AIR UNIT

THE ENVIRONMENTAL MANAGEMENT AUTHORITY

Ambient Air Quality Monitoring Report

4th Quarter 2020 (October – December)

NATIONAL AIR QUALITY INDEX

EMA environmental management authority

Contents

EXECUTIVE SUMMARY

This ambient air quality monitoring report is prepared by the Air Unit of the Environmental Management Authority (EMA) to provide information on air quality for Trinidad and Tobago for the fourth Quarter of 2020 (October to December, 2020). The report supports the EMA's mandate to promote a healthy environment by setting standards, monitoring and reporting on air quality to improve human health and the environment and to fulfill the goals and mandates set in Trinidad and Tobago's Environmental Management Act, Chapter 35:05, the National Environmental Policy (2018) and the Air Pollution Rules, 2014 (APR). It also supports the Government of the Republic of Trinidad and Tobago's (GORTT) commitment to achieving specific United Nations Sustainable Development Goals that relate to air quality.

The purpose of this report is to summarize ambient air quality data, collected from the Ambient Air Quality Monitoring Network (AAQMN), presenting average concentrations, comparisons and trends. Average concentrations are compared to Schedule 1, of the APR, 2014 for the following criteria pollutants:

- Particulate Matter [PM_{10} (≤10 micrometers), $PM_{2.5}$ (≤2.5 micrometers in diameter)]
- Carbon Monoxide (CO)
- Sulfur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Ozone (O_3)

Monitoring these criteria pollutants is crucial as they cause acute and chronic impacts on human health. The criteria pollutants are measured using approved United States Environmental Protection Agency (US EPA) federal reference methods (FRM) and federal equivalent methods (FEM), to assess compliance with the standards listed in the APR.

The AAQMN was expanded in the fourth quarter with the establishment of an Ambient Air Quality Monitoring Station (AAQMS) at San Fernando in November 2020.

The data analyzed for the fourth quarter of 2020 demonstrates that the ambient air quality for Trinidad and Tobago, for the criteria pollutants, is acceptable. There were no exceedances of the APR Schedule 1 at Point Lisas for PM_{10} and CO. There were no exceedances recorded for any pollutants at the San Fernando AAQMS.

During the fourth quarter of 2020 ambient air quality monitoring data was unavailable for the following:

1. $PM_{2.5}$, NO_2, O_3 and SO_2 at Point Lisas due to non-functioning equipment;
2. Port of Spain AAQMS for all parameters due to faulty air conditioning systems;
3. Signal Hill Tobago for all parameters due to lack of internet connectivity to access data and conduct verification checks.

The Air Quality Index (AQI) values during the fourth quarter were generally good, without the influence of Saharan dust. Saharan dust was recorded for fifteen (15) days during November and December. On days with Saharan Dust in November, four days were recorded with moderate AQI values at Point Lisas, whilst San Fernando recorded four moderate AQIs in November and one in December 2020.

Analysis of filter tape samples of PM_{10} and $PM_{2.5}$, collected on Saharan and Non-Saharan dust days found the presence of iron, calcium, zinc, copper and lead with calcium being the most abundant. The $PM_{2.5}$ samples contained higher concentrations of these metals. The analysis of the PM_{10} sample for June 21, 2020 recorded the highest concentration of lead. This was the most severe Saharan dust occurrence on record in Trinidad and Tobago.

1.0 INTRODUCTION

This report is prepared by the Air Unit of the Environmental Management Authority (EMA) to provide information on air quality for Trinidad and Tobago for the 4th Quarter of 2020 (October – December, 2020). The report supports the EMA's mandate to promote a healthy environment by setting standards, monitoring and reporting on air quality to improve human health and the environment and to fulfill the goals and mandates set in Trinidad and Tobago's Environmental Management Act, Chapter 35:05, the National Environmental Policy (2018) and the Air Pollution Rules, 2014 (APR). It also supports the Government of the Republic of Trinidad and Tobago's (GORTT) commitment towards achieving the United Nations Sustainable Development Goals 3, 7, 9, 11, 12, 13 and 15 that relate to air quality.

The purpose of this report is to present ambient air quality data as recorded in the AAQMN, highlighting average concentrations, comparisons and trends. Ambient air is the outdoor, breathable air. Ambient air quality standards/permissible levels for the criteria pollutants are stated in Schedule 1, of the APR. Criteria pollutants are the most common air pollutants found in the atmosphere, as a result of anthropogenic activity and are used as indicators of general air quality. They are the most common by-products of transportation and industrial activity and produce local, acute impacts on human health. The criteria pollutants are:

- Particulate Matter [PM_{10} (≤10 micrometers), $PM_{2.5}$ (≤2.5 micrometers in diameter)]
- Carbon Monoxide (CO)
- Sulfur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Ozone (O_3)

The following meteorological parameters are also monitored at each site:

- Temperature
- Relative Humidity
- Barometric Pressure
- Wind Speed
- Wind Direction

Meteorological data is collected when pollutants are sampled to provide context for measurements and subsequently, trends that may emerge from them. This is particularly important, since meteorological conditions can affect the concentrations and behaviour of air pollutants in the ambient environment. For example, high temperatures, calm winds and high levels of solar radiation catalyse reactions between Oxides of Nitrogen (NO_X) and Volatile Organic Compounds (VOCs) from automobile exhaust to produce ground-level O_3.

Ambient air monitoring is an integral part of the EMA's air quality management programme. The data collected can be used to:

1. Assess the extent of air pollution;
2. Provide information on air quality trends and air quality indices;
3. Provide data for use in air quality models;
4. Support the revision of air quality standards (Schedule 1 of the APR, Maximum Permissible Levels for Ambient Air);
5. Evaluate the effectiveness of emissions control strategies;
6. Conduct impact assessments of source(s) categories;
7. Evaluate the effectiveness/impacts of land-use planning on air quality;
8. Provide real-time air pollution data to the general public; and
9. Support research.

The monitoring data for the fourth quarter was unavailable for the following:

1. $PM_{2.5}$, NO_2, O_3 and SO_2 at Point Lisas due to non-functioning equipment;
2. Port of Spain AAQMS for all parameters due to faulty air conditioning systems;
3. Signal Hill Tobago for all parameters due to lack of internet connectivity to access data and conduct verification checks.

2.0 MONITORING RESULTS FOR FOURTH QUARTER 2020

2.1 Particulate Matter (≤10 micrometers and ≤2.5 micrometers)

FIGURE 1: PARTICULATE MATTER (PM_{10}) CONCENTRATIONS FOR POINT LISAS OCTOBER – DECEMBER 2020

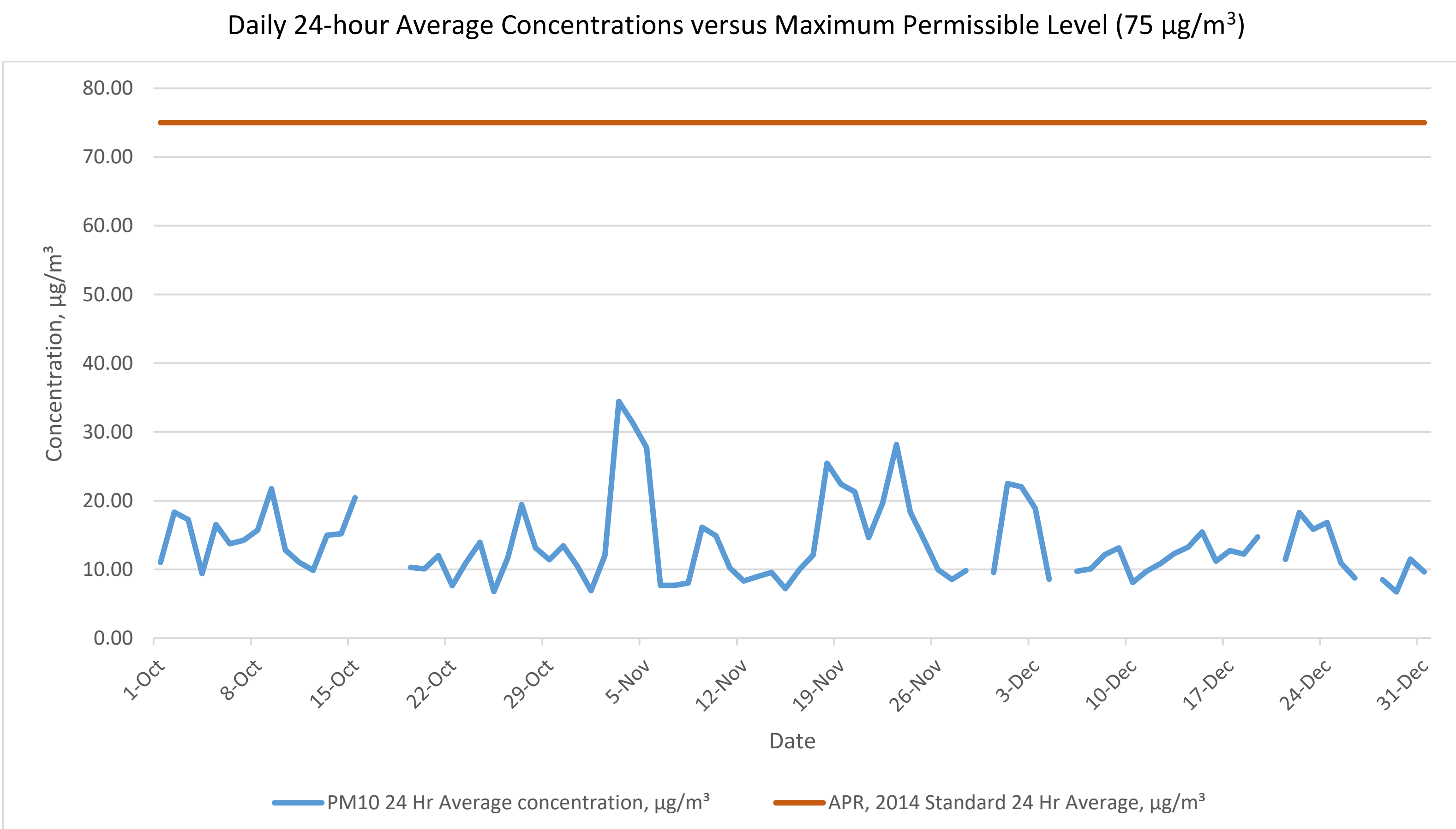


FIGURE 2: PARTICULATE MATTER (PM_{10}) CONCENTRATIONS FOR SAN FERNANDO, TRINIDAD, NOVEMBER – DECEMBER 2020

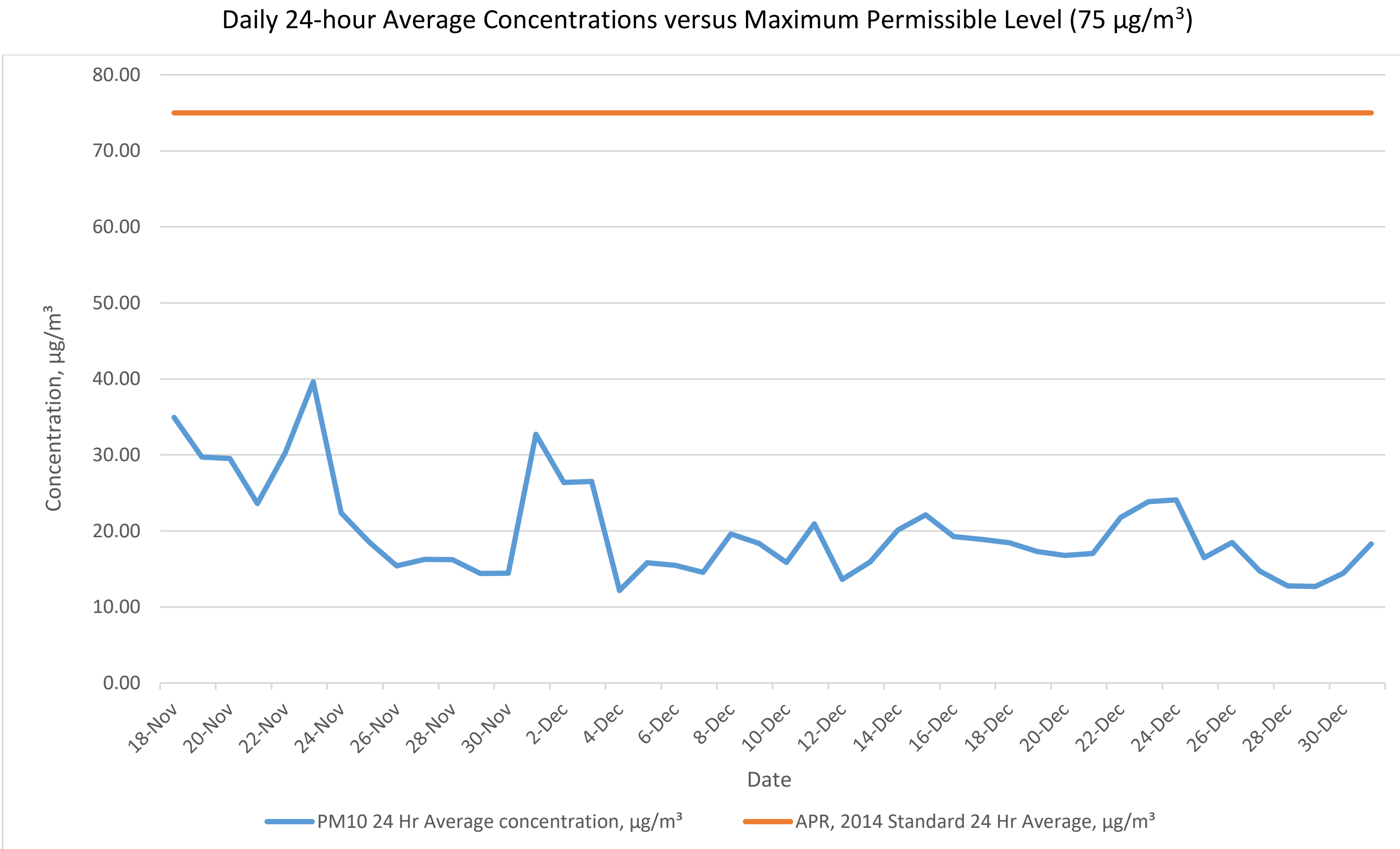


FIGURE 3: PARTICULATE MATTER ($PM_{2.5}$) CONCENTRATIONS FOR SAN FERNANDO, TRINIDAD, NOVEMBER – DECEMBER 2020

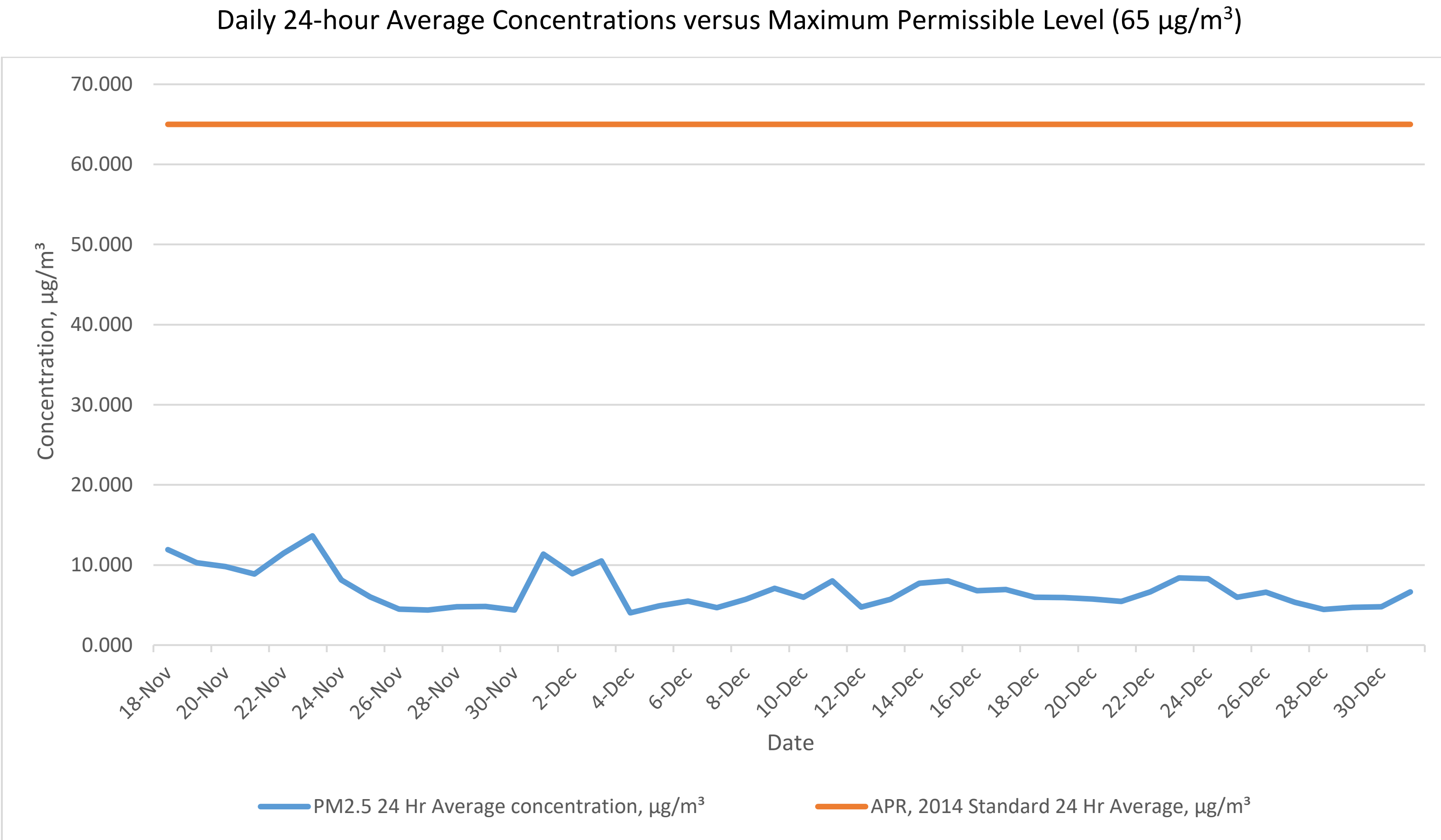


TABLE 1: MONTHLY SUMMARY DATA FOR PM_{10} and $PM_{2.5}$

POINT LISAS, TRINIDAD							
Month	**$PM_{2.5}$ µg/m³**				**PM_{10} µg/m³**		
	Monthly Average	**Max**	**Min**		**Monthly Average**	**Max**	**Min**
Oct-20	data unavailable				13.34	21.75	6.78
Nov-20					15.02	34.45	6.89
Dec-20					12.72	22.51	6.74
No. of Exceedances with APR, 2014	n/a days				0 days		
% of Valid Data	n/a%				70.72%		
SAN FERNANDO, TRINIDAD							
Month	**$PM_{2.5}$ µg/m³**				**PM_{10} µg/m³**		
	Monthly Average	**Max**	**Min**		**Monthly Average**	**Max**	**Min**
Nov-20	7.92	13.63	4.36		23.49	39.62	14.42
Dec-20	6.50	11.36	4.03		18.57	32.73	12.18
No. of Exceedances with APR, 2014	0 days				0 days		
% of Valid Data	98.50%				98.50%		

Notes:

1. PM_{10} data at Point Lisas was unavailable for period October 16-18, November 29, December 05 and 29, 2020 due to equipment downtime and communication errors. $PM_{2.5}$ data was unavailable for the fourth quarter.

2. Data for the PM_{10} and $PM_{2.5}$ at Port-of-Spain, Trinidad, were not presented in this report, due to analyser downtime due to malfunctioning air cooling system.

3. Data for PM_{10} and $PM_{2.5}$ is available from November 18, 2020 for San Fernando when the unit was commissioned.

4. The PM_{10} and $PM_{2.5}$ analysers at Signal Hill, Tobago, were inaccessible due to connectivity issues during the reporting period, hence data was not reported for the period.

2.2 Carbon Monoxide (CO)

FIGURE 4: CARBON MONOXIDE (CO) CONCENTRATIONS FOR POINT LISAS, OCTOBER – DECEMBER 2020

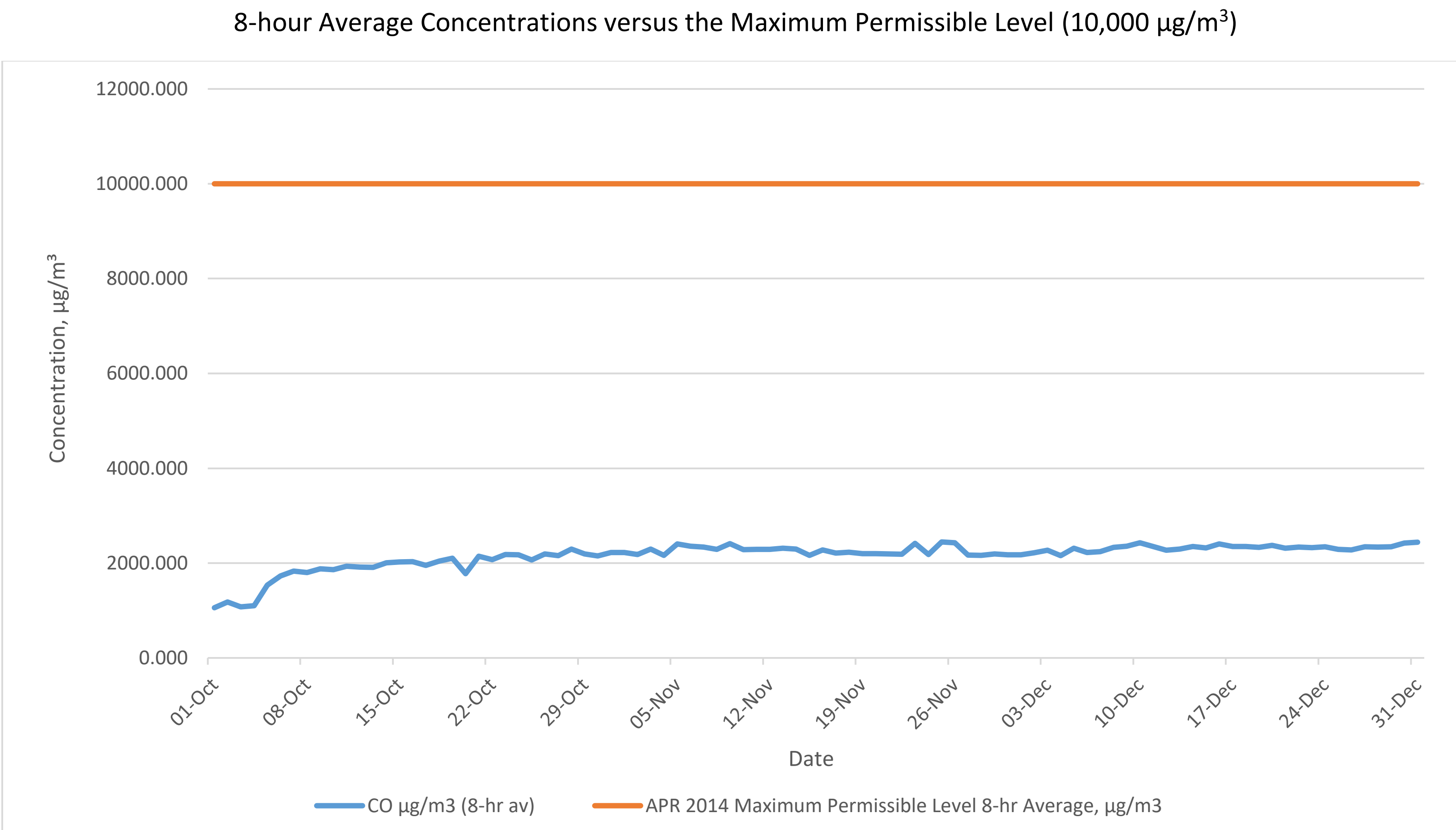


FIGURE 5: CARBON MONOXIDE (CO) CONCENTRATIONS FOR SAN FERNANDO, NOVEMBER - DECEMBER 2020

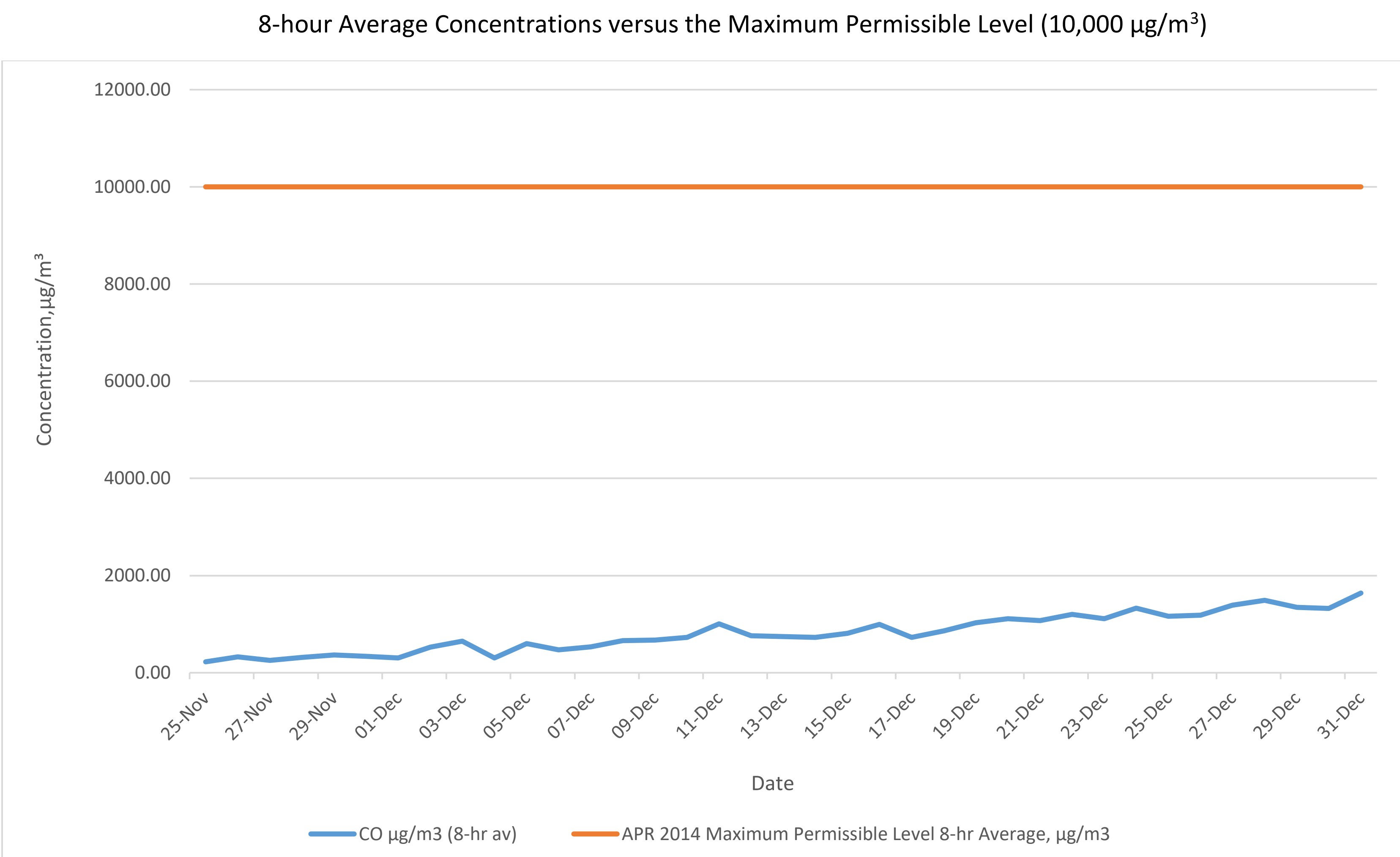


TABLE 2: MONTHLY SUMMARY DATA FOR CO

POINT LISAS, TRINIDAD CO µg/m³			
Month	**Monthly Average**	**Max**	**Min**
Oct-20	2000.444	3006.637	1058.613
Nov-20	2328.918	2603.313	2161.923
Dec-20	2391.105	2652.577	2155.407
No. of Exceedances with APR, 2014	0 days		
% of Valid Data	95.4%		
SAN FERNANDO, TRINIDAD CO µg/m³			
Nov-20	361.206	1427.687	124.857
Dec-20	845.039	1639.900	267.375
No. of Exceedances with APR, 2014	0 days		
% of Valid Data	95.2%		

Note:

1. Data for the CO analyser at Port-of-Spain, Trinidad, was not presented in this report, due to analyser downtime due to a malfunctioning air cooling system.

2. Data for San Fernando is reported from November 25, 2020. Data represents the period from completion of analyser's calibration and response validation checks subsequent to commissioning.

3. The CO analyser at Signal Hill, Tobago, was inaccessible due to connectivity issues during the reporting period, hence data was not reported for the period.

2.3 Nitrogen Dioxide (NO_2)

FIGURE 6: NITROGEN DIOXIDE (NO_2) CONCENTRATIONS FOR SAN FERNANDO, NOVEMBER 2020

1-hour Average Concentrations versus the Maximum Permissible Level (200 µg/m^3)

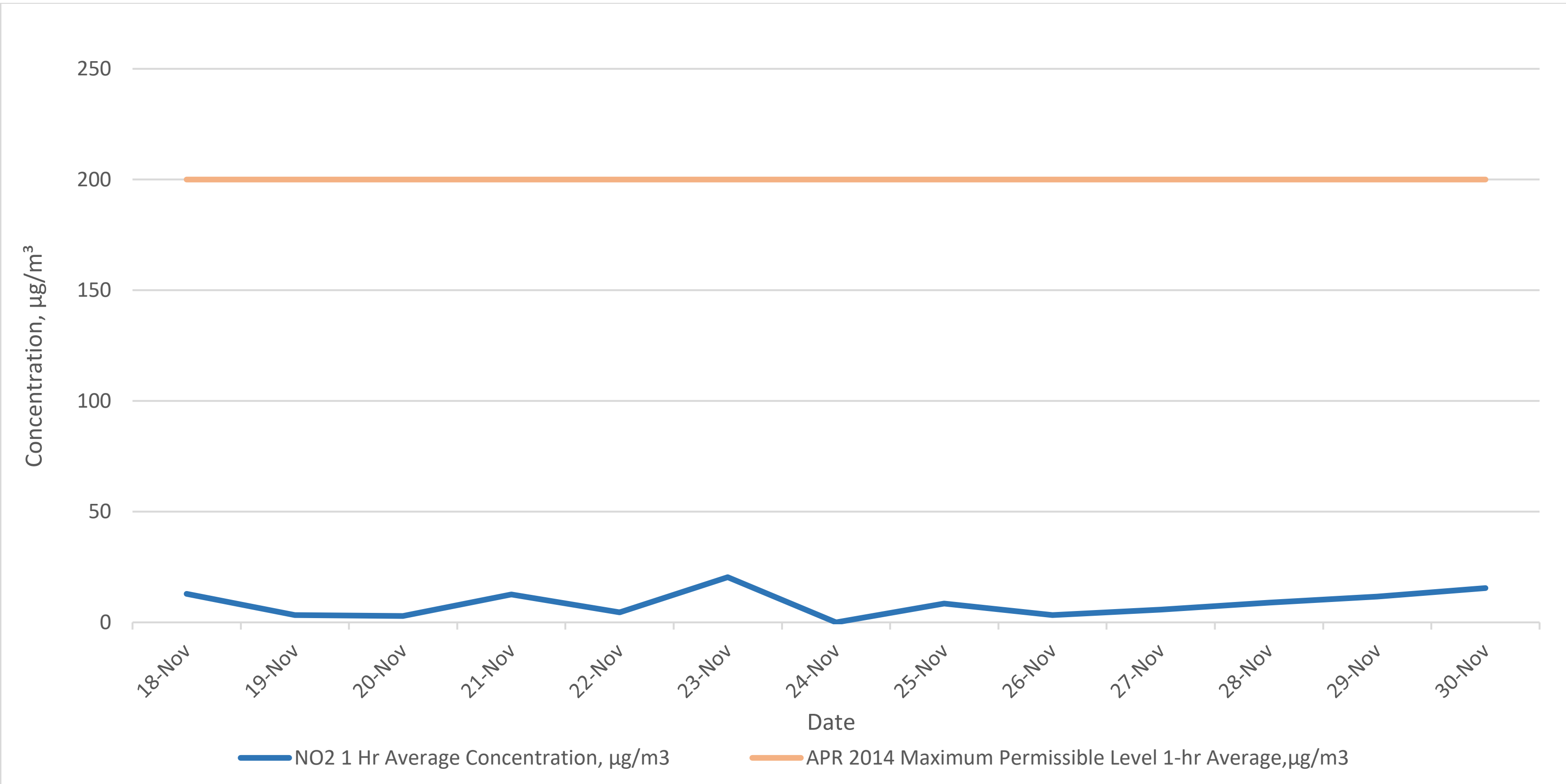


FIGURE 7: NITROGEN DIOXIDE (NO_2) CONCENTRATIONS FOR SAN FERNANDO, DECEMBER 2020

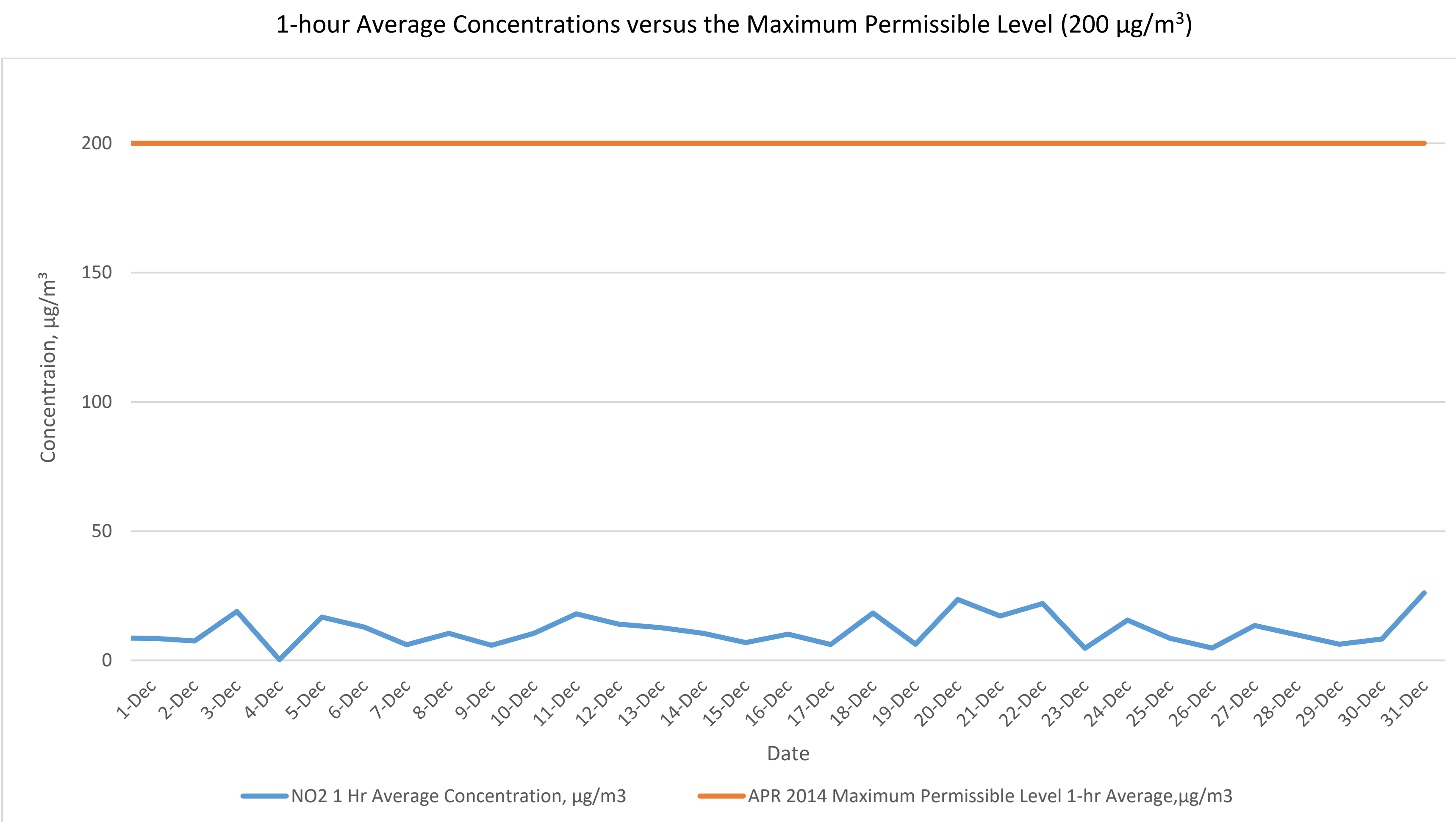


TABLE 3: MONTHLY SUMMARY FOR NO_2 FOR SAN FERNANDO, NOVEMBER – DECEMBER 2020

SAN FERNANDO, TRINIDAD NO_2 µg/m^3			
Month	**Monthly Average**	**Max**	**Min**
Nov-20	10.64	33.92	0.56
Dec-20	11.23	42.04	0.56
No. of Exceedances with APR, 2014	0 days		
% of Valid Data	97.65%		

Note:

1. Data for San Fernando is reported from November 18, 2020. Data represents the period from completion of analyser's calibration and response validation checks subsequent to commissioning.

2. Data for the NOx analyser at Point Lisas, Trinidad, was not presented in this report, due to analyser downtime due to a malfunctioning heater.

3. Data for the NOx analyser at Port-of-Spain, Trinidad, was not presented in this report, due to analyser downtime due to a malfunctioning air conditioning system.

3. The NOx analyser at Signal Hill, Tobago, was inaccessible due to connectivity issues during the reporting period, hence data was not reported for the period.

2.4 Ozone (O_3)

FIGURE 8: OZONE (O_3) CONCENTRATIONS FOR SAN FERNANDO, TRINIDAD, NOVEMBER – DECEMBER 2020

8-hour Averages Concentrations versus the Maximum Permissible Level (120 μg/m³)

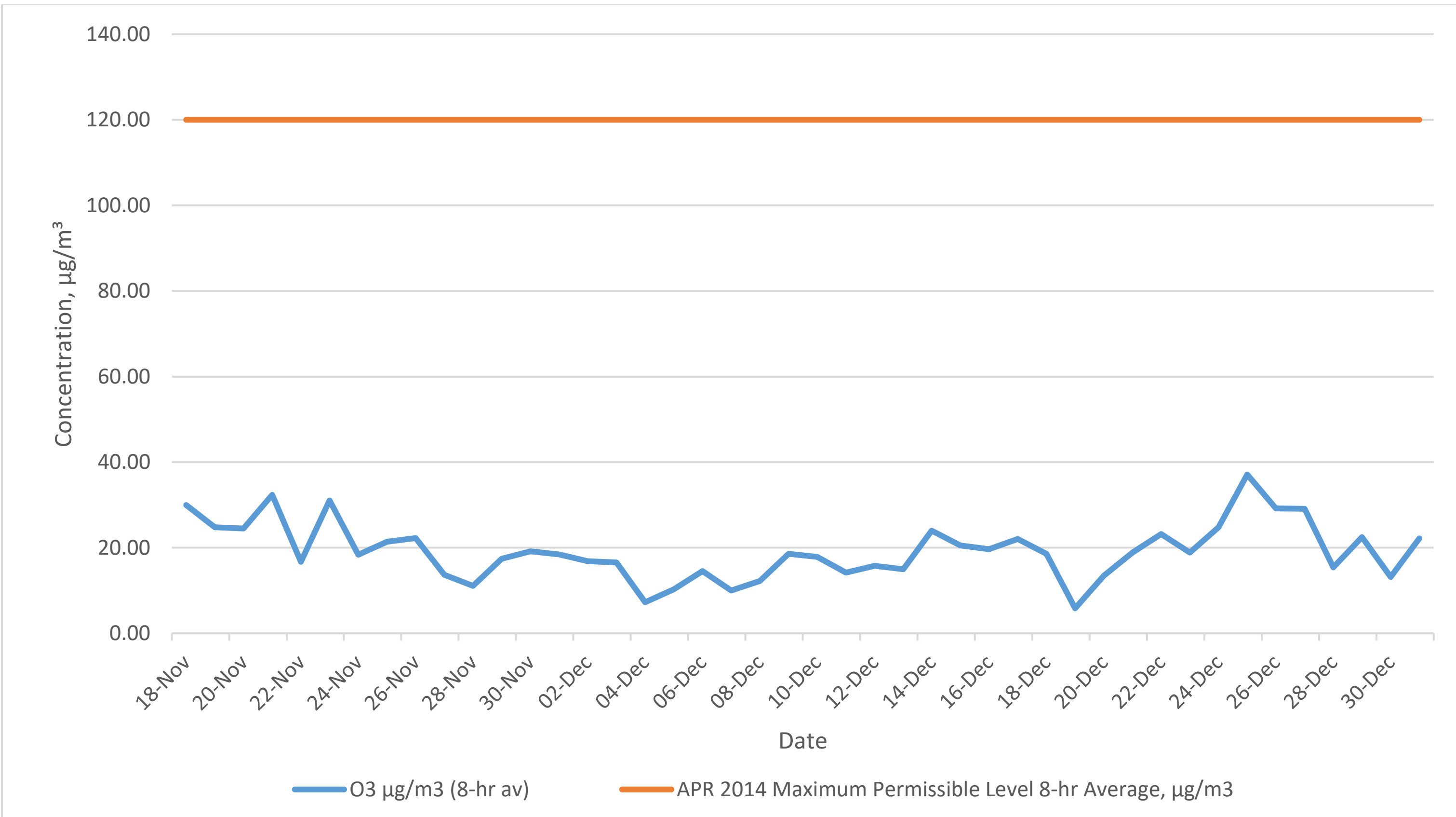


TABLE 4: MONTHLY SUMMARY FOR O_3

SAN FERNANDO, TRINIDAD O_3 µg/m^3			
Month	**Monthly Average**	**Max**	**Min**
Nov -20	24.87	39.44	4.92
Dec-20	21.10	49.42	1.16
No. of Exceedances with APR, 2014	0 days		
% of Valid Data	96.11%		

Note:

1. Data for San Fernando is reported from November 18, 2020. Data represents the period from completion of analyser's calibration and response validation checks subsequent to commissioning.

2. The O_3 analyser at Point Lisas, Trinidad was down due to a faulty AC unit for the reporting period October – December, 2020.

3. The O_3 analyser at Port-of-Spain, Trinidad was down due to a faulty AC unit for the reporting period October – December, 2020.

4. The O_3 analyser at Signal Hill, Tobago was inaccessible due to connectivity issues during the reporting period, hence data was not reported for the period.

2.5 Sulfur Dioxide (SO_2)

The Sulfur Dioxide concentration at San Fernando for the period November 18 to December 31, 2020 was mostly below the analyser's detection level. The maximum value recorded for November was 9.68 µg/m^3 whilst the maximum for December was 8.37 µg/m^3. The APR Maximum Permissible 24-hour average for SO_2 is 125 µg/m^3 and no exceedances were recorded for San Fernando.

Sulfur Dioxide data was unavailable for the reporting period October to December 2020 for Point Lisas, Port of Spain and Signal Hill. The SO_2 analysers at Point Lisas and Port- of-Spain were non-functional due to a faulty AC unit, whilst the analyser at Signal Hill was inaccessible due to connectivity issues during the reporting period.

2.6 Air Quality Index (AQI)

TABLE 5: AQI SUMMARY FOR POINT LISAS, TRINIDAD FOR THE PERIOD OCTOBER – DECEMBER 2020

AQI Category	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2
Good	83	n/a	n/a	65	n/a	n/a
Moderate	0	n/a	n/a	4	n/a	n/a
Unhealthy (Sensitive)	0	n/a	n/a	1	n/a	n/a
Unhealthy	0	n/a	n/a	0	n/a	n/a
Very Unhealthy	0	n/a	n/a	0	n/a	n/a
Hazardous	0	n/a	n/a	0	n/a	n/a
TOTAL	**83**	**n/a**	**n/a**	**70**	**n/a**	**n/a**

AQI by percentage for PM_{10}: Good = 92.9%, Moderate = 5.7%, Unhealthy = 1.4%

Note:
1. NO_2, O_3, $PM_{2.5}$ and SO_2 were unavailable due to equipment downtime

TABLE 6: AQI SUMMARY FOR SAN FERNANDO, TRINIDAD FOR THE PERIOD NOVEMBER18 – DECEMBER 31, 2020

AQI Category	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2
Good	31	33	36	38	44	n/a
Moderate	0	0	0	6	0	n/a
Unhealthy (Sensitive)	0	0	0	0	0	n/a
Unhealthy	0	0	0	0	0	n/a
Very Unhealthy	0	0	0	0	0	n/a
Hazardous	0	0	0	0	0	n/a
TOTAL	**31**	**33**	**36**	**44**	**44**	**n/a**

AQI by percentage for PM_{10}: Good = 86.4%, Moderate = 13.6%

Note:
1. AQI for Port of Spain for all parameters were unavailable due to equipment downtime.

2. AAQMS at Signal Hill, Tobago was inaccessible during the reporting period, hence data was not reported for the period.

3.0 OBSERVED TRENDS FOR THE PERIOD OCTOBER – DECEMBER, 2020

3.1 Saharan Dust Occurrences and its Relationship with Particulate Matter and the AQI

The Saharan Air Layer (SAL) is a mass of very dry, dusty air which forms over the Sahara Desert during the late spring, summer, and early fall and usually moves out over the tropical North Atlantic Ocean every 3-5 days. The National Oceanic and Atmospheric Administration (NOAA) states that the SAL extends between 5,000 to 20,000 feet in the atmosphere and is associated with large amounts of mineral dust, dry air and strong winds (~10-25 m/s). These strong winds, or jets, are usually found between 6,500-14,500 feet above the surface in the central and western North Atlantic and have a depth of ~1-2 miles.

For the fourth quarter of 2020, there were no Saharan dust events for October, whilst November and December recorded twelve (12) and three (3) events respectively. There were no exceedances of the APR, 2014 for PM_{10} at Point Lisas and San Fernando for the days with Saharan dust. The AQI during the reporting period were generally good.

Table 7 illustrates that on days with Saharan dust occurrences, the AQI values were either good or moderate. Moderate AQI were noted for four Saharan dust days during November 2020 for Point Lisas and four days in November and one day for December at San Fernando. The PM_{10} concentrations at Point Lisas and San Fernando for the Saharan dust days were less than the APR, 2014 maximum permissible level.

The highest AQI for days with Saharan dust for Point Lisas was 58 with a corresponding PM_{10} concentration of 34.447$\mu g/m^3$ on November 03, 2020, whilst for San Fernando, the highest AQI was 63 occurring on November 23, 2020 with a corresponding PM_{10} concentration of 39.616 $\mu g/m^3$.

TABLE 7: SAHARAN DUST OCCURRENCES FOR OCTOBER – DECEMBER 2020

Saharan Dust Events[1]	PM_{10} Concentrations µg/m³		$PM_{2.5}$ Concentrations µg/m³		AQI (Based on PM_{10})	
	Pt Lisas	San Fernando	Pt Lisas	San Fernando	Pt Lisas	San Fernando
11/02/2020	12.075		n/a		23	
11/03/2020	34.447		n/a		58	
11/04/2020	31.345		n/a		55	
11/05/2020	27.729		n/a		51	
11/06/2020	7.693		n/a		13	
11/19/2020	22.424	29.729	n/a	10.294	42	53
11/20/2020	21.278	29.535	n/a	9.802	38	53
11/21/2020	14.658	23.607	n/a	8.872	28	45
11/22/2020	19.622	30.318	n/a	11.456	36	54
11/23/2020	28.173	39.616	n/a	13.635	50	63
11/24/2020	18.341	22.371	n/a	8.125	35	42
11/25/2020	14.253	18.552	n/a	6.010	25	34
12/01/2020	22.511	32.729	n/a	11.360	44	56
12/02/2020	22.035	26.380	n/a	8.908	n/a	49
12/03/2020	18.898	26.516	n/a	10.498	n/a	45

Key:
n/a – insufficient data
APR, 2014 standard: PM_{10} - 75 µg/m³ and $PM_{2.5}$ - 65 µg/m³
0-50 – AQI Good
51-100 – AQI Moderate
101-150 – AQI Unhealthy for Sensitive Groups
151-200 - AQI Unhealthy
201-300– AQI Very Unhealthy
301-500 – AQI Hazardous

[1] Data provided by the Trinidad and Tobago Meteorological Services

3.2 Saharan Dust Filter tape Analysis

The most significant Saharan dust event for 2020 occurred on June 21, 2020. This was noted to be the most severe event on record for Trinidad and Tobago. The AQI value was 485 and was the first hazardous AQI value to be recorded since the establishment of the AAQMS at Signal Hill, Tobago in 2018. The corresponding PM_{10} concentration recorded was 294.40 µg/m^3, almost four times the permissible level stated in the APR.

In addition to the high PM_{10} concentration and AQI value, the hourly samples deposited onto the Filter Tapes in the BAM 1020 monitors were noticed to be a bright orange colour. This observation prompted further investigation and the EMA collaborated with the University of the West Indies to analyze samples during Saharan and non-Saharan dust events.

The PM_{10} and $PM_{2.5}$ deposited on the Filter Tapes were analyzed by the University of the West Indies, Department of Chemistry. Analysis of the samples were conducted for Mineral composition; Chemistry composition (e.g., metals, organics); Elemental analysis; and Electron microscope images.

Seventeen filter tape samples containing hourly concentrations of particulate matter representing days with and without Saharan Dust during the period April to June 2020 were submitted for analysis and comprised the following:

- Non – Saharan dust days, six (6) samples – three (3) $PM_{2.5}$ samples and three (3) PM_{10} samples;
- Saharan dust days, eleven (11) samples – three (3) $PM_{2.5}$ samples and eight (8) PM_{10} samples.

Analyses for metallic species content on Saharan and Non-Saharan dust days for PM_{10} and $PM_{2.5}$ was performed by the use of digestion methods and analyses via Flame Atomic Absorption Spectroscopy (FAAS) for mineral metals Iron (Fe), Zinc (Zn), Copper (Cu), Calcium (Ca), Nickel (Ni), Magnesium (Mg), Potassium (K) and trace metals, Chromium (Cr), Magnesium (Mg), Cadmium (Cd) and Lead (Pb).

Of the eleven (11) elements analysed, only five metals, Fe, Ca, Zn, Cu and Pb were present. The other metals were below the detection limit of the machine used. Figures 9 to 14 illustrates the summary results. The analysis found that Fe, Ca, Zn and Cu were more prevalent in samples collected on non-Saharan dust days. The results shows that $PM_{2.5}$ samples contained higher concentrations of these metals. Ca was the most abundant species found in the dust samples. The highest recorded concentration of Pb was found in PM_{10} sample for June 21, which was a Saharan active day. Detailed analysis of the results is presented in Research Paper *'Establishment of a Baseline for Particulate Matter (PM_{10}), Nitrogen Dioxide (NO_2) and Ozone (O_3) Emissions Related to Vehicular Emissions in Point Lisas, Trinidad, and a Discussion of the Associated Health Impacts'*.

Results of further analyses conducted will be presented in subsequent reports.

FIGURE 9: CONCENTRATION OF PM_{10} AND $PM_{2.5}$ ON ACTIVE AND NON-ACTIVE SAHARAN DUST DAYS

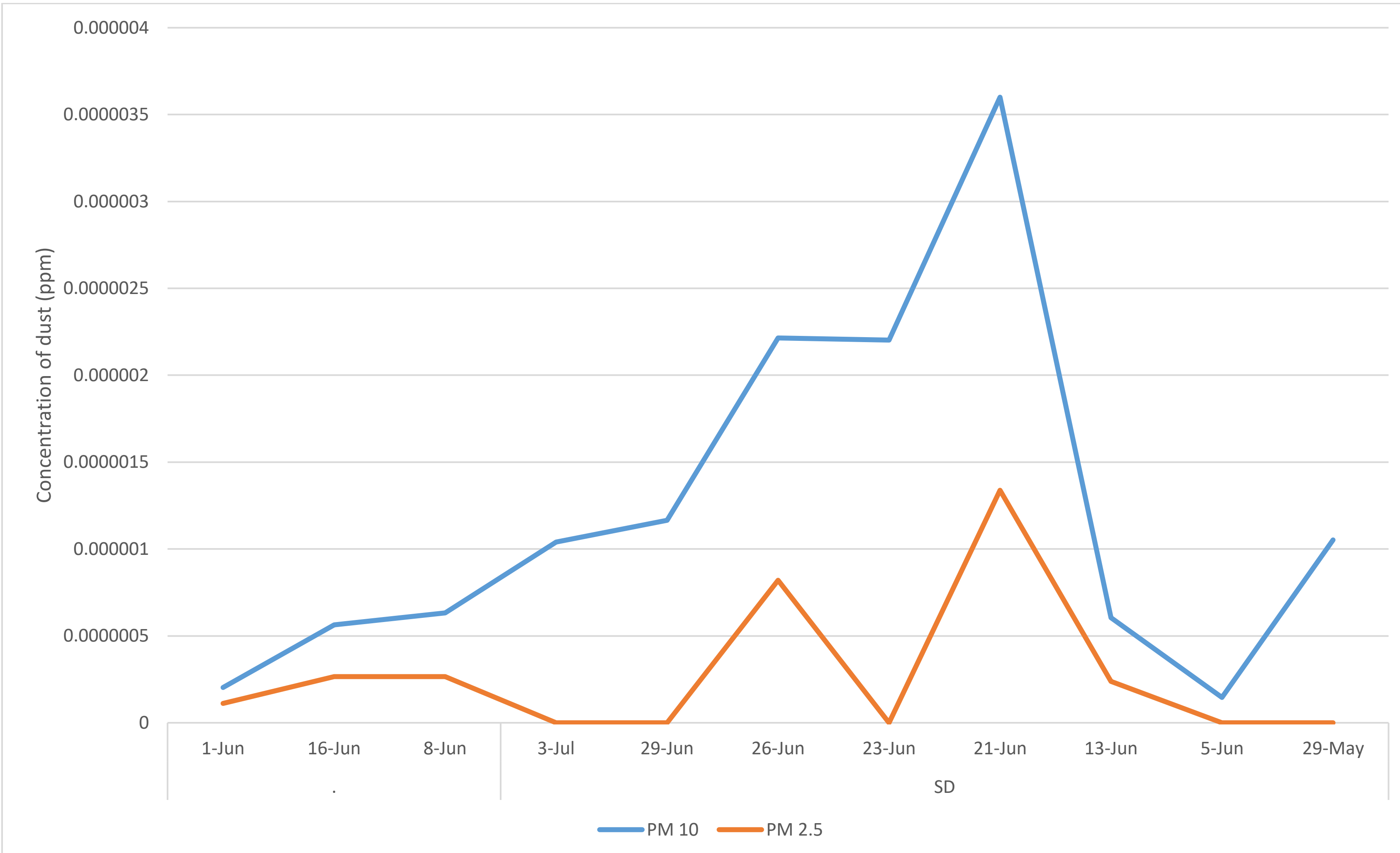


FIGURE 10: CONCENTRATION OF PM10 AND PM2.5 Fe (mg/kg) ON ACTIVE AND NON-ACTIVE SAHARAN DUST DAYS

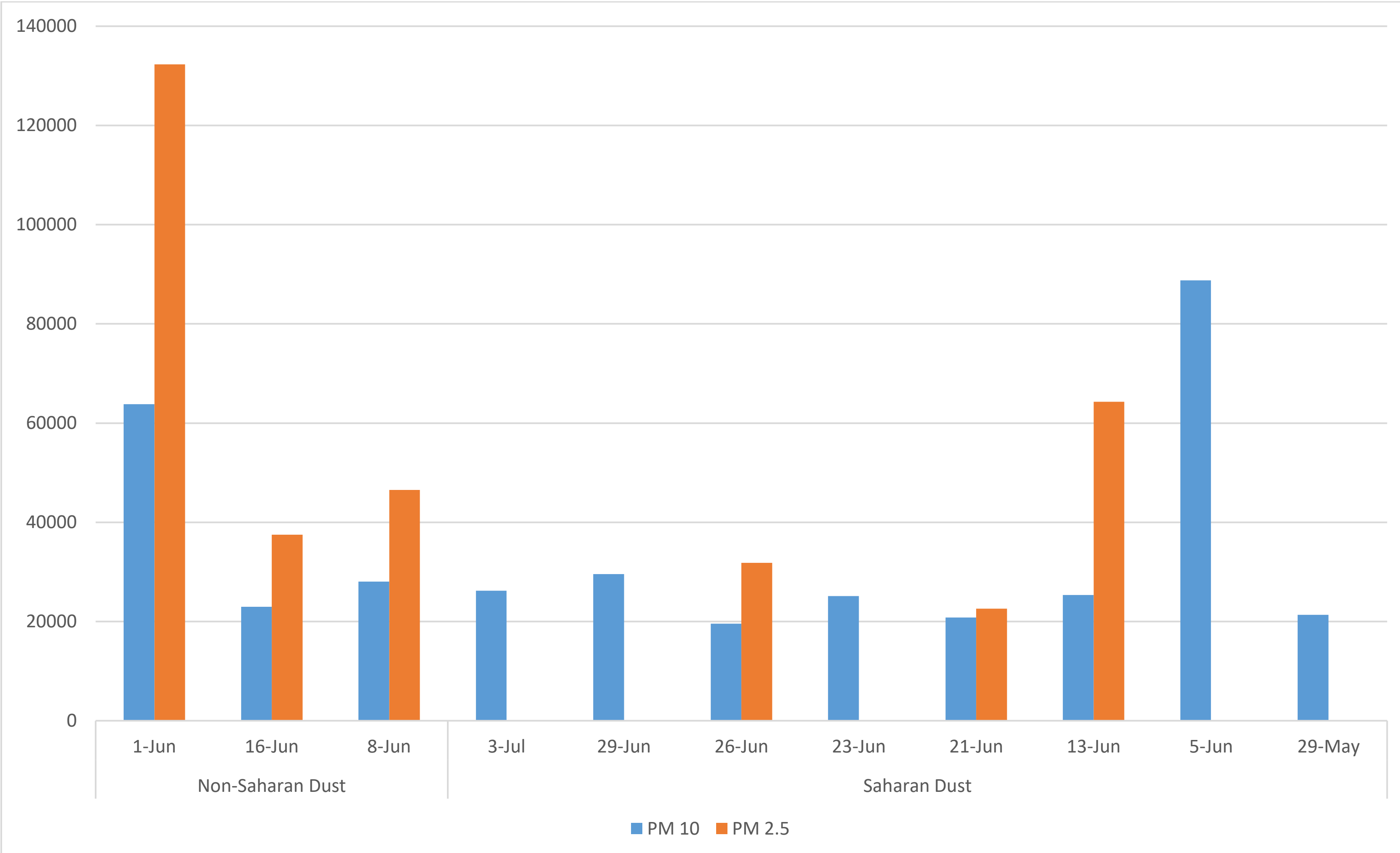


FIGURE 11: CONCENTRATION OF PM_{10} AND $PM_{2.5}$ Ca (mg/kg) ON ACTIVE AND NON-ACTIVE SAHARAN DUST DAYS

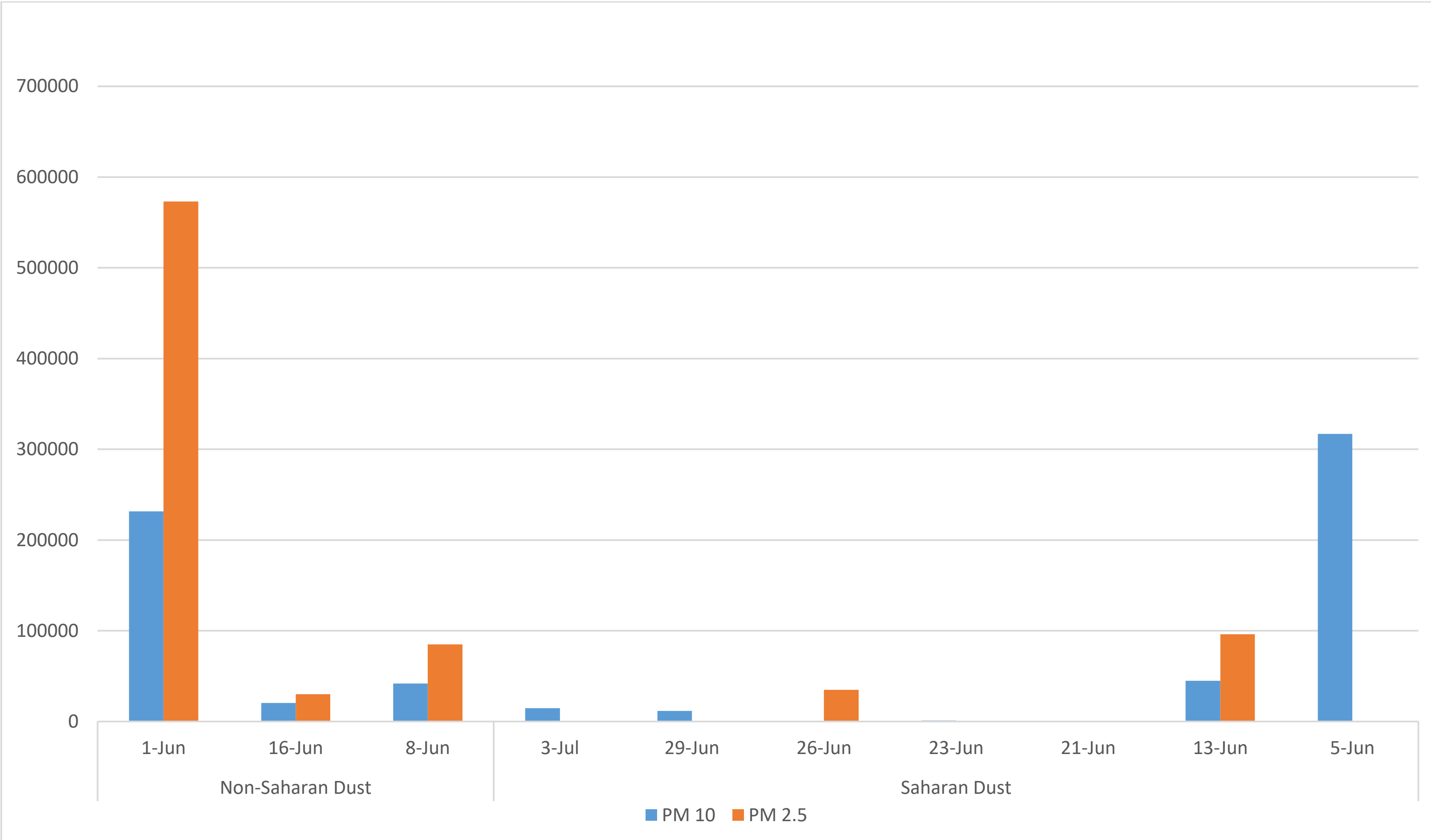


FIGURE 12: CONCENTRATION OF PM_{10} AND $PM_{2.5}$ Zn (mg/kg) ON ACTIVE AND NON-ACTIVE SAHARAN DUST DAYS

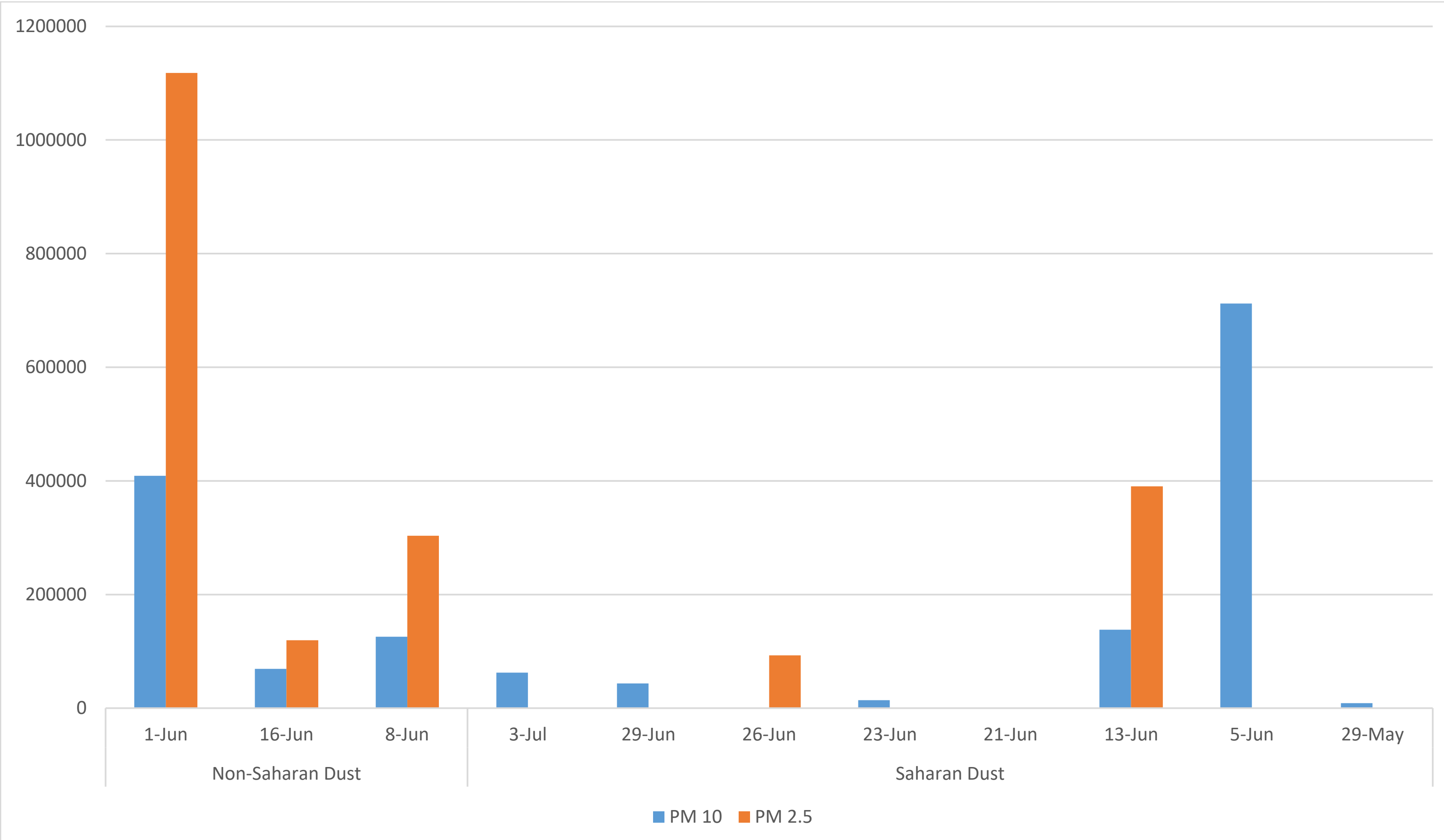


FIGURE 13: CONCENTRATION OF PM_{10} AND $PM_{2.5}$ Cu (mg/kg) ON ACTIVE AND NON-ACTIVE SAHARAN DUST DAYS

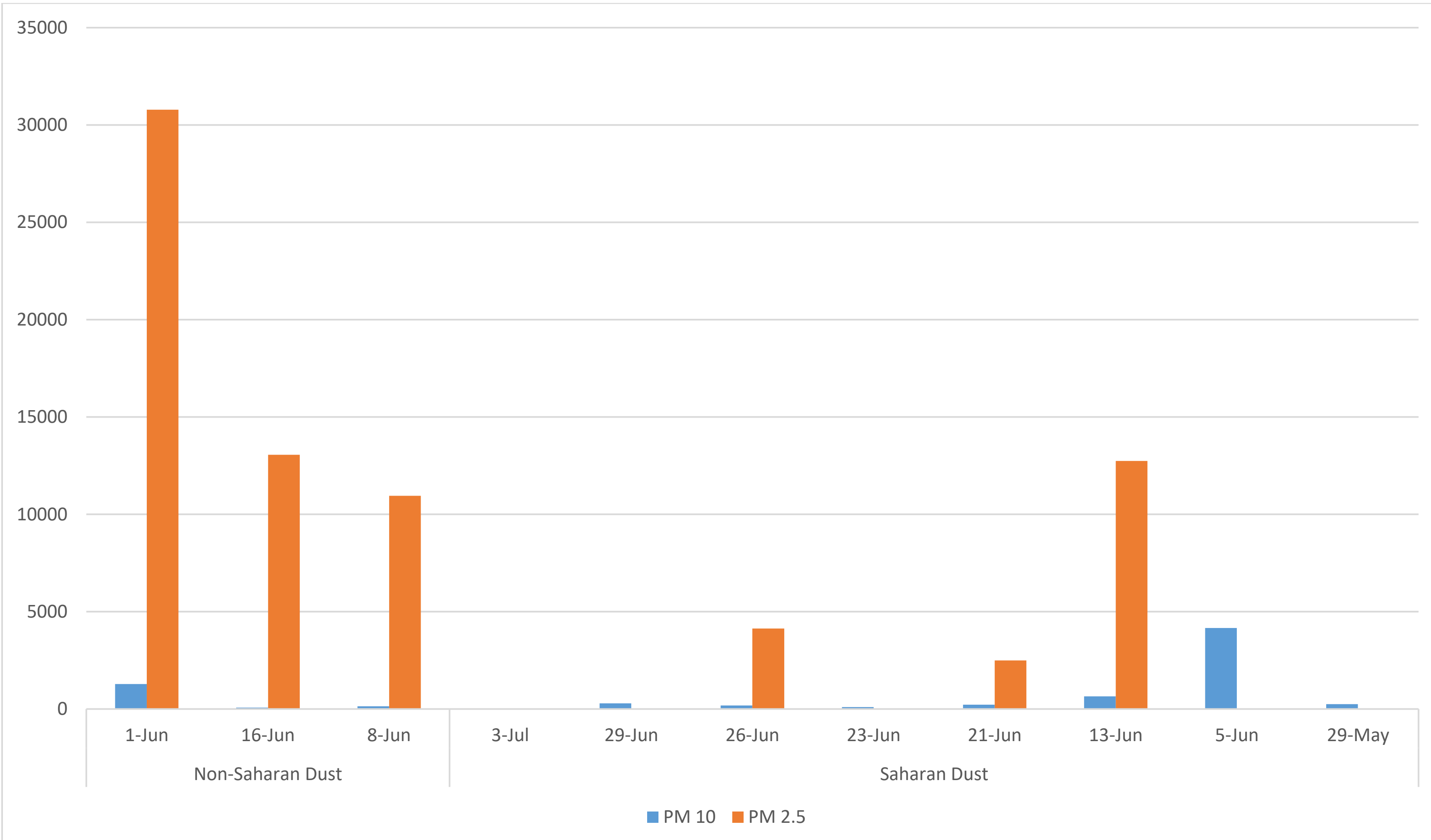
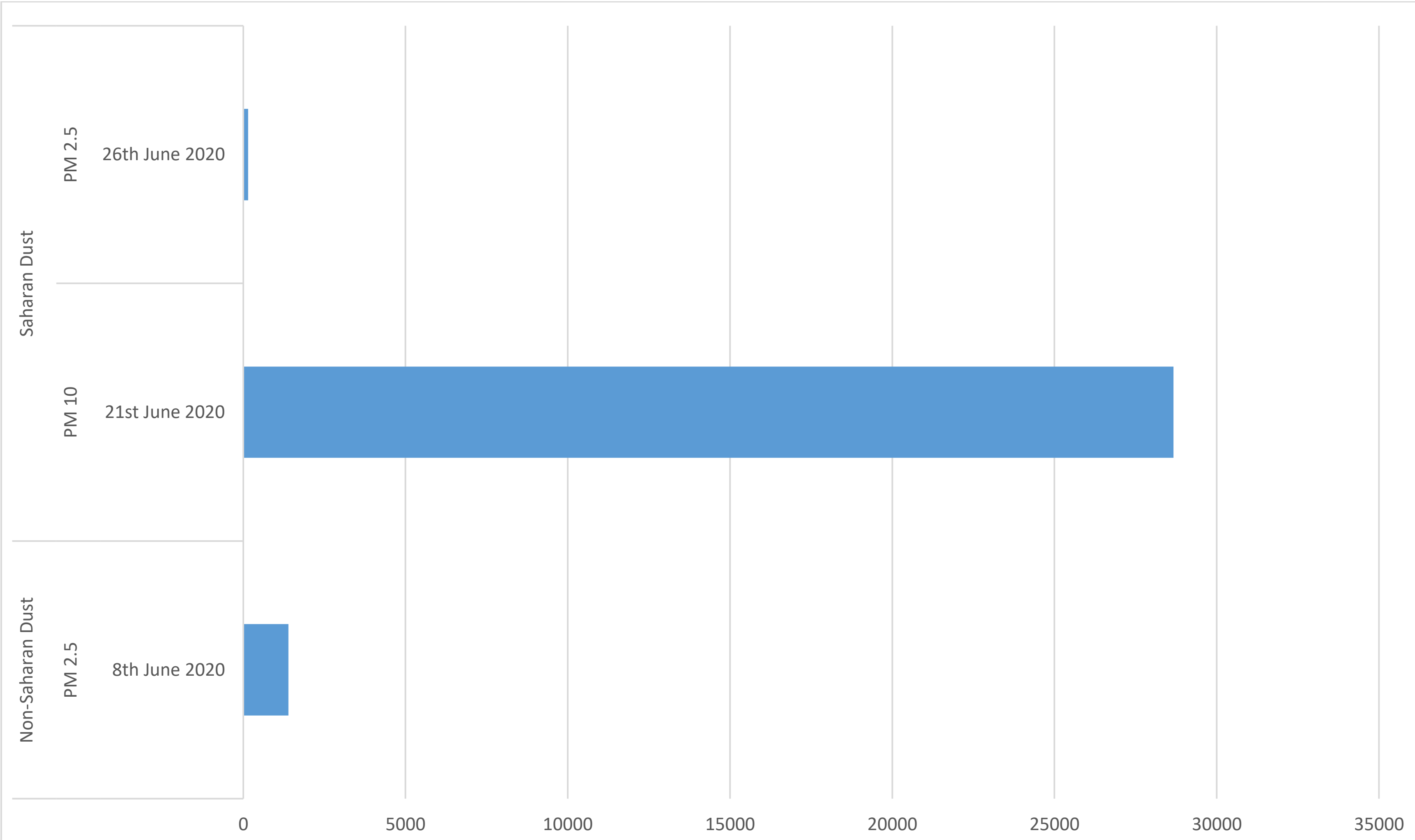


FIGURE 14: CONCENTRATION OF PM_{10} AND $PM_{2.5}$ Pb (mg/kg) ON ACTIVE AND NON-ACTIVE SAHARAN DUST DAYS



4.0 CONCLUSION

The data analysed for the fourth quarter of 2020 demonstrates that the ambient air quality for Trinidad and Tobago, for the criteria pollutants, is acceptable and within the APR 2014 Maximum Permissible levels. There were no days during the period October to December, 2020 where concentrations for measured pollutants exceeded the maximum permissible limits in the APR.

Ambient air quality monitoring data was not reported for the following parameters during the fourth quarter:

1. $PM_{2.5}$, NO_2, O_3 and SO_2 data was unavailable for the Point Lisas AAQMS;
2. Data for all parameters were unavailable for the Port-of-Spain AAQMS;
3. Data for all parameters for the Signal Hill, Tobago AAQMS.

For the San Fernando monitoring location, all parameters are reported from the date of verification of the analyzers. The AAQMS at San Fernando was added to the AAQMN during the fourth quarter of 2020. The station was installed and commissioned by the Air Unit. Calibration and verification of the analyzers response were completed between November 18 and 25 for all analyzers.

The Tobago station was offline during this reporting period due to internet connectivity issues. The IT Unit was engaged and the issue remained unresolved at the time of this report preparation.

Saharan dust events were recorded on fifteen days during the fourth quarter. There were no exceedances of the APR 2014 Maximum Permissible levels noted for PM_{10} on the days with Saharan dust during the fourth quarter. For Saharan dust days, the AQI values were generally good with four instances of AQI values being moderate for Point Lisas and five instances at San Fernando.

The analyses conducted by UWI for PM_{10} and $PM_{2.5}$ samples for Saharan and Non-Saharan dust days found the presence of Fe, Ca, Zn, Cu and Pb with Ca being the most abundant. The $PM_{2.5}$ samples contained higher concentrations of these metals. The highest recorded concentration of Pb was found in PM_{10} sample for June 21 which was a Saharan active day.

5.0 REFERENCES

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APPENDIX 1

AIR QUALITY STANDARDS

The APR was developed under Sections 26, 27, 49, 50 and 51 of the Environmental Management Act, Chapter 35:05 of 2000. The aim of the APR is to protect human health and the environment from the adverse effects of air pollution. This is achieved by identifying the activities that generate air pollutants (i.e., Schedule 3) and by setting permissible levels or standards for Point Sources/ Stack Emissions (i.e., Schedule 2) and Ambient Air (i.e., Schedule 1). Priority is given to meeting the permissible levels or standards for Schedule 1, ambient air [Sub-rule 19(2)].

The ambient air quality standards for the criteria pollutants are identified in Table A1-1 below.

TABLE A1-1: AMBIENT AIR QUALITY STANDARDS FOR CRITERIA POLLUTANTS

Parameter	Short-Term Maximum Permissible Levels		Long-Term Maximum Permissible Levels	
	Maximum Permissible Levels	Averaging Time	Maximum Permissible Levels	Averaging Time
PM_{10}	75 µg/m^3	24 hours	50 µg/m^3	1 year
$PM_{2.5}$	65 µg/m^3	24 hours	15 µg/m^3	1 year
Carbon Monoxide (CO)	100 000 µg/m^3	15 minutes		
	60 000 µg/m^3	30 minutes		
	30 000 µg/m^3	1 hour		
	10 000 µg/m^3	8 hours		
Nitrogen Dioxide (NO_2)	200 µg/m^3	1 hour		
Sulfur Dioxide (SO_2)	500 µg/m^3	10 minutes		
	125 µg/m^3	24 hours		
Ozone (O_3)	120 µg/m^3	8 hours		

The APR standards are classified as primary standards since they protect against adverse effects on the health of vulnerable populations such as persons with underlying health conditions e.g., heart disease and asthmatics. The standard for each pollutant may have different averaging times (e.g., hourly and 8-hour averages). These different forms of the standard are created and enforced to address varied health impacts that occur as a result of shorter, high-level exposure versus longer, low-level exposure.

APPENDIX 2

HEALTH AND ENVIRONMENTAL IMPACTS OF MONITORED POLLUTANTS

A2.1 Carbon Monoxide (CO)

Carbon Monoxide (CO) is a colourless, odourless gas emitted from combustion processes. Elevated levels of CO in ambient air can occur in areas with heavy traffic congestion, as internal combustion engines do not completely convert burnt fuel to Carbon Dioxide (CO_2) and water.

CO can cause harmful health effects by reducing oxygen delivery to the body's organs and tissues and can result in death at very high levels. People with cardiovascular disease or respiratory problems might experience chest pain and increased cardiovascular symptoms, particularly while exercising if CO levels are high. High levels of CO can affect alertness and vision even in healthy individuals. Its environmental effects include acid rain, which can corrode buildings and monuments after prolonged exposures or in high concentrations.

A2.2 Nitrogen Dioxide (NO_2)

The term "NO_X" refers to Oxides of Nitrogen, which includes nitric oxide (NO) and NO_2. NO_2 is used as the indicator for the larger group of oxides of nitrogen. NO_2 forms quickly from emissions from internal combustion engines e.g., cars, trucks, buses, and off-road equipment. Other sources include emissions from power plants.

NO_2 is linked with a number of adverse effects on the respiratory system. It can irritate the lungs and lower resistance to respiratory infections such as influenza. It may cause increased incidence of acute respiratory illness in children. NO_X react with ammonia, moisture, and other compounds to form small particles. These small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease, such as emphysema and bronchitis, and can aggravate existing heart disease, leading to increased hospital admissions and premature death. O_3 is formed when NO_X and VOCs react in the presence of heat and sunlight. Excessive O_3 in the air can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases in humans.

NO_X play a significant role in the formation of photochemical smog. It contributes to the greenhouse effect, and also plays a role in the depletion of the ozone layer and production of acid rain. It can adversely affect terrestrial and aquatic ecosystems and result in the eutrophication of coastal waters.

A2.3 Ozone (O_3)

Ground level ozone (O_3) is not emitted directly into the air, but is formed by chemical reactions between NO_X and Volatile Organic Compounds (VOCs) in the presence of sunlight. Emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapours, and chemical solvents are some of the major sources of NO_X and VOC.

Breathing O_3 can irritate the lungs and throat in both healthy adults and children and those with impaired respiratory systems (such as asthmatics). It reduces lung function and induces respiratory inflammation in normal, healthy people during periods of moderate exercise. Symptoms can include chest pain, coughing, nausea, and pulmonary congestion. Repeated exposure can cause permanent structural damage in the lungs. Studies have shown that it reduces visibility. In addition to its health effects, ground level O_3 can also have harmful effects on sensitive vegetation and ecosystems.

A2.4 Sulfur Dioxide (SO_2)

Sulfur Dioxide (SO_2) is one of a group of highly reactive gases known as "Oxides of Sulfur". It is a colourless, reactive gas produced by burning fuels containing sulfur and by industrial processes. The largest source of SO_2 in the atmosphere is the burning of fossil fuels by power plants and other industrial facilities. Smaller sources of SO_2 emissions include, natural sources such as volcanoes, industrial processes, such as, extracting metal from ore, ships and other vehicles and heavy equipment that burn fuel with a high sulphur content.

Current scientific evidence links short-term exposures to SO_2, ranging from 5 minutes to 24 hours, with an array of adverse respiratory effects, including bronchoconstriction and increased asthma symptoms. These effects are particularly important for asthmatics at elevated ventilation rates, for example, while exercising or playing. SO_2 emissions that lead to high concentrations of SO_2 in the air also lead to the formation of other Oxides of Sulfur (SO_X), which can react with other compounds in the atmosphere to form small particles. These particles contribute to Particulate Matter (PM) pollution and can penetrate deeply into sensitive parts of the lungs causing additional health problems. SO_2 is a precursor to sulphates which are associated with acidification of lakes, streams and soil.

A2.5 Particulate Matter [≤10 micrometers (PM_{10}) and ≤2.5 micrometers ($PM_{2.5}$)]

Particulate Matter also known as particle pollution or PM is defined by the US EPA as a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals and soil or dust particles.

The size of particles is directly linked to their potential for causing health problems. The US EPA groups particle pollution into two categories:

- "Inhalable coarse particles," such as those found near roadways and dusty industries, are larger than 2.5 micrometers and smaller than 10 micrometers in diameter.
- "Fine particles," such as those found in smoke and haze, are 2.5 micrometers in diameter and smaller. These particles can be directly emitted from sources such as forest fires, or they can form when gases emitted from power plants, industries and automobiles react in the air.

Another source of PM in Trinidad and Tobago is Saharan Dust which results in elevated PM levels when present in the atmosphere.

PM_{10} includes both fine and coarse particles and can aggravate respiratory conditions such as asthma. Particles smaller than 2.5 micrometers in diameter are called “fine particles” or $PM_{2.5}$. $PM_{2.5}$ generally comes from wood burning, agricultural burning and vehicle exhaust including cars, diesel trucks and buses. Secondary sources include the formation of fine particulate in the atmosphere by complex reactions of chemicals such as SO_2 and NO_X, which are pollutants emitted from power plants, industries and automobiles.

PM exposure can lead to serious health effects since the particles can penetrate and lodge deep inside the lungs. Fine particles are most closely associated with increased respiratory disease, decreased lung function and even premature death. Older adults, children and people with some illnesses are most sensitive and more likely to develop heart and lung problems associated with PM. Chronic exposure to particles contributes to the risk of developing cardiovascular and respiratory diseases, as well as of lung cancer. Small particulate pollution can have health impacts even at very low concentrations.

PM can make lakes and streams acidic. It causes changes in nutrient balances in coastal waters and large river basins, depletes nutrients in soil, and damages sensitive forests and farm crops.

APPENDIX 3

MONITORING NETWORK

The distribution of ambient air quality monitoring sites throughout Trinidad and Tobago prioritizes areas that are close to sources, such as industrial areas and roadways; sensitive receptors, such as, schools, hospitals, and health centers; and areas with high population density. The siting of stations follows the requirements outlined in the United States Environmental Protection Agency (US EPA) 40 CFR Part 58 Appendix E: Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring. The distribution of commissioned ambient air quality monitoring equipment is summarized in Table A3-1.

TABLE A3-1: AMBIENT AIR QUALITY MONITORING STATION LOCATIONS

Location	Address	GPS Coordinates
TRINIDAD		
Port-of Spain	Water and Sewerage Authority's Beetham Waste Water Treatment Plant, East Sea Lots, Beetham Highway, San Juan	Datum: WGS84 UTM: Zone 20 X Coordinate (m): 664727.996 Y Coordinate (m): 1176857.003
Point Lisas	Point Lisas Industrial Port Development Corporation Limited (PLIPDECO) House, Orinoco Drive, Point Lisas Industrial Estate, Couva	Datum: WGS84 UTM: Zone 20 X Coordinate (m): 666970.000 Y Coordinate (m): 1151813.005
San Fernando	Southern Academy for the Performing Arts (SAPA), Corner Todd Street and Rienzi Kirton Highway, San Fernando	Datum: WGS84 UTM: Zone 20 X Coordinate (m): 667884.000 Y Coordinate (m): 1135445.000
TOBAGO		
Signal Hill	Signal Hill Secondary Comprehensive School, Signal Hill Road, Signal Hill	Datum: WGS84 UTM: Zone 20 X Coordinate (m): 744611.001 Y Coordinate (m): 1236207.001

At each location meteorological and pollutant-specific parameters are monitored. The stations are owned, operated and maintained by the EMA. Best management practices are followed in the operation and maintenance of the AAQMS, and strict protocols for its operation are documented in the EMA's AAQMN Quality Assurance Project Plan, Standard Operating Procedures and the equipment manual.

Table A3-2 below, presents a summary of the stations and parameters monitored. Figures A3-1 illustrates the locations of the monitoring stations, whilst photographs of the stations at each location are presented in Figures A3-2 to A3-5.

Criteria pollutants are measured using approved United States Environmental Protection Agency (US EPA) federal reference methods (FRM) and federal equivalent methods (FEM), to assess compliance with the standards listed in the APR. Table A3-3 lists the methods used for the various pollutants.

TABLE A3-2: MONITORING NETWORK

Area	PM_{10}	$PM_{2.5}$	O_3	NO_x	CO	SO_2	Met
Point Lisas, Trinidad	√	√	√	√	√	√	√
Port of Spain, Trinidad	√	√	√	√	√	√	√
San Fernando, Trinidad	√	√	√	√	√	√	√
Signal Hill, Tobago	√	√	√	√	√	√	√

Notes:
PM_{10} – Particulate Matter ≤10 micrometers
NO_x – Oxides of Nitrogen
O_3 - Ozone
$PM_{2.5}$ – Particulate Matter ≤2.5 micrometers
CO – Carbon Monoxide
SO_2 – Sulfur Dioxide
Met - Meteorological parameters - Temperature, Rainfall, Relative Humidity, Barometric Pressure, Solar Radiation, Wind Speed and Direction.

TABLE A3-3: MONITORING METHODS

Pollutant	Method	Units
Carbon Monoxide (CO)	Non-dispersive Infrared Radiation	ppm, ppb, µg/m^3, mg/m^3
Oxides of Nitrogen (NO_x)	Chemiluminescence	ppm, ppb, µg/m^3, mg/m^3
Ozone (O_3)	Ultraviolet Photometry	ppm, ppb, µg/m^3, mg/m^3
Sulfur Dioxide (SO_2)	Ultraviolet Fluorescence	ppm, ppb, µg/m^3, mg/m^3
Particulate Matter ≤10 micrometers (PM_{10})	Beta Ray Attenuation; Scattered Light Spectrometry	mg/m^3
Particulate Matter ≤2.5 micrometers ($PM_{2.5}$)	Beta Ray Attenuation; Scattered Light Spectrometry	mg/m^3

Notes:
ppm – Parts per million
ppb – Parts per billion
mg/m^3 - Milligrams per Cubic Meter
µg/m^3 - Micrograms per Cubic Meter

FIGURE A3-15~~1~~: MAP SHOWING THE LOCATIONS OF THE AMBIENT AIR QUALITY MONITORING STATIONS

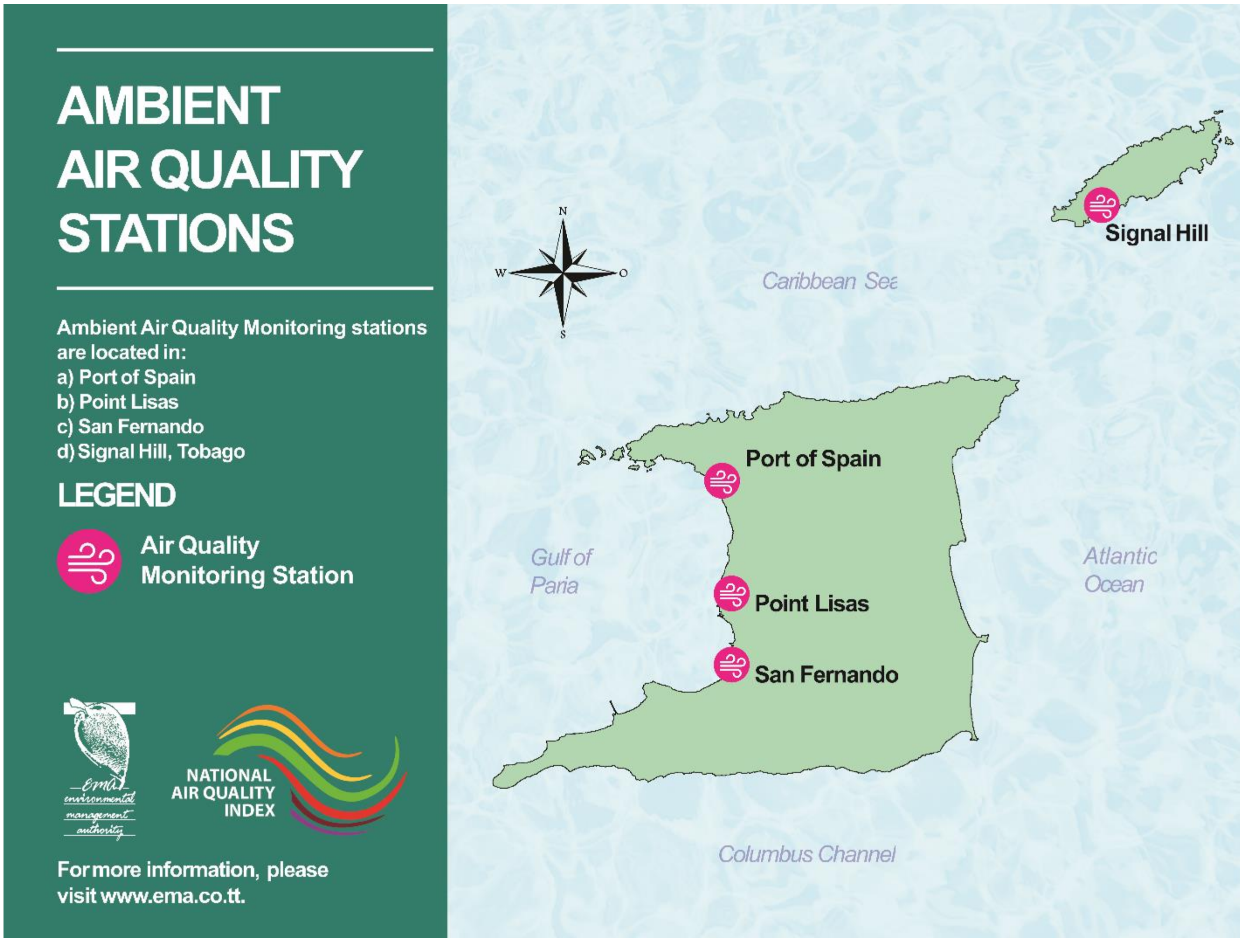

FIGURE A3 - 2: AMBIENT AIR QUALITY MONITORING STATION, PORT OF SPAIN, TRINIDAD

FIGURE A3 - 3: AMBIENT AIR QUALITY MONITORING STATION, POINT LISAS, TRINIDAD

FIGURE A3 - 4: AMBIENT AIR QUALITY MONITOIRNG STATION, SAN FERNANDO, TRINIDAD

FIGURE A 3- 5: AMBIENT AIR QUALITY MONITOIRNG STATION, SIGNAL HILL, TOBAGO

APPENDIX 4

PRINCIPLE OF OPERATION

A4.1 Particulate Matter (PM_{10} and $PM_{2.5}$)

A4.1.1 Beta Attenuation Mass Monitor

The Met One Instruments, Inc. Model BAM-1020 Beta Attenuation Mass Monitor automatically measures and records hourly ambient particulate mass concentration using the principle of beta attenuation. The concentration is determined in units of milligrams per cubic meter (mg/m^3) or micrograms per cubic meter ($\mu g/m^3$). The monitor consists of three (3) basic components: the central unit, the sampling pump and the sampling inlet hardware. Each component is self-contained and may be easily disconnected for servicing and replacement.

The inlet of the BAM-1020 can be configured for either PM_{10} or $PM_{2.5}$ measurement. For PM_{10} measurements, a 10-micron inertial impactor is installed on the top of the inlet. For $PM_{2.5}$ measurements, a 2.5 micron very sharp cut cyclone is installed in line between the 10-micron inertial impactor and the inlet tube.

Ambient temperature and pressure sensors are attached to the BAM-1020 monitors to meet the requirements of the applicable United States Environmental Protection Agency (USEPA) designated equivalent test methods.

A4.1.2 Scattered Light Spectrometry

The Model T640 PM Mass Monitor is an optical aerosol spectrometer that converts optical measurements to mass measurements with sharp accuracy by determining sampled particle size via scattered light at the single particle level according to the Lorenz-Mie Theory.

Briefly, the sampling head draws in ambient air with different-sized particles, which are dried with the Aerosol Sample Conditioner (ASC) and moved into the optical particle sensor where scattered light intensity is measured to determine particle size diameter. The particles move separately into the T-aperture through an optically differentiated measurement volume that is homogeneously illuminated with polychromatic light. The polychromatic light source, an LED, combined with a 90° scattered light detection achieves a precise and unambiguous calibration curve, resulting in a large size resolution.

Each particle generates a scattered light impulse that is detected at an 85° to 95° angle where amplitude and signal length are measured; the amplitude (height) of the scattered light impulse is directly related to the particle size diameter.

The T-aperture and simultaneous signal length measurements eliminate border zone error, which is characterized by the partial illumination of particles at the border of the measurement range.

A4.2 Carbon Monoxide (CO)

This component uses a high energy heated element to generate a beam of broad-band Infrared (IR) light with a known intensity at 4.7μm wavelength (measured during Instrument calibration). This beam is directed through a multi-pass cell filled with sample gas.

The sample cell uses mirrors at each end to reflect the IR beam back and forth through the sample gas to generate a 14-meter absorption path. Upon exiting the sample cell, the beam shines through a band-pass filter that allows only light at a wavelength of 4.7μm to pass. Finally, the beam strikes a solid-state photo-detector that converts the light signal into a modulated voltage signal representing the attenuated intensity of the beam.

A4.3 Oxides of Nitrogen (NO_X)

The NO_x module utilises the principal of Chemiluminescence. The device measures the concentration of NO and NO_x in a gas sample and is able to calculate the concentration of NO_2 by subtracting the concentration of NO from the concentration of NO_x. NO_2 cannot be measured directly because it does not react with O_3. O_3 is fed into the reaction cell and reacts with NO; light at a specific wavelength is emitted due to the chemical reaction. The light intensity produced is measured by a Photomultiplier Tube (PMT) and is directly proportional to the concentration of excited molecules.

A4.4 Sulfur Dioxide (SO_2)

The measurement principle is based on absorption or detection of photons. Within the SO_2 reaction cell the SO_2 molecules are excited by ultraviolet light of wavelength 214 nm generated by low pressure zinc vapor lamp, refer to the equation (1) below. The SO_2 molecules absorb this light energy which is in turn is emitted as a light pulse (photon), refer to equation (2). These photons have a wavelength of 330 nm and are recorded by a photomultiplier tube (PMT) detector which measures its fluorescence and sends an analog signal.

$SO_2 + h\upsilon \longrightarrow SO_2^*$ (1)

$SO_2^* \longrightarrow SO_2 + h\upsilon$ (2)

The optical design of the sample chamber optimizes the fluorescent reaction between SO_2 and Ultra Violet (UV) light ensuring that only UV light resulting from the decay of SO_2 into SO_2 is sensed by the instrument's fluorescence. The analyzer uses two stages of optical filters to enhance performance:

1. Conditioning the UV light used to excite the 2 by removing frequencies of light that are not needed to produce SO_2, and
2. Protecting the PMT detector from reacting to light not produced by the SO_2 returning to its ground state.

Other measures/ design to assure the PMT only detects the light emitted by the decaying SO_2* include:

1. The pathway of excitation UV and field of view of the PMT are perpendicular to each other.
2. The inner surfaces of the sample chamber are coated with a layer of black Teflon to absorb light of other wavelengths.

A4.5 Ozone (O_3)

The ozone analyzer measures each of the variables: Sample Temperature, Sample Pressure, the intensity of the UV light beam with and without O_3 present, inserts known values for the length of the absorption path and the absorption coefficient, and calculates the concentration of O_3 present in the sample gas.

In the most basic terms, it uses a high energy, mercury vapor lamp to generate a beam of UV light. This beam passes through a window of material specifically chosen to be both non-reactive to O_3 and transparent to UV radiation at 254 nm and into an absorption tube filled with Sample Gas. Because ozone is a very efficient absorber of UV radiation, the absorption path length required to create a measurable decrease in UV intensity is short enough (approximately 42 cm) to pass the light beam only one time through the absorption tube. Therefore, no complex mirror system is needed to lengthen the effective path by bouncing the beam back and forth.

Finally, the UV passes through a similar window at the other end of the absorption tube and is detected by a specially designed vacuum diode that only detects radiation at or very near a wavelength of 254 nm. The selectivity of the detector is high enough that no extra optical filtering of the UV light is needed. The detector assembly reacts to the UV light and outputs a voltage that varies in direct relationship with the light's intensity. This voltage is digitized and sent to the instrument's central processing unit (CPU) to be used in computing the concentration of O_3 in the absorption tube.

A4.6 Meteorological Parameters

The Wind Sensor (WS) family is a range of low-cost smart combination of weather sensors for the acquisition of a variety of measurement variables, as used for example for environmental data logging in road traffic management systems. The WS500 model has a combination of sensors for various measurement variables as follows:

- Wind Direction
- Wind Speed
- Air Temperature
- Relative Humidity
- Air Pressure

- Compass
- Rainfall

Table A4-1 summarizes the principle of operation of the meteorological sensors, Trinidad stations and Table A-2 presents the Tobago station.

TABLE A4-1: SENSORS OF THE WS500 AND MEASUREMENT DESCRIPTION

SENSOR	MEASUREMENT DESCRIPTION, TRINIDAD	MEASUREMENT DESCRIPTION, TOBAGO
Wind Speed & Direction	The wind meter uses 4 ultrasonic sensors which take cyclical measurements in all directions. The resulting wind speed and direction are calculated from the measured run-time sound differential. The sensor delivers a quality output signal indicating the number of good readings that were taken during the measurement interval.	The wind speed and direction sensor measures via analog transmitters. The wind speed sensor propeller rotation produces an AC sine wave voltage signal with frequency directly proportional to wind speed. Wind direction vane angle is sensed by a precision potentiometer. With known excitation voltage applied to the potentiometer, the output voltage is directly proportional to the vane angle.
Compass	The integrated electronic compass can be used to check the north-south adjustment of the sensor housing for wind direction measurement. It is also used to calculate the compass corrected wind direction.	Not available
Air Temperature and Humidity	Temperature is measured by way of a highly accurate NTC-resistor while humidity is measured using a capacitive humidity sensor. In order to keep the effects of external influences (e.g., solar radiation) as low as possible, these sensors are located in a ventilated housing with	Relative Humidity Sensor measures variance in the capacitance change of a one-micron thick dielectric polymer layer. This film absorbs water molecules through a metal electrode and causes capacitance change proportional to relative

	radiation protection. In contrast to conventional non-ventilated sensors, this allows significantly more accurate measurement during high radiation conditions. Additional variables such as dew point, absolute humidity and mixing ratio are calculated from air temperature and relative humidity, taking account of air pressure.	humidity. The thin polymer layer reacts very quickly, providing up to 90% of the final value of relative humidity in fewer than five seconds. The sensor's response is essentially linear, with small hysteresis, and negligible temperature dependence. The temperature sensor is a three element composite thermistor type with linear response over the range of -50°C to +50°C. The sensor is designed to be mounted in a radiation shield.
Air Pressure	Absolute air pressure is measured by way of a built-in sensor (MEMS). The relative air pressure referenced to sea level is calculated using the barometric formula with the aid of the local altitude, which is user-configurable on the equipment.	The sensor measures absolute atmospheric pressure and converts it into a linear, proportional voltage, using digital computer technology. The pressure sensor uses an on board microcontroller and piezoresistive pressure sensor module. This module contains an analog-to-digital converter, a temperature sensor and non-volatile memory for storage of factory determined calibration coefficients. The microcontroller polls the senor module once per second. Measurements are temperature corrected, the calibration coefficients applied and the processed pressure measurement stored for output.
Precipitation	Precipitation is measured on a continuous basis by a sensor working with a Doppler radar. The	Rainfall is measured on a continuous basis. Water is not retained in the sensor. The

	precipitation drop speed is measured and the precipitation quantity and type is calculated by correlating the drop size and speed.	tipping bucket is drained when it fills with 0.1 mm of rainfall. As the bucket tips overs and pours the water out the base of the sensor, a switch closure pulse is sent to a connected translator module or data logger for counting.
Solar Radiation	Radiation is measured with a pyranometer. The thermopile sensor construction measures the solar energy received from the total solar spectrum and the whole hemisphere and provides an output in Watts per square meter.	

APPENDIX 5

AIR QUALITY INDEX

The Air Quality Index (AQI) is an index for reporting daily air quality. It gives an indication of how clean or polluted the air is in relation to the permissible levels. The generation of an AQI value involves a conversion of measured pollutant concentrations to a number on a scale of 0 to 500. The AQI values are categorized by the level of health concern, with each category assigned a colour. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little or no potential to affect public health, while an AQI value over 300 represents air quality so hazardous that everyone may experience serious effects. An AQI value of 100 generally corresponds to the national air quality standard for the pollutant. AQI values at or below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy.

The AQI can be viewed on the EMA's Air Quality Management Information System (AQMIS) website using the following link: http://ei.weblakes.com/rttpublic or accessed from the EMA's website, www.ema.co.tt. (As examples, see Figures A5-1, A5-2, A5-3 and A5-4).

TABLE A5-1: POLLUTION CONCENTRATION BREAKPOINTS FOR EACH CATEGORY OF THE AQI

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0-50	Air Quality is considered satisfactory and air pollution poses little or no risk
Moderate	51-100	Air Quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101-150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151-200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201-300	Health alert: everyone may experience more serious health effects.
Hazardous	>300	Health warnings of emergency conditions. The entire population is more likely to be affected.

FIGURE A5-1: AQI WEBPAGE, POINT LISAS, TRINIDAD

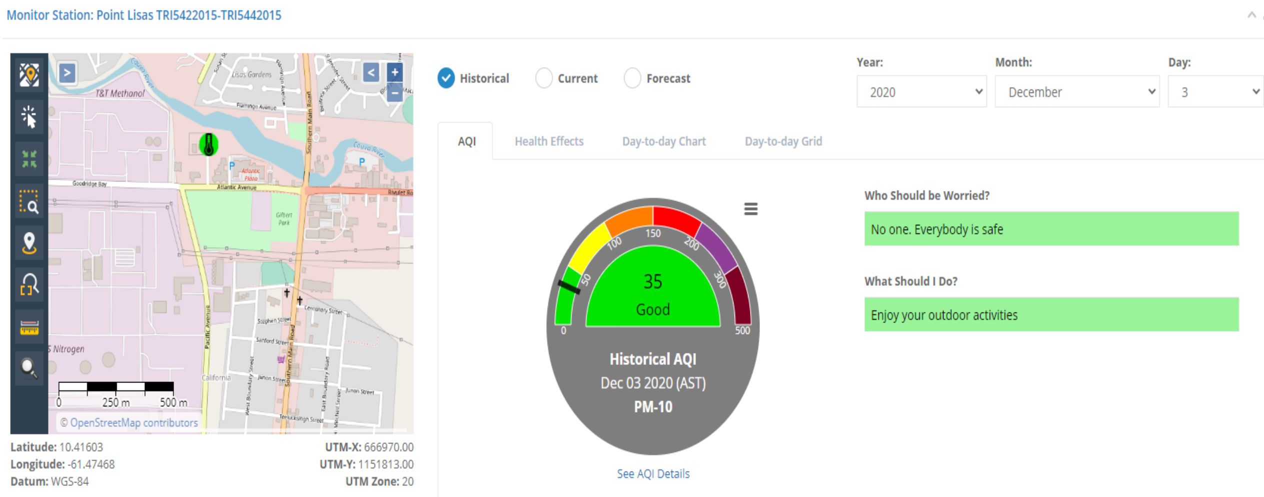

FIGURE A5-2: AQI WEBPAGE, PORT-OF-SPAIN, TRINIDAD

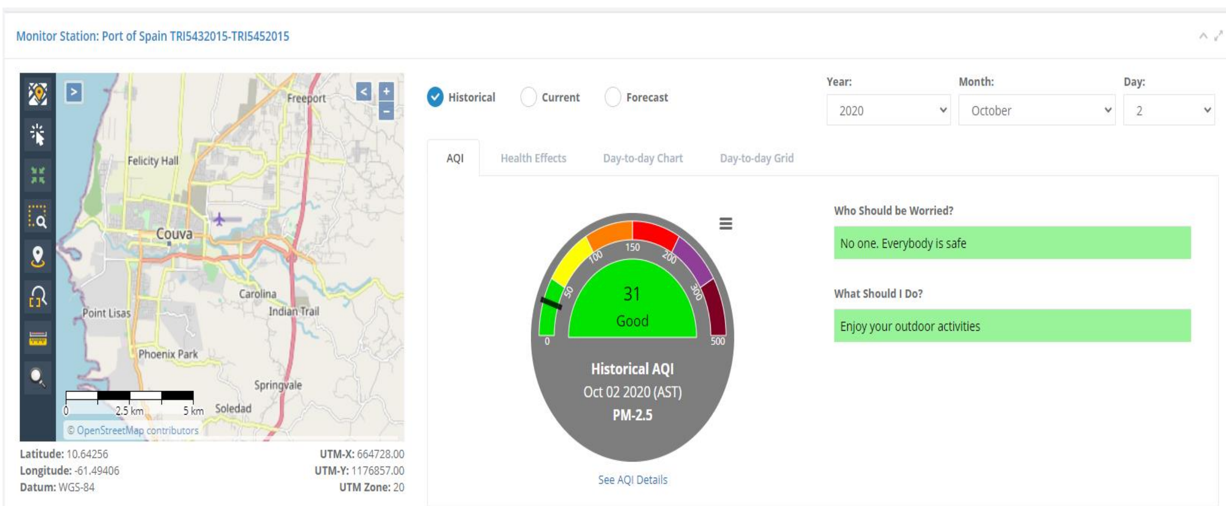

FIGURE A5-3: AQI WEBPAGE, SAN FERNANDO, TRINIDAD

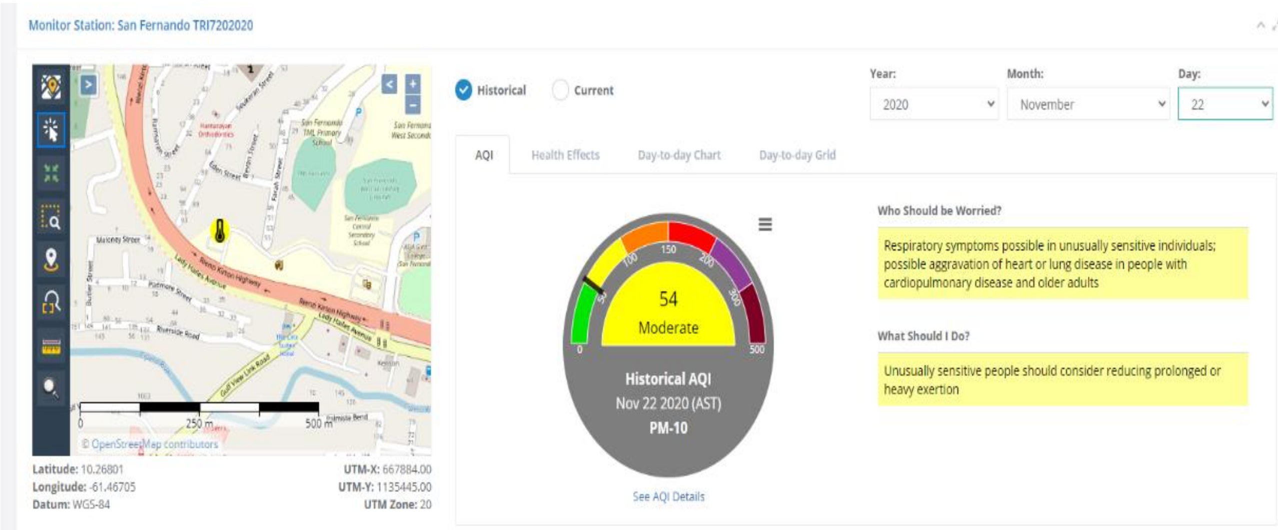

FIGURE A5-4: AQI WEBPAGE, SIGNAL HILL, TOBAGO