb ± 0.2 ppb with a Std. Dev. < 0.2 ppb. If the sensor response error is greater than ± 0.2 ppb then an offset adjustment is required. If the Std. Dev. is greater than 0.2 ppb then the sensor is outside acceptable range and may need relacement.
2. The adjusted zero response NEW offset should be -1 < OFFSET < 1 and the sensor response 0.0 ppb ± 0.2 ppb.
3. The NO2 sensor SPAN response should be 400 ppb ± 20 ppb (5% span of 400 ppb) with a Std. Dev. < 8 ppb (2% span of 400 ppb). If the sensor response error is greater than ±20 ppb then a GAIN adjustment is required. If the Std. Dev. is greater than 8.0 ppb then the sensor is outside acceptable range and may need relacement.
4. The adjusted span response NEW gain should be 0.2 < GAIN < 5.0 and the sensor response 400 ppb ± 20 ppb.

Comments:

Unadjusted calibration post-deployment.

Technician: *Dennis Weyburne*

QA Review: Kenneth Stein

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 FLOW and LEAK CHECK FORM

QC Checks are: X Scheduled _____ Unscheduled (If unscheduled, explain reason why in "Comments" Section)

Network:	City of Detroit (Amazon)	**Site:**	Fairgrounds	**Date of Checks:**	7/13/2021
Operator:	Rob Bienenstein			**Time Off-Line:**	9:39 EDT
AEROQUAL QS-1 S/N	1479			**Time On-Line:**	9:49 EDT

Reference Standards:

Flow Standard:	Aeroqual 0-5 LPM Rotometer	**S/N#**	n/a	**Cert Date:**	n/a

AS FOUND CHECK DATA

Checks are "as found" checks. Adjust profiler flow or resolve leak and complete "as left" section below if any acceptability limits are exceeded or if any adjustments to the monitor are to be made.

FLOW CHECK DATA:

AQS-1 Expected Flow Rate (A)	Reference Flow Rate (B)	Profiler Flow Rate Error LPM (A-B)	Profiler Flow Rate Error Δ% (A-B) ÷ A x 100
1.0 LPM	1.0 LPM	0.00	0.0%

Flow Check Procedure Link

Acceptability Limits: The expected AQS-1 Particle Profiler Flow Rate is 1.0 LPM ± 0.05 LPM (between 0.95 LPM and 1.05 LPM) or ≤±5%.

LEAK CHECK DATA:

PROFILER LEAKAGE RATE:	>30 seconds	(Must be >10 sec for 10 kPa pressure change)

Leak Check Procedure Link

AS LEFT CHECK DATA

FLOW CHECK DATA:

AQS-1 Expected Flow Rate (A)	Reference Flow Rate (B)	Profiler Flow Rate Error LPM	Profiler Flow Rate Error Δ%
1.0 LPM	LPM		

LEAK CHECK DATA:

PROFILER LEAKAGE RATE:	seconds	(Must be > 10 sec for 10 kPa pressure change)

Comments:

Technician: *Rob Bienenstein*

QA Review: Ken Leggiero

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 VOC HIGH RANGE MODULE VERIFICATION/CALIBRATION FORM

Network:	City of Detroit	Site:	MTMS Lab	Date:	6/16/21
Time Off-Line:	09:00 EDT	Time On-Line:	10:20 EDT	Technician:	Denis Weyburne

Calibration Equipment Info.	Analyzer Model:	Aeroqual AQS-1	S/N:	1480	Last Cal:	4/22/21
	Calibrator Model No:	Teledyne API	S/N:	69	Cal. Date:	12/29/20
	Zero Air Model No:	Teledyne API	S/N:	n/a	Cert Date:	n/a
	Gas Supplier:	GASCO #1-4	Cyl. Conc. (PPM):	0.99	Cyl. Pressure (PSIG)	550
	Gas Supplier:	GASCO #3-3	Cyl. Conc. (PPM):	3.10	Cyl. Pressure (PSIG)	150

VOC Sensor Module Calibration Settings	"As Found" (Before Any Adjustment)	"As Left" (After Adjustment)
OFFSET	0.00	0.00
GAIN	2.047	1.539

"AS FOUND" (UNADJUSTED) TEST DATA

Calibrator Flow and Test Gas Data					Observed VOC Response from AQS-1		Error (Δ%)
Calibrator Gas Channel		Calibrator Air Channel		Known VOC Input Gas Conc. (PPM)			
Display Setting (SLPM)	Actual Flow Rate (SLPM)	Display Setting (SLPM)	Actual Flow Rate (SLPM)		Response (PPM)	Std. Dev. (PPM)	

"AS LEFT" (ADJUSTED) TEST DATA

Calibrator Flow and Test Gas Data					Observed VOC Response from AQS-1		Error (Δ%)
Calibrator Gas Channel		Calibrator Air Channel		Known VOC Input Gas Conc. (PPM)			
Display Setting (SLPM)	Actual Flow Rate (SLPM)	Display Setting (SLPM)	Actual Flow Rate (SLPM)		Response (PPM)	Std. Dev. (PPM)	
OFF	OFF	5.0000	5.0130	0.00	-0.01	0.00	-
n/a	n/a	1.0000	n/a	0.99	1.01	0.00	2.0%
n/a	n/a	1.0000	n/a	3.10	3.09	0.00	-0.3%

NOTES:

1. The VOC sensor zero response should be 0.0 ppm ± 0.2 ppm with a Std. Dev. < 0.2 ppm. If the sensor response error is greater than ± 0.2 ppm then an offset adjustment is required. If the Std. Dev. is greater than 0.2 ppm then the sensor is outside acceptable range and may need relacement.
2. The adjusted zero response NEW offset should be -1 < OFFSET < 1 and the sensor response 0.0 ppm ± 0.2 ppm.
3. The VOC sensor SPAN response should be ± 1 ppm (5% span of 20 ppm) with a Std. Dev. < 0.4 ppm (2% span of 20 ppm). If the sensor response error is greater than ± 1 ppm then a GAIN adjustment is required. If the Std. Dev. is greater than 0.4 ppm then the sensor is outside acceptable range and may need relacement.
4. The adjusted span response NEW gain should be 0.2 < GAIN < 5.0 and the sensor response 0.0 ppm ± 1 ppm.

Comments:

Adjusted to 1 ppm and ran calibration prior to field deployment.

Technician: *Dennis Weyburne*

QA Review: [signature]

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 NO2 MODULE MULTI-POINT CALIBRATION FORM

Calibration Data on This Form Are For:			Unadjusted Cal.		Adjusted Cal.	X
Network:	City of Detroit	Site:	MTMS Lab	Date:	6/16/21	
Time Off-Line:	10:08 EDT	Time On-Line:	10:53 EDT	Technician:	Kevin Ruggiero	

Calibration Equipment Info.	Analyzer Model:	Aeroqual AQS-1	S/N:	1480	Last Cal:	4/22/21
	Calibrator Model No.:	Teledyne API	S/N:	69	Cal. Date:	12/29/20
	Zero Air Model No.:	Teledyne API	S/N:	n/a	Cert Date:	n/a
	Gas Supplier:	Airgas	Cyl. Cert. Date:	1/26/21	Cyl. Pressure (PSIG)	2,000
	Gas Cylinder ID #:	D068357	Cyl. Conc. (PPM):	30.95	Gas Module Total Flow Rate	130 mL

Analyzer Calibration Settings	"As Found" (Before Any Adjustment)	"As Left" (After Adjustment)
OFFSET	0.6	0.4
GAIN	1.273	1.292

Calibrator Flow and Test Gas Data					NO_2 Response *Observed from AQS-1*		Δ% (Observed Response Vs. Known Conc.) 3	PASS/FAIL
Calibrator Gas Channel		**Calibrator Air Channel**						
Display Setting (SLPM)	**Actual Flow Rate** (SLPM)	Display Setting (SLPM)	**Actual Flow Rate** (SLPM)	**Known NO_2 Gas Conc. (PPB)**	Response (PPB)	Std. Dev. (PPB)		
0.0497	0.0498	3.8003	3.8206	398.2	402.9	0.9	1.2%	
0.0145	0.0146	4.4855	4.5085	99.9	95.6	0.9	-4.3%	
0.0081	0.0082	4.9919	5.0139	50.5	45.0	0.4	-10.9%	
0.0048	0.0050	4.9952	5.0164	30.8	26.9	0.3	-12.7%	
OFF	OFF	5.0000	5.0150	0.0	-0.7	0.2		
Linear Regression Analysis:								
Slope:	1.020668	Intercept:	-4.335048	Corr. Coefficient (r):	0.999895			

NOTES:

1. The NO2 sensor zero response should be 0.0 ppb ± 0.2 ppb with a Std. Dev. < 0.2 ppb. If the sensor response error is greater than ± 0.2 ppb then an offset adjustment is required. If the Std. Dev. is greater than 0.2 ppb then the sensor is outside acceptable range and may need relacement.
2. The adjusted zero response NEW offset should be -1 < OFFSET < 1 and the sensor response 0.0 ppb ± 0.2 ppb.
3. The NO2 sensor SPAN response should be 400 ppb ± 20 ppb (5% span of 400 ppb) with a Std. Dev. < 8 ppb (2% span of 400 ppb). If the sensor response error is greater than ±20 ppb then a GAIN adjustment is required. If the Std. Dev. is greater than 8.0 ppb then the sensor is outside acceptable range and may need relacement.
4. The adjusted span response NEW gain should be 0.2 < GAIN < 5.0 and the sensor response 400 ppb ± 20 ppb.

Comments:

Adjusted and calibrated NO2 module prior to field deployment.

Technician: *Dennis Weyburne*

QA Review: Kevin Ruggiero

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 FLOW and LEAK CHECK FORM

QC Checks are: X Scheduled _____ Unscheduled (If unscheduled, explain reason why in "Comments" Section)

Network:	City of Detroit (Amazon)	**Site:**	Fairgrounds	**Date of Checks:**	6/17/2021
Operator:	Rob bienenstein			**Time Off-Line:**	12:23 EDT
AEROQUAL QS-1 S/N	1480			**Time On-Line:**	12:39 EDT

Reference Standards:

Flow Standard:	Aeroqual 0-5 LPM Rotometer	**S/N#**	n/a	**Cert Date:**	n/a

AS FOUND CHECK DATA

Checks are "as found" checks. Adjust profiler flow or resolve leak and complete "as left" section below if any acceptability limits are exceeded or if any adjustments to the monitor are to be made.

FLOW CHECK DATA:

AQS-1 Expected Flow Rate (A)	Reference Flow Rate (B)	Profiler Flow Rate Error LPM (A-B)	Profiler Flow Rate Error Δ% (A-B) ÷ A x 100
1.0 LPM	1.0 LPM	0.00	0.0%

Flow Check Procedure Link

Acceptability Limits: The expected AQS-1 Particle Profiler Flow Rate is 1.0 LPM ± 0.05 LPM (between 0.95 LPM and 1.05 LPM) or ≤±5%.

LEAK CHECK DATA:

PROFILER LEAKAGE RATE:	>30 seconds	(Must be >10 sec for 10 kPa pressure change)

Leak Check Procedure Link

AS LEFT CHECK DATA

FLOW CHECK DATA:

AQS-1 Expected Flow Rate (A)	Reference Flow Rate (B)	Profiler Flow Rate Error LPM	Profiler Flow Rate Error Δ%
1.0 LPM	LPM		

LEAK CHECK DATA:

PROFILER LEAKAGE RATE:	seconds	(Must be > 10 sec for 10 kPa pressure change)

Comments:

Technician: *Rob Bienenstein*

QA Review: Ken Rogers

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 VOC HIGH RANGE MODULE VERIFICATION/CALIBRATION FORM

Network:	City of Detroit	Site:	MTMS Lab	Date:	7/12/21
Time Off-Line:	13:05EDT	Time On-Line:	13:58 EDT	Technician:	Denis Weyburne

Calibration Equipment Info.	Analyzer Model:	Aeroqual AQS-1	S/N:	1480	Last Cal:	6/16/21
	Calibrator Model No:	Teledyne API	S/N:	69	Cal. Date:	12/29/20
	Zero Air Model No:	Teledyne API	S/N:	n/a	Cert Date:	n/a
	Gas Supplier:	AirGas	Cyl. Conc. (PPM):	49.33	Cyl. Pressure (PSIG)	2,000

VOC Sensor Module Calibration Settings	"As Found" (Before Any Adjustment)	"As Left" (After Adjustment)
OFFSET	0.00	0.00
GAIN	1.539	1.673

"AS FOUND" (UNADJUSTED) TEST DATA

Calibrator Flow and Test Gas Data					Observed VOC Response from AQS-1		Error (Δ%)
Calibrator Gas Channel		Calibrator Air Channel		Known VOC Input Gas Conc. (PPM)			
Display Setting (SLPM)	Actual Flow Rate (SLPM)	Display Setting (SLPM)	Actual Flow Rate (SLPM)		Response (PPM)	Std. Dev. (PPM)	
OFF	OFF	5.0000	5.0130	0.00	-0.01	0.00	-
0.0500	0.0501	4.9400	4.9660	0.49	0.44	0.01	-10.7%
0.0500	0.0501	5.0000	2.5000	0.97	0.92	0.00	-5.1%

"AS LEFT" (ADJUSTED) TEST DATA

Calibrator Flow and Test Gas Data					Observed VOC Response from AQS-1		Error (Δ%)
Calibrator Gas Channel		Calibrator Air Channel		Known VOC Input Gas Conc. (PPM)			
Display Setting (SLPM)	Actual Flow Rate (SLPM)	Display Setting (SLPM)	Actual Flow Rate (SLPM)		Response (PPM)	Std. Dev. (PPM)	
OFF	OFF	5.0000	5.0153	0.00	-0.01	0.0	-
0.0500	0.0501	4.9493	4.9716	0.49	0.48	0.0	-2.0%
0.05	0.0501	2.4493	2.4683	0.98	1.00	0.0	2.0%

NOTES:

1. The VOC sensor zero response should be 0.0 ppm ± 0.2 ppm with a Std. Dev. < 0.2 ppm. If the sensor response error is greater than ± 0.2 ppm then an offset adjustment is required. If the Std. Dev. is greater than 0.2 ppm then the sensor is outside acceptable range and may need relacement.
2. The adjusted zero response NEW offset should be -1 < OFFSET < 1 and the sensor response 0.0 ppm ± 0.2 ppm.
3. The VOC sensor SPAN response should be ± 1 ppm (5% span of 20 ppm) with a Std. Dev. < 0.4 ppm (2% span of 20 ppm). If the sensor response error is greater than ± 1 ppm then a GAIN adjustment is required. If the Std. Dev. is greater than 0.4 ppm then the sensor is outside acceptable range and may need relacement.
4. The adjusted span response NEW gain should be 0.2 < GAIN < 5.0 and the sensor response 0.0 ppm ± 1 ppm.

Comments:

Unadjusted calibration performed post-deployment of 6-20-21 to 6-26-21 field sampling.
Adjusted to 1 ppm and ran calibration for pre-deployment of 7-18-21 to 7-24-21 field sampling.

Technician: *Dennis Weyburne*

QA Review: [illegible]

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 NO2 MODULE MULTI-POINT CALIBRATION FORM

Calibration Data on This Form Are For:			Unadjusted Cal.	X	Adjusted Cal.	
Network:	City of Detroit	Site:	MTMS Lab		Date:	7/14/21
Time Off-Line:	12:13 EDT	Time On-Line:	14:06 EDT		Technician:	Dennis Weyburne

Calibration Equipment Info.	Analyzer Model:	Aeroqual AQS-1	S/N:	1480	Last Cal:	6/16/21
	Calibrator Model No.:	Teledyne API	S/N:	69	Cal. Date:	12/29/20
	Zero Air Model No.:	Teledyne API	S/N:	n/a	Cert Date:	n/a
	Gas Supplier:	Airgas	Cyl. Cert. Date:	1/26/21	Cyl. Pressure (PSIG)	2,000
	Gas Cylinder ID #:	D068357	Cyl. Conc. (PPM):	30.95	Gas Module Total Flow Rate	130 mL

Analyzer Calibration Settings	"As Found" (Before Any Adjustment)	"As Left" (After Adjustment)
OFFSET	0.4	
GAIN	1.292	

Calibrator Flow and Test Gas Data					NO_2 Response *Observed from AQS-1*		Δ% (Observed Response Vs. Known Conc.) 3	PASS/FAIL
Calibrator Gas Channel		**Calibrator Air Channel**		**Known NO_2 Gas Conc. (PPB)**				
Display Setting (SLPM)	**Actual Flow Rate** (SLPM)	Display Setting (SLPM)	**Actual Flow Rate** (SLPM)		Response (PPB)	Std. Dev. (PPB)		
0.0490	0.0491	3.7510	3.7651	398.4	414.3	0.4	4.0%	
0.0323	0.0324	4.9677	4.9887	199.7	205.7	0.3	3.0%	
0.0161	0.0162	4.9839	5.0053	99.8	100.4	0.6	0.6%	
0.0081	0.0082	4.9919	5.0139	50.5	48.3	0.1	-4.4%	
OFF	OFF	5.0000	5.0150	0.0	-0.6	0.3		
Linear Regression Analysis:								
Slope:	1.045744	Intercept:	-2.906901	Corr. Coefficient (r):	0.999957			

NOTES:

1. The NO2 sensor zero response should be 0.0 ppb ± 0.2 ppb with a Std. Dev. < 0.2 ppb. If the sensor response error is greater than ± 0.2 ppb then an offset adjustment is required. If the Std. Dev. is greater than 0.2 ppb then the sensor is outside acceptable range and may need relacement.
2. The adjusted zero response NEW offset should be -1 < OFFSET < 1 and the sensor response 0.0 ppb ± 0.2 ppb.
3. The NO2 sensor SPAN response should be 400 ppb ± 20 ppb (5% span of 400 ppb) with a Std. Dev. < 8 ppb (2% span of 400 ppb). If the sensor response error is greater than ±20 ppb then a GAIN adjustment is required. If the Std. Dev. is greater than 8.0 ppb then the sensor is outside acceptable range and may need relacement.
4. The adjusted span response NEW gain should be 0.2 < GAIN < 5.0 and the sensor response 400 ppb ± 20 ppb.

Comments:

Unadjustedcalibration post-deployment.

Technician: *Dennis Weyburne*

QA Review: Kenneth Stein

MONTROSE AIR QUALITY SERVICES LLC

AEROQUAL AQS-1 FLOW and LEAK CHECK FORM

QC Checks are: X Scheduled ______ Unscheduled (If unscheduled, explain reason why in "Comments" Section)

Network:	City of Detroit (Amazon)	**Site:** Fairgrounds		**Date of Checks:**	7/13/2021
Operator:	Rob bienenstein			**Time Off-Line:**	9:39 EDT
AEROQUAL QS-1 S/N	1480			**Time On-Line:**	9:49 EDT

Reference Standards:

Flow Standard:	Aeroqual 0-5 LPM Rotometer	**S/N#**	n/a	**Cert Date:**	n/a

AS FOUND CHECK DATA

Checks are "as found" checks. Adjust profiler flow or resolve leak and complete "as left" section below if any acceptability limits are exceeded or if any adjustments to the monitor are to be made.

FLOW CHECK DATA:

AQS-1 Expected Flow Rate (A)	Reference Flow Rate (B)	Profiler Flow Rate Error LPM (A-B)	Profiler Flow Rate Error Δ% (A-B) ÷ A x 100
1.0 LPM	1.0 LPM	0.00	0.0%

Flow Check Procedure Link

Acceptability Limits: The expected AQS-1 Particle Profiler Flow Rate is 1.0 LPM ± 0.05 LPM (between 0.95 LPM and 1.05 LPM) or ≤±5%.

LEAK CHECK DATA:

PROFILER LEAKAGE RATE:	>30 seconds	(Must be >10 sec for 10 kPa pressure change)

Leak Check Procedure Link

AS LEFT CHECK DATA

FLOW CHECK DATA:

AQS-1 Expected Flow Rate (A)	Reference Flow Rate (B)	Profiler Flow Rate Error LPM	Profiler Flow Rate Error Δ%
1.0 LPM	LPM		

LEAK CHECK DATA:

PROFILER LEAKAGE RATE:	seconds	(Must be > 10 sec for 10 kPa pressure change

Comments:

Technician: *Rob Bienenstein*

QA Review: ____________

MONTROSE AIR QUALITY SERVICES LLC

B: Calibration Certification Sheets

MesaLabs

NVLAP Lab Code 200661-0
Calibration

Calibration Certificate

CertificateNo.	388679	**Sold To:**	Montrose Air Quality Services, LLC
Product	200-530+ Medium Defender 530+ Medium Flow		45 US Hwy 46 East, Suite 601
Serial No.	153584		Pine Brook, NJ 07058
Cal. Date	08-May-2020		US

All calibrations are performed at Mesa Laboratories, Inc., 10 Park Place, Butler, NJ, 07405, an ISO 17025:2005 accredited laboratory through NVLAP of NIST. This report shall not be reproduced except in full without the written approval of the laboratory. Results only relate to the items calibrated. This report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

As Received Calibration Data

		Lab. Pressure	747 mmHg
Technician	Lilianna Malinowska	**Lab. Temperature**	22.1 °C

Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Received
4807.28 sccm	4794.46 sccm	0.27%	1.00%	In Tolerance
1088.33 sccm	1089.94 sccm	-0.15%	1.00%	In Tolerance
289.44 sccm	290.04 sccm	-0.21%	1.00%	In tolerance
21.5 °C	21.9 °C	-	± 0.8°C	In Tolerance
747 mmHg	746 mmHg	-	± 3.5 mmHg	In Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML-800-24	100439	30-Mar-2020	30-Mar-2021
Percision Thermometer	305460	08-Oct-2019	07-Oct-2020
Precision Barometer	2981392	19-Jul-2019	18-Jul-2020

MesaLabs

NVLAP Lab Code 200661-0
Calibration

As Shipped Calibration Data

Certificate No	388679	**Lab. Pressure**	747 mmHg
Technician	Lilianna Malinowska	**Lab. Temperature**	22.1 °C

Instrument Reading	Lab Standard Reading	Deviation	Allowable Deviation	As Shipped
4790.5 sccm	4802.74 sccm	-0.25%	1.00%	In Tolerance
1089.45 sccm	1091.86 sccm	-0.22%	1.00%	In Tolerance
290.28 sccm	290.92 sccm	-0.22%	1.00%	In Tolerance
22.8 °C	22.8 °C	-	± 0.8°C	In Tolerance
747 mmHg	747 mmHg	-	± 3.5 mmHg	In Tolerance

Mesa Laboratories Standards Used

Description	Standard Serial Number	Calibration Date	Calibration Due Date
ML-800-24	117991	11-Feb-2020	10-Feb-2021
Percision Thermometer	305460	08-Oct-2019	07-Oct-2020
Precision Barometer	2981392	19-Jul-2019	18-Jul-2020

Calibration Notes

The expanded uncertainty of flow, temperature, and pressure measurements all have a coverage factor of k = 2 for a confidence interval of approximately 95%.

Flow testing is in accordance with our test number PR18-13 with an expanded uncertainty of 0.18% using high-purity nitrogen or filtered laboratory air. Flow readings in sccm are performed at STP of 21.1°C and 760 mmHg.

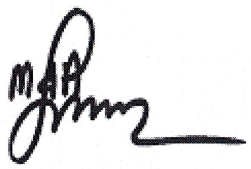
Pressure testing is in accordance with our test number PR18-11 with an expanded uncertainty of 0.16 mmHg.

Temperature testing is in accordance with our test number PR18-12 with an expanded uncertainty of 0.04 °C.

Traceability to the International System of Units (SI) is verified by accreditation to ISO/IEC 17025 by NVLAP under NVLAP Code 200661-0.

Technician Notes:

By:



Mohammed Aziz
Director of Engineering
Mesa Laboratories, Inc., Butler, NJ

TAPI T700 MFC CALIBRATION

PPLICATION INFORMATION:

Calibrator Model/S/N:	TAPI T700; SN 69	NETWORK:	Marathon Detroit PAMS	SITE:	MTMS
Calibration Site:	MTMS Site	Test Date:	12/29/2020		
Barometric Pressure (Pa, in mmHg):	740.0	Calibrated by:	Dennis Weyburne		
Flow Standard Model:	Mesa Labs Defender 530+	Air Temp. (Ta, in deg. C):	27.4	(=deg. K):	300.6
Flow Standard Base S/N:	Not Applicable	Flow Cell Model No:	530+ High Flow		
Certification Date:	Not Applicable	Flow Cell S/N:	153452		
		Flow Cell Certification Date:	5/8/2020		

Check One: **X** Air Channel _____ Gas Channel

(X) MFC Drive Voltage (mVDC)	Flow Meter Readings (5 sets of 10 averaged flows) F_1 (SLPM)	F_2 (SLPM)	F_3 (SLPM)	F_4 (SLPM)	F_5 (SLPM)	Average Flow (F1...F5) (SLPM)	STD DEV F1...F5 (in *sccm*)	Flow Rate ***From Previous Cal*** (SLPM)	Δ% ("New Cal Flow" Vs "Prev. Cal Flow")
5000	10.6340	10.6400	10.6380	10.6400	10.6350	10.637	2.8	10.657	0.2%
4750	10.1050	10.1020	10.0960	10.0950	10.0870	10.097	7.0	10.101	0.0%
4500	9.5920	9.5815	9.5763	9.5981	9.5759	9.585	9.9	9.573	-0.1%
4250	8.9901	8.9977	8.9954	8.9918	8.9909	8.993	3.2	9.030	0.4%
4000	8.4595	8.4595	8.4599	8.4604	8.4516	8.458	3.7	8.478	0.2%
3750	7.9298	7.9289	7.9244	7.9223	7.9254	7.926	3.1	7.955	0.4%
3500	7.3934	7.3891	7.3861	7.3909	7.3974	7.391	4.3	7.406	0.2%
3250	6.8480	6.8463	6.8474	6.8470	6.8487	6.847	0.9	6.872	0.4%
3000	6.3225	6.3215	6.3208	6.3174	6.3198	6.320	1.9	6.332	0.2%
2750	5.7859	5.7866	5.7889	5.7868	5.7835	5.786	1.9	5.800	0.2%
2500	5.2548	5.2542	5.2557	5.2541	5.2538	5.255	0.8	5.264	0.2%
2250	4.7312	4.7316	4.7310	4.7321	4.7311	4.731	0.5	4.738	0.1%
2000	4.2061	4.2039	4.2018	4.1994	4.1999	4.202	2.8	4.203	0.0%
1750	3.6657	3.6700	3.6710	3.6695	3.6697	3.669	2.0	3.673	0.1%
1500	3.1310	3.1318	3.1317	3.1316	3.1320	3.132	0.4	3.140	0.3%
1250	2.6006	2.6011	2.6014	2.6026	2.6023	2.602	0.8	2.609	0.3%
1000	2.0700	2.0706	2.0695	2.0687	2.0696	2.070	0.7	2.075	0.2%
750	1.5436	1.5450	1.5450	1.5466	1.5465	1.545	1.2	1.548	0.2%
500	1.0150	1.0150	1.0150	1.0150	1.0150	1.015	0.0	1.015	0.0%
250	0.48082	0.48108	0.48340	0.48327	0.48351	0.482	1.3	0.483	0.0%

SLOPE: 0.002135607 **INTERCEPT: -0.068705011** **CORRELATION COEFF (r): 0.999983645**

Comments:

echnician: Dennis Weyburne 12/29/2020

(signature) Date

TAPI T700 MFC CALIBRATION

CALIBRATOR APPLICATION INFORMATION:

Calibrator Model/S/N:	TAPI T700; SN 69	NETWORK:	Marathon Detroit PAMS	SITE:	MTMS
Calibration Site:	MTMS Site	Test Date:	12/29/2020		
Barometric Pressure (Pa, in mmHg):	731.0	Calibrated by:	Dennis Weyburne		
Flow Standard Model:	Mesa Labs Defender 530+	Air Temp. (Ta, in deg. C):24.4	25.0	(=deg. K):	298.2
Flow Standard Base S/N:	Not Applicable	Flow Cell Model No:	530+ Low Flow		
Base Certification Date:	Not Applicable	Flow Cell S/N:	153435		
		Flow Cell Certification Date:	5/8/2020		

Check One: _____ Air Channel **X** Gas Channel

(X) MFC Drive Voltage (mVDC)	Flow Meter Readings (5 sets of 10 averaged flows) F_1 (SLPM)	F_2 (SLPM)	F_3 (SLPM)	F_4 (SLPM)	F_5 (SLPM)	Average Flow (F1...F5) (SLPM)	STD DEV F1...F5 (in *sccm*)	Flow Rate ***From Previous Cal*** (SLPM)	Δ% ("New Cal Flow" Vs "Prev. Cal Flow")
5000	0.05390	0.05399	0.05399	0.05399	0.05399	0.0540	0.04	0.0540	0.0%
4750	0.05139	0.05138	0.05136	0.05140	0.05141	0.0514	0.02	0.0514	0.0%
4500	0.04866	0.04868	0.04867	0.04870	0.04866	0.0487	0.02	0.0487	0.1%
4250	0.04596	0.04597	0.04598	0.04599	0.04599	0.0460	0.01	0.0459	-0.1%
4000	0.04325	0.04327	0.04327	0.04329	0.04330	0.0433	0.02	0.0432	-0.1%
3750	0.04059	0.04056	0.04058	0.04057	0.04051	0.0406	0.03	0.0406	0.1%
3500	0.03791	0.03789	0.03790	0.03790	0.03791	0.0379	0.01	0.0380	0.3%
3250	0.03522	0.03524	0.03524	0.03524	0.03524	0.0352	0.01	0.0353	0.3%
3000	0.03259	0.03258	0.03258	0.03259	0.03259	0.0326	0.01	0.0327	0.2%
2750	0.02990	0.02991	0.02992	0.02991	0.02993	0.0299	0.01	0.0300	0.3%
2500	0.02724	0.02724	0.02725	0.02724	0.02724	0.0272	0.00	0.0274	0.5%
2250	0.02462	0.02462	0.02463	0.02454	0.02460	0.0246	0.04	0.0247	0.3%
2000	0.02190	0.02188	0.02189	0.02190	0.02191	0.0219	0.01	0.0220	0.3%
1750	0.01917	0.01918	0.01918	0.01918	0.01918	0.0192	0.00	0.0193	0.4%
1500	0.01644	0.01644	0.01643	0.01641	0.01643	0.0164	0.01	0.0165	0.6%
1250	0.01370	0.01369	0.01369	0.01369	0.01369	0.0137	0.00	0.0138	0.6%
1000	0.01098	0.01096	0.01097	0.01091	0.01092	0.0109	0.03	0.0110	0.5%
750	0.00819	0.00818	0.00819	0.00818	0.00819	0.0082	0.01	0.0082	0.5%
500	0.00536	0.00533	0.00535	0.00535	0.00538	0.0054	0.02	0.0054	1.0%
250	0.00250	0.00250	0.00250	0.00250	0.00250	0.0025	0.00	0.0025	0.0%
SLOPE: 0.000011			**INTERCEPT: 0.0002130**			**CORRELATION COEFF (r): 0.999980**			

Comments:

Technician: Dennis Weyburne (signature) 12/29/20 Date

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA, LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: TRACEABILITY STANDARD

Part Number:	X02NI99T33W0004	Reference Number:	54-402006473-1
Cylinder Number:	D068357	Cylinder Volume:	32.0 CF
Laboratory:	124 - Chicago (SAP) - IL	Cylinder Pressure:	2218 PSIG
		Valve Outlet:	660
		Certification Date:	Jan 26, 2021

Expiration Date: Jan 26, 2024

This cylinder has been analytically certified as directly traceable to NIST with a total analytical uncertainty as stated below with a confidence level of 95%, in accordance with Airgas ISO procedures. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a mole/mole basis unless otherwise noted.

Do Not Use This Cylinder Below 100 psig.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Total Relative Uncertainty
NITROGEN DIOXIDE	30.00 PPM	30.95 PPM	+/- 1% NIST Traceable
NITROGEN	Balance		

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
GMIS	401438584104	EB0120492	48.18 PPM NITROGEN DIOXIDE/NITROGEN	+/- 1.8%	Nov 01, 2022

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
MKS FTIR NO2 017707558	FTIR	Jan 07, 2021

Triad Data Available Upon Request

PERMANENT NOTES: OXYGEN ADDED TO MAINTAIN STABILITY

Approved for Release

GASCO®

GASCO AFFILIATES, LLC.

320 Scarlet Blvd.
Oldsmar, FL 34677
(800) 910-0051
fax: (866) 755-8920
www.gascogas.com

CERTIFICATE OF ANALYSIS

Date: January 13, 2021
Order Number: 1199610
Lot Number: 304-402007938-1

Customer: Cal Gas Direct Inc.

Use Before: 01/13/2025

Component	Requested Concentration	Analytical Result (+/- 2%)
Isobutylene	1 PPM	0.99 PPM
Air	Balance	Balance

Cylinder Size: 1.2 Cu. Ft.
Contents: 34 Liter

Valve: CGA 600
Pressure: 500 psig

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/ or N.I.S.T. Gas Mixture reference materials.

Analyst:

Afton Eakins

Afton Eakins

GASCO AFFILIATES, LLC.

320 Scarlet Blvd.
Oldsmar, FL 34677
(800) 910-0051
fax: (866) 755-8920
www.gascogas.com

CERTIFICATE OF ANALYSIS

Date: January 13, 2021
Order Number: 1199610
Lot Number: 304-402007939-1

Customer: Cal Gas Direct Inc.

Use Before: 01/13/2025

Component	Requested Concentration	Analytical Result (+/- 2%)
Isobutylene	3 PPM	3.1 PPM
Air	Balance	Balance

Cylinder Size: 1.2 Cu. Ft.
Contents: 34 Liter

Valve: CGA 600
Pressure: 500 psig

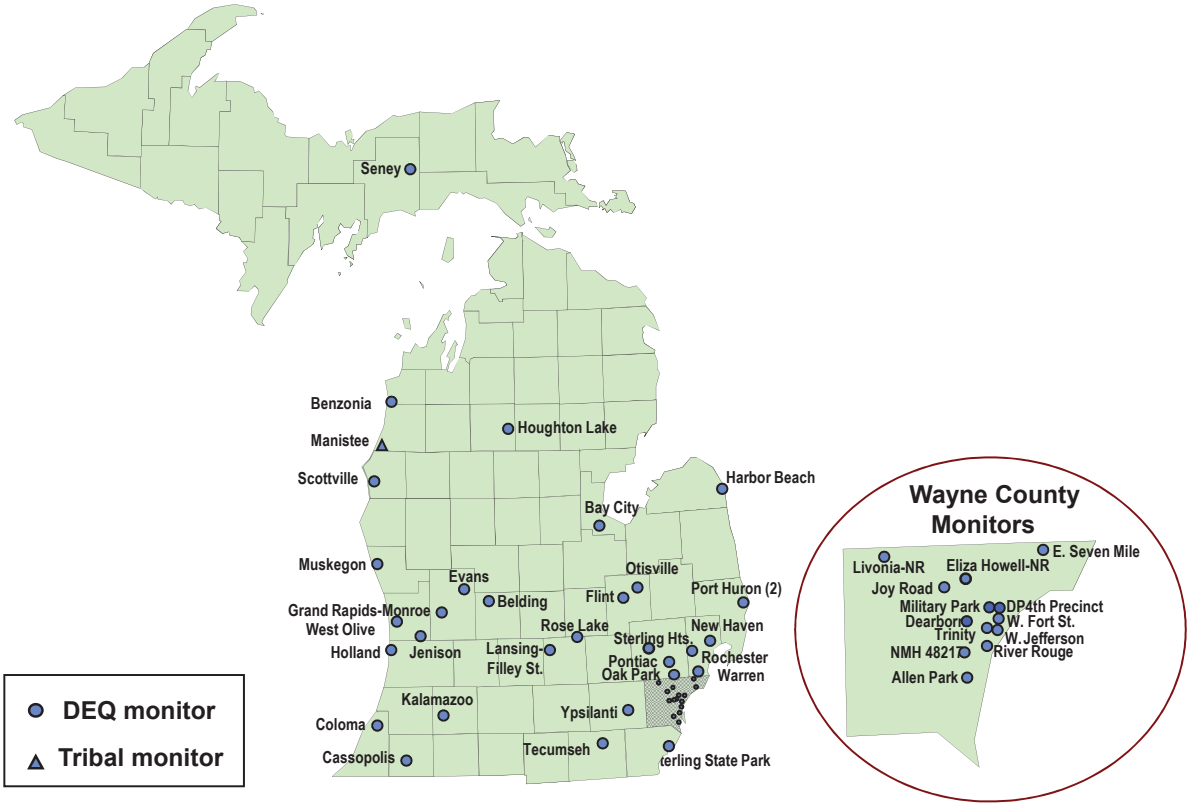
Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/ or N.I.S.T. Gas Mixture reference materials.

Analyst:

Clifton Eakins
Clifton Eakins

C: State Monitor Map

Michigan Air Monitor Network



Updated June 2019