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Connolly Station, Dublin 1, D01 V6V6
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Iarnród Éireann
Irish Rail

10th December 2019

[redacted]

PH: +353 [redacted]
Email: [redacted]

Re: AIE Response [IE_AIE_014]

Dear [redacted],

I refer to your request dated 14th October 2019 which was received by this office on that date, which you have made under the EC (Access to Information on the Environment) Regulations 2007 to 2014.

Request –

- Any data and analysis held by Iarnród Éireann on air quality in and near Connolly Station Dublin, including monitoring and modelling information and information on emissions. If a time limit is required for this request, please supply any information relating to any time in the last 10 years

Response

Please find attached documentation

Yours sincerely,

Lynette O'Toole

Freedom of Information Officer

IE_AIE_014 - Statement

Statement for AIE Response:

We have completed a 2-week air quality study in Connolly Station in August and October. All parameters for gases were below the Occupational Exposure Limit Values. The consultant has recommended that we do further testing for Diesel Particulates as standard practice. We will undertake this study in the coming months. It should be noted however, that Carbon Dioxide levels were low, which is an indicator of good ventilation and so we would expect Diesel Particulates to be low as well.

While the air quality has been shown to be within standards for workplace safety, Irish Rail is aware of the perception of poor air quality noted by passengers who pass along Platform 4 at certain peak commuting times. Irish Rail will be undertaking a feasibility study to determine what options are available to improve this in the new year.

Verde Environmental Consultants

Air Quality Assessment

Connolly Station

December 2019

www.verde.ie

TABLE OF CONTENTS

APPENDICES

DOCUMENT CONTROL

Project Title:	Air Quality Report – Connolly Station Dublin
Report Ref.:	52351
Status:	Final
Client:	Iarnród Éireann
Site Details:	Connolly Station, Dublin
Issued By:	Verdé Environmental Consultants Ltd.

Document Production / Approval Record				
	Name	**Signature**	**Date**	**Position**
Draft Prepared by	[redacted]	[redacted]	21/10/2019	Senior EHS Consultant
Finalised by	[redacted]	[redacted]	02/12/2019	Senior EHS Consultant
Approved by	[redacted]	[redacted]	03/12/2019	Operations Director

LIMITATIONS

This report represents the results of monitoring works conducted at the above referenced site. Best practice was followed at all times and within the limitations stated; works were undertaken according to budgetary considerations. This report is the property of Verdé Environmental Consultants Limited and cannot be used, copied or given to any third party without the explicit prior approval or agreement of Verdé Environmental Consultants Limited.

EXECUTIVE SUMMARY

Verdé Environmental Consultants, (Verdé) was commissioned by Iarnród Éireann (IE) to undertake air quality monitoring at Connolly Railway Station, Dublin. Monitoring was undertaken at four chosen locations during two separate occasions in August & October 2019 for gases (carbon monoxide, carbon dioxide, sulphur dioxide, nitrogen monoxide and nitrogen dioxide). Monitoring was also undertaken at one location over seven consecutive days for metals, Volatile Organic Compounds (VOC's) and Polyaromatic Hydrocarbons (PAH's).

This report discusses monitoring results with reference to workplace occupational exposure limit values (OELVs). The following summary applies:

- 8-hour averaged results indicate that all gaseous parameters were within limit values on every day monitored.
- 1-hourly data showed significant variation from day to day and at different times of the day as demonstrated by graphs in Appendix B. This data is useful for identifying "peak" activity times even though average daily concentrations are all within acceptable limits.
- The HSA recommend that CO_2 concentrations should be maintained below 1000 ppm as an overall general indicator of good air quality (20% of the OELV). This was achieved on all days monitored indicating that the area was well ventilated during survey.
- Metals, Volatile organic compounds (VOCs) and Polycyclic Aromatic Hydrocarbons (PAHs) were tested every day for seven consecutive days and measured concentrations in all cases were below relevant OELVs and published guideline values.

It may be concluded that air quality at the site was within limit values during the survey period. It must be considered that measured concentrations can also be influenced by external factors such as traffic on adjacent roads and as the site is close to city centre traffic, external factors may be significant.

The following general recommendations are made to maintain good long term air quality:

- Maintain diesel engines so they burn efficiently;
- Replace diesel engines where possible with cleaner fuel types;
- Prevent diesel engines from running for extended periods in close proximity to personnel;
- Ensure there is adequate ventilation of the railway.

It is recommended that future monitoring at the site should include sampling for diesel particulate matter. Sampling should be undertaken for diesel particulate matter as carbon by NIOSH method 5040 or equivalent. A combination of real-time monitoring as well as active filtration sampling methods is preferable to demonstrate daily fluctuations in particulate matter.

1 INTRODUCTION

1.1 Project Contractual Basis & Parties Involved

Verdé Environmental Consultants, (Verdé) was commissioned by Iarnród Éireann (IE) to undertake air quality monitoring at Connolly Railway Station, Dublin. Monitoring was undertaken as part of a tender agreement for multiple railway stations and train servicing areas across Ireland.

The key personnel involved in the delivery of this project were Cyril Tynan, John Jennings and Kevin Cleary of Verdé. Cyril Tynan is a Chartered Environmentalist with 20 years' experience in environmental and occupational health and safety assessment. John is an Environmental Scientist with over 10 years' experience in environmental monitoring and reporting. The report was reviewed by Kevin Cleary, operations director with Verdé and Chartered Environmentalist with 21 years' experience in the management of scientific projects.

1.2 Scope of Work

In order to meet the requirements of the brief, air quality monitoring stations were set up on site to test for harmful gases at various railway stations and train servicing areas. At Connolly Station, works consisted of the following:

- Continuous monitoring for two weeks at four locations for gases (carbon monoxide, carbon dioxide, sulphur dioxide, nitrogen monoxide and nitrogen dioxide);
- Monitoring at one location over seven consecutive days for metals, Volatile Organic Compounds (VOC's) and Polyaromatic Hydrocarbons (PAH's).
- Preparation of interpretative report.

2 SURVEY DETAILS

2.1 Monitoring Locations

Monitoring was undertaken at 4 locations on site as follows:

- Location 1 was on a vending machine towards the northern end of Platform 4.
- Location 2 was on top of a vending machine mid- way along Platform 4.
- Location 3 was on top of an information booth on platform 4 inside the access gate (rail side) close to where IE ticketing and security staff spend much of the working day.
- Location 4 was on top of a vending machine in the Enterprise Rail waiting area.

The locations chosen were intended to provide representative data spatially across the railway station and focussing on areas where workers or the general public would be present. The monitors required a power supply and this needed consideration in location choice. Photos of the monitoring locations are included in Appendix A.

2.2 Survey Implementation and Methodology

Monitoring was undertaken at the four chosen locations commencing on 16th August 2019. Some of the monitors failed after approximately one week due to a break in power supply or file capacity issues; monitors were then re-installed on 1st October to ensure that at least two weeks of data was collected for each location. The following parameters were monitored on a continuous basis:

- Carbon monoxide,
- Carbon dioxide,
- Sulphur dioxide,
- Nitric oxide and
- Nitrogen dioxide;

In addition to the continuous monitors, at one location over seven separate consecutive days, 8-hour sampling was undertaken for metals, Volatile Organic Compounds (VOC's) and Polycyclic Aromatic Hydrocarbons (PAH's).

Table 2.1 summarises monitoring methodologies employed.

Test Parameter		Monitoring Method
Gases	Carbon monoxide, Carbon dioxide Nitrogen dioxide, Nitric oxide, Sulphur dioxide	In-situ (Multi Rae) gas monitor with data logging
Metals	Cadmium, Chromium, Copper, Iron, Nickel, Lead, Zinc	MCE Filters pre-loaded in Cassettes Inductively coupled plasma optical emission spectroscopy (ICP/OES)
Volatile Organic Compounds (VOCs)	Total VOCs Benzene, Toluene, Ethylbenzene, Xylene (BTEX)	Active adsorption - GCMS
Polycyclic aromatic hydrocarbons (PAHs)	US-EPA 16 PAHs	Active adsorption - GCMS

2.3 Assessment Criteria

Monitoring for all parameters was undertaken simultaneously and the recorded results were compared against limit values relevant in Ireland. The Health and Safety Authority (HSA) published a code of practice which is routinely updated under the Safety, Health and Welfare at Work (Chemical Agents) Regulations, 2001.[1]

The most recent COP was published in 2018 providing the most up to date and legally enforceable Occupational Exposure Limit Values (OELVs) and Short-Term Exposure Limits (STELs) for various chemical agents. An OELV for a given chemical represents the maximum exposure to the chemical in workplace air. In practice, exposure levels should be maintained well below the OELV and should always be as low as reasonably achievable. This is particularly important for carcinogens, mutagens and substances causing sensitisation (occupational asthma or allergic contact dermatitis). Carcinogens are identified by the notation "Carc.1A/1B", mutagens by "Muta.1A/1B", reproductive toxins by "Repr.1A/1B'' and sensitizers as "Sens."

Exposure standards represent airborne concentrations of individual chemicals which, according to current knowledge, should neither impair the health of nor cause undue discomfort to nearly all workers who are occupationally exposed. OELVs relate to 8- hour reference exposure periods representing long-term exposure to substances over an eight-hour day for five days per week over an entire working life. Short term Exposure Limits (STEL) relate to 15-minute reference periods which apply for certain parameters which have identified short term more acute health risks.

1. HSA 2018 Code of Practice for the Chemical Agents Regulations

The HSA expect that chemical concentrations are maintained a safe margin below OELVs in particular until a statistically reliable dataset of exposure concentrations is available. The real-time monitors employed in this survey allowed considerable data to be collected over a full working week and is therefore considered statistically robust and representative of normal working conditions at the site for comparison with OELVs.

The Health and Safety Executive (UK) and the HSA in Ireland have published separate guidance documents in relation to diesel engine exhaust emissions in the workplace. [2], [3] The HSE and HSA recommend that 8-hr average concentrations of carbon dioxide should be maintained below 1000 ppm (20% of the OELV) as a useful indicator of the overall adequacy of control measures for diesel exhaust emissions. This alert level is also considered in the results assessment as a guideline for good ventilation in the workplace.

[2] HSA Safe Working with Diesel Engine Exhaust Information Sheet, March 2016
[3] HSE (UK) Control of diesel engine exhaust emissions in the workplace HSG 187 3rd Ed 2012

3 SURVEY RESULTS

3.1 Survey Parameters - Gas

Continuous monitoring was undertaken for gases CO, CO_2, SO_2, NO and NO_2 on 2 separate weekly intervals during August and October 2019. The following sections present tabulated summary data for each monitoring day at each location. Results are presented as averages for each of 3 x 8 hour monitoring intervals per day.

Appendix B presents graphs showing 1-hourly results for each location; these are useful in identifying the days and specific times where result peaks occur.

Monitoring for gases was completed using MultiRAE Lite ™ real – time gas analysers at each location. Appendix C includes equipment specification data and calibration certificates.

3.2 Gas Results

Continuous monitoring was undertaken for gases CO, CO_2, SO_2, NO and NO_2. Results for Location 1 are presented in the table below and further details are presented in the graphs in Appendix B.

Table 3.1: Gas 8-Hour Average Summary (ppm) - Location 1

Date/Time	NO(ppm)	CO(ppm)	SO2(ppm)	NO2(ppm)	CO2(ppm)
08/08/2019 16:00	0.00	0.00	0.00	0.00	200
09/08/2019 00:00	0.01	0.00	0.00	0.00	200
09/08/2019 08:00	0.02	0.00	0.00	0.00	200
09/08/2019 16:00	0.08	0.00	0.00	0.00	200
10/08/2019 00:00	0.00	0.00	0.00	0.00	200
10/08/2019 08:00	0.24	0.00	0.00	0.00	200
10/08/2019 16:00	0.00	0.00	0.00	0.00	200
11/08/2019 00:00	0.00	0.00	0.00	0.00	200
11/08/2019 08:00	0.00	0.00	0.00	0.00	200
11/08/2019 16:00	0.00	0.00	0.00	0.00	200
12/08/2019 00:00	0.00	0.00	0.00	0.00	200
12/08/2019 08:00	0.01	0.00	0.00	0.00	200
12/08/2019 16:00	0.00	0.00	0.00	0.00	200
13/08/2019 00:00	0.00	0.00	0.00	0.00	200
13/08/2019 08:00	0.00	0.00	0.00	0.00	200
13/08/2019 16:00	0.00	0.00	0.00	0.00	200
14/08/2019 00:00	0.00	0.00	0.00	0.00	200
14/08/2019 08:00	0.00	0.00	0.00	0.00	200
14/08/2019 16:00	0.00	0.00	0.00	0.00	200
15/08/2019 00:00	0.00	0.00	0.00	0.00	200
01/10/2019 16:00	0.09	0.00	0.00	0.00	222
01/10/2019 00.00	0.13	0.00	0.00	0.00	241
01/10/2019 08.00	0.23	0.00	0.00	0.00	273
02/10/2019 16.00	0.04	0.00	0.00	0.00	225
02/10/2019 00.00	0.09	0.00	0.00	0.00	203
02/10/2019 08.00	0.14	0.00	0.00	0.00	207
03/10/2019 16.00	0.38	0.00	0.00	0.00	236
03/10/2019 00.00	0.94	0.00	0.00	0.04	256
03/10/2019 08.00	0.78	0.00	0.00	0.02	265
04/10/2019 00.00	0.08	0.00	0.00	0.00	210
04/10/2019 08.00	0.04	0.00	0.00	0.00	205
04/10/2019 16.00	0.13	0.00	0.00	0.00	209
05/10/2019 00.00	0.21	0.00	0.00	0.00	218
05/10/2019 08.00	0.01	0.00	0.00	0.00	200
05/10/2019 16.00	0.45	0.00	0.00	0.00	239
06/10/2019 00.00	0.07	0.00	0.00	0.00	213
06/10/2019 08.00	0.14	0.00	0.00	0.00	205
06/10/2019 16.00	0.63	0.00	0.00	0.00	260
07/10/2019 00.00	0.47	0.00	0.00	0.02	268
07/10/2019 08.00	1.10	0.00	0.00	0.07	259
07/10/2019 16.00	0.64	0.00	0.00	0.01	255

08/10/2019 00.00	0.26	0.00	0.00	0.01	250
08/10/2019 08.00	0.57	0.00	0.00	0.07	232
08/10/2019 16.00	0.66	0.00	0.00	0.03	272
09/10/2019 00.00	0.57	0.00	0.00	0.07	232
8 hour OELV:	**2**	**20**	**0.5**	**0.5**	**5000**
STEL:	**-**	**100**	**1**	**1**	**15000**

Notes

- The OELV and STEL are based on the HSA Code of Practice 2018
- Results are presented as averages for each of 3 x 8 hour intervals each day; 00:00-08:00; 08:00-16:00 and 16:00-00:00.
- The HSA recommend that CO_2 concentrations should be maintained below a guideline of 1000 ppm as an overall general indicator of good air quality (20% of the OELV).
- Results are in **bold** where a limit value is exceeded.

It was noted that the CO_2 sensor was unresponsive for the 1st week but when re-installed, the CO_2 levels at all times remained well below limit values and guideline values.

Table 3.2: Gas 8-Hour Average Summary (ppm) - Location 2

Date/Time	NO(ppm)	CO(ppm)	SO2(ppm)	NO2(ppm)	CO2(ppm)
16/08/2019 16:00	0.49	0.00	0.00	0.00	285
17/08/2019 00:00	0.22	0.00	0.00	0.00	231
17/08/2019 08:00	0.49	0.00	0.00	0.00	309
17/08/2019 16:00	0.33	0.00	0.00	0.00	287
18/08/2019 00:00	0.07	0.00	0.00	0.00	214
18/08/2019 08:00	0.09	0.00	0.00	0.00	290
18/08/2019 16:00	0.24	0.00	0.00	0.00	282
19/08/2019 00:00	0.51	0.00	0.00	0.00	276
19/08/2019 08:00	0.35	0.00	0.00	0.00	315
19/08/2019 16:00	0.17	0.00	0.00	0.00	272
20/08/2019 00:00	0.34	0.00	0.00	0.00	295
20/08/2019 08:00	0.38	0.00	0.00	0.00	346
20/08/2019 16:00	0.31	0.00	0.00	0.00	319
21/08/2019 00:00	0.29	0.00	0.00	0.01	271
21/08/2019 08:00	0.47	0.00	0.00	0.00	342
21/08/2019 16:00	0.27	0.00	0.00	0.00	321
22/08/2019 00:00	0.32	0.00	0.00	0.01	274
22/08/2019 08:00	0.67	0.00	0.00	0.01	342
22/08/2019 16:00	0.39	0.00	0.00	0.01	309
23/08/2019 00:00	0.29	0.00	0.00	0.00	268
23/08/2019 08:00	0.87	0.01	0.00	0.00	343
23/08/2019 16:00	0.43	0.00	0.00	0.00	285
24/08/2019 00:00	0.17	0.26	0.00	0.00	295
24/08/2019 08:00	0.31	0.00	0.00	0.00	289
24/08/2019 16:00	0.28	0.00	0.00	0.00	261
25/08/2019 00:00	0.04	0.00	0.00	0.00	262
25/08/2019 08:00	0.43	0.00	0.00	0.00	324
25/08/2019 16:00	0.21	0.00	0.00	0.00	301
26/08/2019 00:00	0.28	0.00	0.00	0.00	261
26/08/2019 08:00	0.25	0.00	0.00	0.00	308
26/08/2019 16:00	0.35	0.00	0.00	0.00	299
27/08/2019 00:00	0.18	0.00	0.00	0.00	263
27/08/2019 16:00	0.16	0.00	0.00	0.00	234
28/08/2019 00:00	0.03	0.00	0.00	0.00	230
01/10/2019 16.00	0.35	0.00	0.00	0.00	323
01/10/2019 00.00	0.85	0.00	0.00	0.01	353
01/10/2019 08.00	0.57	0.00	0.00	0.01	375
02/10/2019 16.00	0.17	0.00	0.00	0.00	319

02/10/2019 00.00	0.18	0.00	0.00	0.00	304
02/10/2019 08.00	0.33	0.00	0.00	0.00	297
03/10/2019 16.00	0.34	0.00	0.00	0.01	311
03/10/2019 00.00	0.61	0.00	0.00	0.03	282
03/10/2019 08.00	0.82	0.02	0.00	0.03	347
04/10/2019 00.00	0.13	0.00	0.00	0.00	309
04/10/2019 08.00	0.06	0.00	0.00	0.00	301
04/10/2019 16.00	0.31	0.00	0.00	0.00	307
05/10/2019 00.00	0.42	0.00	0.00	0.01	300
05/10/2019 08.00	0.01	0.00	0.00	0.00	220
05/10/2018 16.00	0.73	0.00	0.00	0.01	336
06/10/2019 00.00	0.25	0.00	0.00	0.00	312
06/10/2019 08.00	0.27	0.00	0.00	0.00	250
06/10/2019 16.00	0.89	0.00	0.00	0.01	365
07/10/2019 00.00	0.51	0.00	0.00	0.01	328
07/10/2019 08.00	0.98	0.11	0.00	0.06	298
07/10/2019 16.00	0.35	0.00	0.00	0.00	328
08/10/2019 00.00	0.16	0.00	0.00	0.00	305
08/10/2019 08.00	0.82	0.00	0.00	0.06	294
09/10/2019 16.00	0.50	0.00	0.00	0.00	335
8 hour OELV:	**2**	**20**	**0.5**	**0.5**	**5000**
STEL:	**-**	**100**	**1**	**1**	**15000**

Notes

- The OELV and STEL are based on the HSA Code of Practice 2018
- Results are presented as averages for each of 3 x 8 hour intervals each day; 00:00-08:00; 08:00-16:00 and 16:00-00:00.
- The HSA recommend that CO_2 concentrations should be maintained below 1000 ppm as an overall general indicator of good air quality (20% of the OELV).
- Results in **bold** where a limit value is exceeded.

Table 3.3: Gas 8-Hour Average Summary (ppm) - Location 3

Date/Time	NO(ppm)	CO(ppm)	SO2(ppm)	NO2(ppm)	CO2(ppm)
16/08/2019 16:00	0.53	0.00	0.00	0.00	276
17/08/2019 00:00	0.35	0.00	0.00	0.00	233
17/08/2019 08:00	0.40	0.00	0.00	0.00	296
17/08/2019 16:00	0.29	0.00	0.00	0.00	275
18/08/2019 00:00	0.09	0.00	0.00	0.00	215
18/08/2019 08:00	0.01	0.00	0.00	0.00	248
18/08/2019 16:00	0.12	0.00	0.00	0.00	250
19/08/2019 00:00	0.14	0.00	0.00	0.00	242
19/08/2019 08:00	0.18	0.00	0.00	0.00	294
19/08/2019 16:00	0.07	0.00	0.00	0.00	244
20/08/2019 00:00	0.07	0.00	0.00	0.00	239
20/08/2019 08:00	0.35	0.00	0.00	0.00	318
20/08/2019 16:00	0.36	0.00	0.00	0.00	284
21/08/2019 00:00	0.59	0.00	0.00	0.04	265
21/08/2019 08:00	0.34	0.00	0.00	0.00	320
21/08/2019 16:00	0.28	0.00	0.00	0.01	298
22/08/2019 00:00	0.72	0.09	0.00	0.06	271
22/08/2019 08:00	0.54	0.00	0.00	0.01	317
22/08/2019 16:00	0.40	0.00	0.00	0.02	305
23/08/2019 00:00	0.61	0.00	0.00	0.03	271
23/08/2019 08:00	0.91	0.00	0.00	0.01	337
23/08/2019 16:00	0.41	0.00	0.00	0.00	285
24/08/2019 00:00	0.19	0.00	0.00	0.01	291
24/08/2019 08:00	0.62	0.00	0.00	0.01	292
24/08/2019 16:00	0.37	0.00	0.00	0.00	265
25/08/2019 00:00	0.08	0.00	0.00	0.00	253
25/08/2019 08:00	0.26	0.00	0.00	0.01	304
25/08/2019 16:00	0.13	0.00	0.00	0.00	292
26/08/2019 00:00	0.17	0.00	0.00	0.01	245
26/08/2019 08:00	0.38	0.00	0.00	0.00	303
26/08/2019 16:00	0.48	0.00	0.00	0.01	287
27/08/2019 00:00	0.43	0.00	0.00	0.01	263
27/08/2019 16:00	0.31	0.00	0.00	0.01	275
28/08/2019 00:00	0.16	0.00	0.00	0.01	224
28/08/2019 08:00	0.21	0.00	0.00	0.00	298
28/08/2019 16:00	0.21	0.00	0.00	0.01	283
29/08/2019 00:00	0.45	0.00	0.00	0.06	259
29/08/2019 08:00	0.34	0.00	0.00	0.01	301
29/08/2019 16:00	0.42	0.00	0.00	0.03	275
30/08/2019 00:00	0.30	0.00	0.00	0.04	238
30/08/2019 08:00	0.50	0.00	0.00	0.05	302
30/08/2019 16:00	0.45	0.00	0.00	0.03	281
31/08/2019 00:00	0.02	0.00	0.00	0.00	201
31/08/2019 08:00	0.00	0.00	0.00	0.00	223
31/08/2019 16:00	0.04	0.00	0.00	0.01	228
8 hour OELV:	**2**	**20**	**0.5**	**0.5**	**5000**
STEL:	-	**100**	**1**	**1**	**15000**

Notes

- The OELV and STEL are based on the HSA Code of Practice 2018
- Results are presented as averages for each of 3 x 8 hour intervals each day; 00:00-08:00; 08:00-16:00 and 16:00-00:00.
- The HSA recommend that CO_2 concentrations should be maintained below 1000 ppm as an overall general indicator of good air quality (20% of the OELV).
- Results are in **bold** where a limit value is exceeded.

Table 3.4: 8-Hour Average Summary (ppm) - Location 4

Date/Time	NO(ppm)	CO(ppm)	SO2(ppm)	NO2(ppm)	CO2(ppm)
16/08/2019 16:00	0.14	0.00	0.00	0.00	353
17/08/2019 00:00	0.23	0.00	0.00	0.00	306
17/08/2019 08:00	0.25	0.00	0.00	0.00	377
17/08/2019 16:00	0.17	0.00	0.00	0.00	324
18/08/2019 00:00	0.01	0.00	0.00	0.00	300
18/08/2019 08:00	0.00	0.00	0.00	0.00	343
18/08/2019 16:00	0.03	0.00	0.00	0.00	330
19/08/2019 00:00	0.08	0.00	0.00	0.00	307
19/08/2019 08:00	0.06	0.00	0.00	0.00	387
19/08/2019 16:00	0.02	0.00	0.00	0.00	327
20/08/2019 00:00	0.08	0.00	0.00	0.00	311
20/08/2019 08:00	0.14	0.00	0.00	0.00	417
20/08/2019 16:00	0.07	0.00	0.00	0.00	352
21/08/2019 00:00	0.21	0.00	0.00	0.00	321
21/08/2019 08:00	0.26	0.00	0.00	0.00	401
21/08/2019 16:00	0.23	0.00	0.00	0.00	358
22/08/2019 00:00	0.23	0.00	0.00	0.00	313
22/08/2019 08:00	0.34	0.00	0.00	0.00	418
22/08/2019 16:00	0.20	0.00	0.00	0.00	360
23/08/2019 00:00	0.25	0.00	0.00	0.00	312
23/08/2019 08:00	0.65	0.00	0.00	0.00	443
23/08/2019 16:00	0.36	0.00	0.00	0.00	347
24/08/2019 00:00	0.20	0.00	0.00	0.00	315
24/08/2019 08:00	0.50	0.00	0.00	0.00	382
24/08/2019 16:00	0.47	0.00	0.00	0.00	367
25/08/2019 00:00	0.02	0.00	0.00	0.00	300
25/08/2019 08:00	0.09	0.00	0.00	0.00	397
25/08/2019 16:00	0.09	0.00	0.00	0.00	354
16/10/2019 16:00	0.21	0.00	0.00	0.00	370
16/10/2019 00.00	0.00	0.00	0.00	0.00	323
17/10/2019 08.00	0.08	0.00	0.00	0.00	419
17/10/2019 16.00	0.08	0.00	0.00	0.00	433
17/10/2019 00.00	0.00	0.00	0.00	0.00	310
18/10/2019 08.00	0.35	0.00	0.00	0.00	392
18/10/2019 16.00	0.10	0.00	0.00	0.00	358
18/10/2019 00.00	0.06	0.00	0.00	0.00	304
19/10/2019 08.00	0.20	0.00	0.00	0.00	410
19/10/2019 16.00	0.12	0.00	0.00	0.00	354
19/10/2019 00.00	0.01	0.00	0.00	0.00	356
20/10/2019 08.00	0.10	0.00	0.00	0.00	381
20/10/2019 16.00	0.22	0.00	0.00	0.00	352
20/10/2019 00.00	0.00	0.00	0.00	0.00	300
21/10/2019 08.00	0.03	0.00	0.00	0.00	356
21/10/2019 16.00	0.04	0.00	0.00	0.00	357
21/10/2019 00.00	0.22	0.00	0.00	0.00	325
22/10/2019 08.00	0.29	0.00	0.00	0.00	420
22/10/2019 16.00	0.15	0.00	0.00	0.00	365
22/10/2019 00.00	0.60	0.00	0.00	0.00	341

23/10/2019 08.00	0.15	0.00	0.00	0.04	405
23/10/2019 16.00	0.02	0.00	0.00	0.00	350
23/10/2019 00.00	0.23	0.00	0.00	0.00	325
24/10/2019 00.00	0.16	0.00	0.00	0.00	403
8 hour OELV:	**2**	**20**	**0.5**	**0.5**	**5000**
STEL:	**-**	**100**	**1**	**1**	**15000**

Notes

- The OELV and STEL are based on the HSA Code of Practice 2018
- Results are presented as averages for each of 3 x 8 hour intervals each day; 00:00-08:00; 08:00-16:00 and 16:00-00:00.
- The HSA recommend that CO_2 concentrations should be maintained below 1000 ppm as an overall general indicator of good air quality (20% of the OELV).
- Results are in **bold** where a limit value is exceeded.

3.3 Results Summary – Metals VOCs and PAHs

Monitoring for Metals VOCs and PAHs was undertaken at one central location along Platform 4 for seven consecutive days between Tuesday 27th August and Monday 2nd September 2019. Static air monitors were set up on top of a vending machine for approximately 8 hours per day, generally between the hours 08:00 – 16:00 each day. Results are summarised in the tables below and discussed in the next chapter.

Notes to accompany the following tables are listed below.

Notes for tables 3.5, 3.6 and 3.7:

OELV = Occupational exposure Limit Value based on HSA Code of Practice 2018

Results are in **bold** if they exceed the 8hr OELV .

Note 1: The OELV for VOCs is based on Total VOCs (as diesel fuel/ kerosene) due to the presence of oils. Separate OELVs would apply for any specific VOC peaks identified

Note 3: No OELV exists for PAHs apart from Naphthalene (50mg/m3). The OELV listed as a guideline for other PAHs is based on the 2013 ACGIH limit for Coal tar pitch volatiles (CTPVs)

ACGIH 2013: American Conference of Governmental Industrial Hygienists for Coal tar pitch volatiles (CTPVs)

Carc 1B = Carcinogen Class 1B;

Sens = respiratory or dermal sensitising agents

Sk - Substances which have the capacity to penetrate intact skin when they come in contact with it and be absorbed into the body.

IOELV = Indicative occupational exposure limit values are health-based, non-binding values

BOELV = Binding Occupational Exposure Limit Values transposed from the relevant EU Directives are transposed from the relevant EU Directives

Repr 1A = Substances which are known human reproductive toxicants

Muta.1A - Substances which are known to induce heritable mutations in the germ cells of humans.

Muta.1 B = Substances which should be regarded as if they induce heritable mutations heritable mutations in the germ cells of humans;

Table 3.5 Occupational Exposure Results - Metals and Dusts

	Sample Date:	Tue 27/08/2019	Wed 28/08/2019	Thurs 29/08/2019	Fri 30/08/2019	Sat 31/08/2019	Sun 01/09/2019	Mon 02/09/2019	8 hr OELV, mg/m3	Verdé Alert Level, mg/m3	Notes
	Sample Vol, (litres):	730.0	1080.0	1260.0	960.0	984.0	960.0	960.0			
Determinand	Units	1-METALS	2-METALS	3-METALS	4-METALS	5-METALS	6-METALS	7-METALS			
Cadmium	mg/m³	<0.001	<0.0009	<0.0008	<0.001	<0.001	<0.001	<0.001	0.01 (0.002 R)	0.002	Note 1, Carc.1B
Chromium	mg/m³	<0.001	<0.0009	<0.0008	<0.001	<0.001	<0.001	<0.001	2	0.4	Note 1,
Copper	mg/m³	<0.001	<0.0009	<0.0008	<0.001	<0.001	<0.001	<0.001	1 (dust/mist)	0.2	Note 1, IOELV
Iron	mg/m³	<0.001	<0.0009	0.0014	<0.001	<0.001	<0.001	<0.001	5 (iron oxide fume)	1.0	Note 1,
Nickel	mg/m³	<0.001	<0.0009	<0.0008	<0.001	<0.001	<0.001	<0.001	0.5	0.1	Note 1, Sens
Lead	mg/m³	<0.001	<0.0009	<0.0008	<0.001	<0.001	<0.001	<0.001	0.15	0.030	Note 1, Repr.1A, BOELV
Zinc	mg/m³	<0.001	<0.0009	<0.0008	<0.001	<0.001	<0.001	0.0030	2 (R) Zinc oxide Fume	0.4	Note 1,

Table 3.6 Occupational Exposure Results - Volatile Organic Compounds

	Sample Date:	Tue 27/08/2019	Wed 28/08/2019	Thurs 29/08/2019	Fri 30/08/2019	Sat 31/08/2019	Sun 01/09/2019	Mon 02/09/2019	8 hr OELV, mg/m3	Verdé Alert Level, mg/m3	Notes
	Sample Vol, (litres):	73.0	108.0	126.0	96.0	96.0	96.0	96.0			
Determinand	Units	1A-VOC	2A-VOC	3A-VOC	4A-VOC	5A-VOC	6A-VOC	7A-VOC			
VOC(Total)	mg/m³	0.120	0.074	0.063	0.100	0.080	0.060	0.080	100	20.0	Note 1, Sk
Benzene	mg/m³	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	3	0.6	Note 1, BOELV, Sk, Carc.1A, Muta.1B
Ethylbenzene	mg/m³	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	192	38.4	Note 1, Sk, IOELV
Toluene	mg/m³	<0.07	<0.046	<0.040	<0.05	<0.05	<0.05	<0.05	442	88.4	Note 1, Sk, IOELV
M/P Xylene	mg/m³	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	221	44.2	Note 1, Sk, IOELV
O Xylene	mg/m³	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01			

Table 3.7 Occupational Exposure Results - Polycyclic Aromatic hydrocarbons

	Sample Date:	Tue 27/08/2019	Wed 28/08/2019	Thurs 29/08/2019	Fri 30/08/2019	Sat 31/08/2019	Sun 01/09/2019	Mon 02/09/2019	8 hr OELV, mg/m3	Verdé Alert Level, mg/m3	Notes
	Sample Vol, (litres):	7.3	10.8	12.6	9.6	9.6	9.6	9.6			
Determinand	Units	1B-PAH	2B-PAH	3B-PAH	4B-PAH	5B-PAH	6B-PAH	7B-PAH			
Acenaphthene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Acenaphthylene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Anthracene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Benzo(a)Anthracene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Benzo(a)Pyrene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Benzo(b/k)Fluoranthene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Benzo(ghi)Perylene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Chrysene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Dibenzo(ah)Anthracene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Fluoranthene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Fluorene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Indeno(123-cd)Pyrene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Naphthalene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	50	10	Note 1, IOELV
Phenanthrene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3
Pyrene	mg/m^3	<0.01	<0.009	<0.008	<0.01	<0.01	<0.01	<0.01	0.2	0.04	Note 3

4 DISCUSSION OF RESULTS

4.1 Gases (carbon monoxide, carbon dioxide, sulphur dioxide, nitric oxide and nitrogen dioxide)

Monitoring was undertaken at four locations for gases CO, CO_2, SO_2, NO and NO_2 between the dates 16th to 30th August and from the 1st to the 10th of October 2019. The following summary applies:

- 8-hour averaged results indicate that all gaseous parameters were within limit values..
- The 1-hour graphs in Appendix B provide clearer detail on the days and times these peaks occurred. It is noted that short-term results are not intended to be compared against OELVs.
- The HSA recommend that CO_2 concentrations should be maintained below 1000 ppm as an overall general indicator of good air quality (20% of the OELV). This was achieved on all days monitored indicating that the area was well ventilated during survey.
- It is noted that the survey was undertaken during August and October; August had warmer environmental conditions which can improve air movement and ventilation. Operational factors will also influence results.

4.2 Metals, VOCs and PAHs

Monitoring for Metals VOCs and PAHs was undertaken at one central location along Platform 4 for seven consecutive days between Tuesday 27th August and Monday 2nd September 2019. Results for the seven days may be summarised as follows:

- Metals tested included Cadmium, Chromium, Copper, Iron, Nickel, Lead and Zinc; measured concentrations in all cases were below relevant OELVs and lower Verdé alert levels.
- Volatile organic compounds (VOCs) in air were tested and results are presented for total VOCs and specific VOCs Benzene, Toluene, Ethylbenzene and Xylene. Measured concentrations in all cases were below relevant OELVs.
- Polycyclic Aromatic Hydrocarbons (PAHs) were tested for an EPA-16 suite and results are presented for specific PAHs. In Ireland no OELV exists for PAHs apart from Naphthalene (50mg/m^3). The OELV used for reference for other PAHs is therefore a guideline value published by the American Conference of Governmental Industrial Hygienists (ACGIH) in 2013. Measured concentrations in all cases were below relevant OELVs and published guideline values.

4.3 Final comments

It may be concluded that air quality at the site was within limit values during the survey period. It must be considered that measured concentrations can also be influenced by external factors such as traffic on adjacent roads and as the site is close to city centre traffic, external factors may be significant. CO2 concentrations were low below 100ppm in all

cases. The HSA (Ireland) and HSE (UK) recommend this as a useful indicator of the overall adequacy of control measures for diesel exhaust emissions.

It is recommended that future monitoring at the site should include sampling for diesel particulate matter. Sampling should be undertaken for diesel particulate matter as carbon by NIOSH method 5040 or equivalent. A combination of real-time monitoring as well as active filtration sampling methods is preferable to demonstrate daily fluctuations in particulate matter.

General controls to maintain good long term air quality include the following:

- Maintain diesel engines so they burn efficiently;
- Replace diesel engines where possible with cleaner fuel types;
- Prevent diesel engines from running for extended periods in close proximity to personnel;
- Ensure there is adequate ventilation of the railway and ensure that extraction systems are working efficiently.

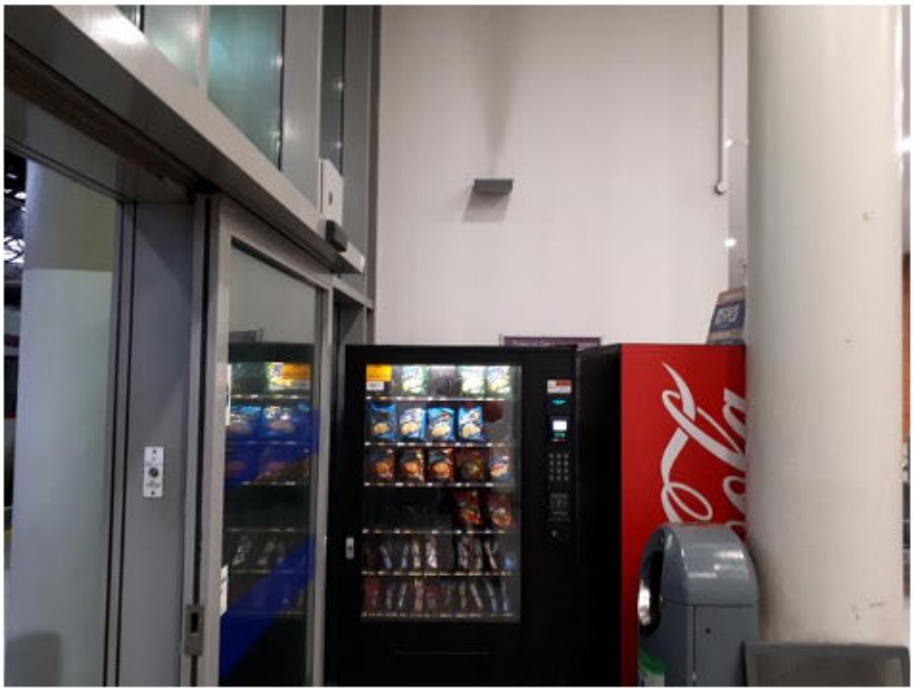
Appendix A

Site Photos

Photographs 1 and 2: Platform 4, monitoring locations 1 and 2 were on the vending machines in the centre and at the northern end of the platform.

Photograph 3: Information booth near the access doors on Platform 4 where monitoring location 3 was situated.

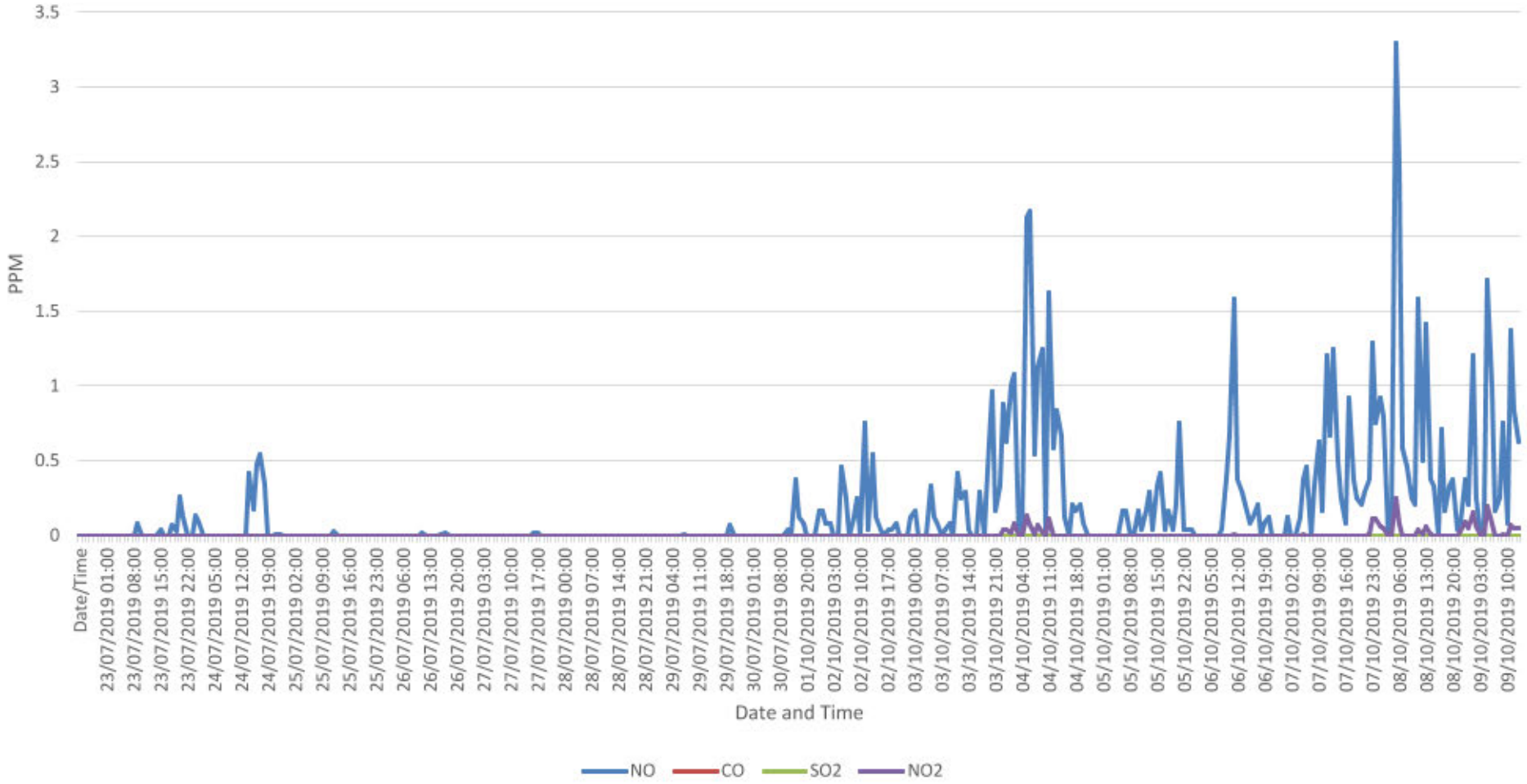
Photograph 4: Monitoring location 4, the vending machines in the enterprise rail waiting area

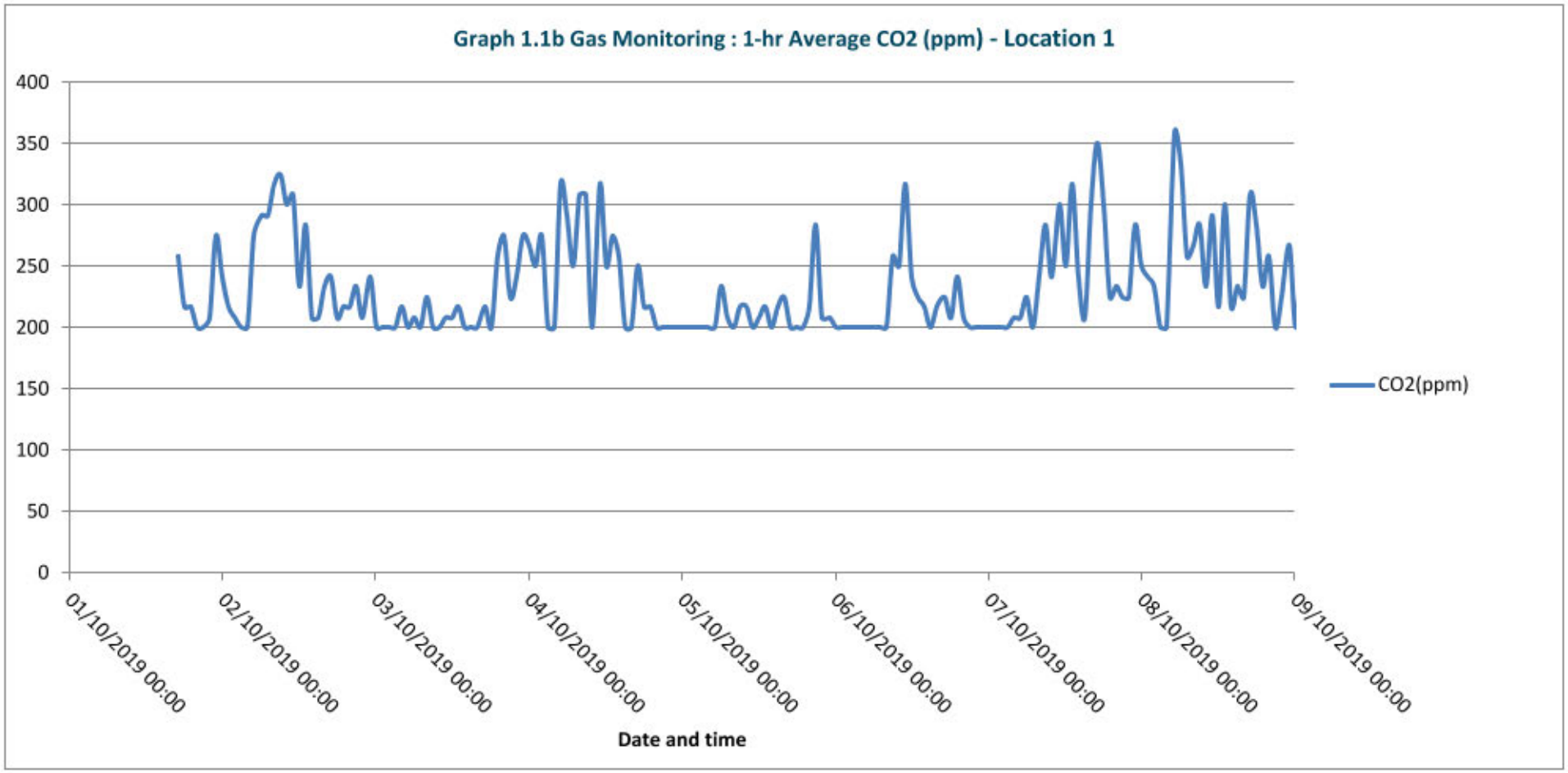


Appendix B

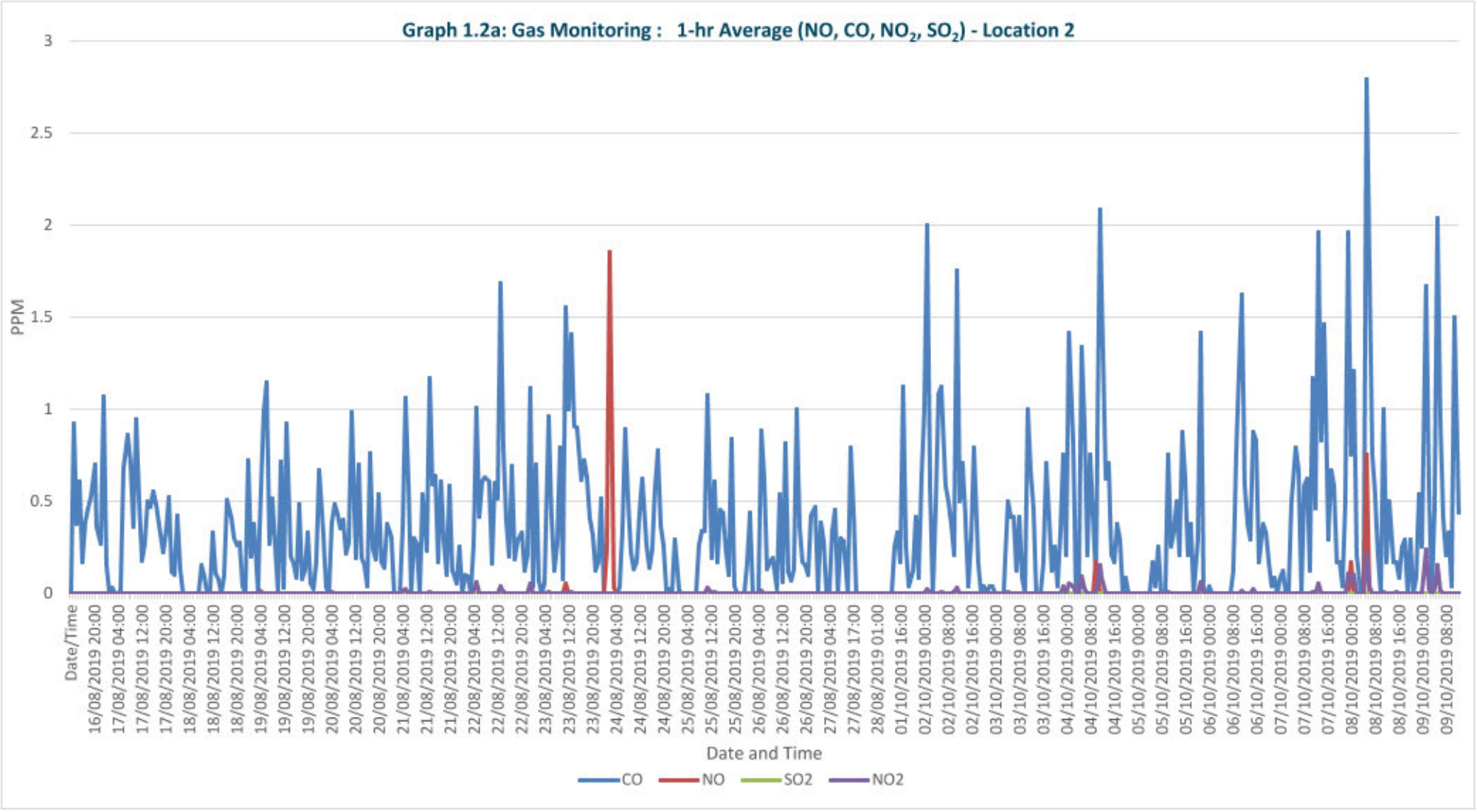
Graphs

Graph 1.1a: Gas Monitoring : 1-hr Average (NO, CO, NO_2, SO_2) - Location 1

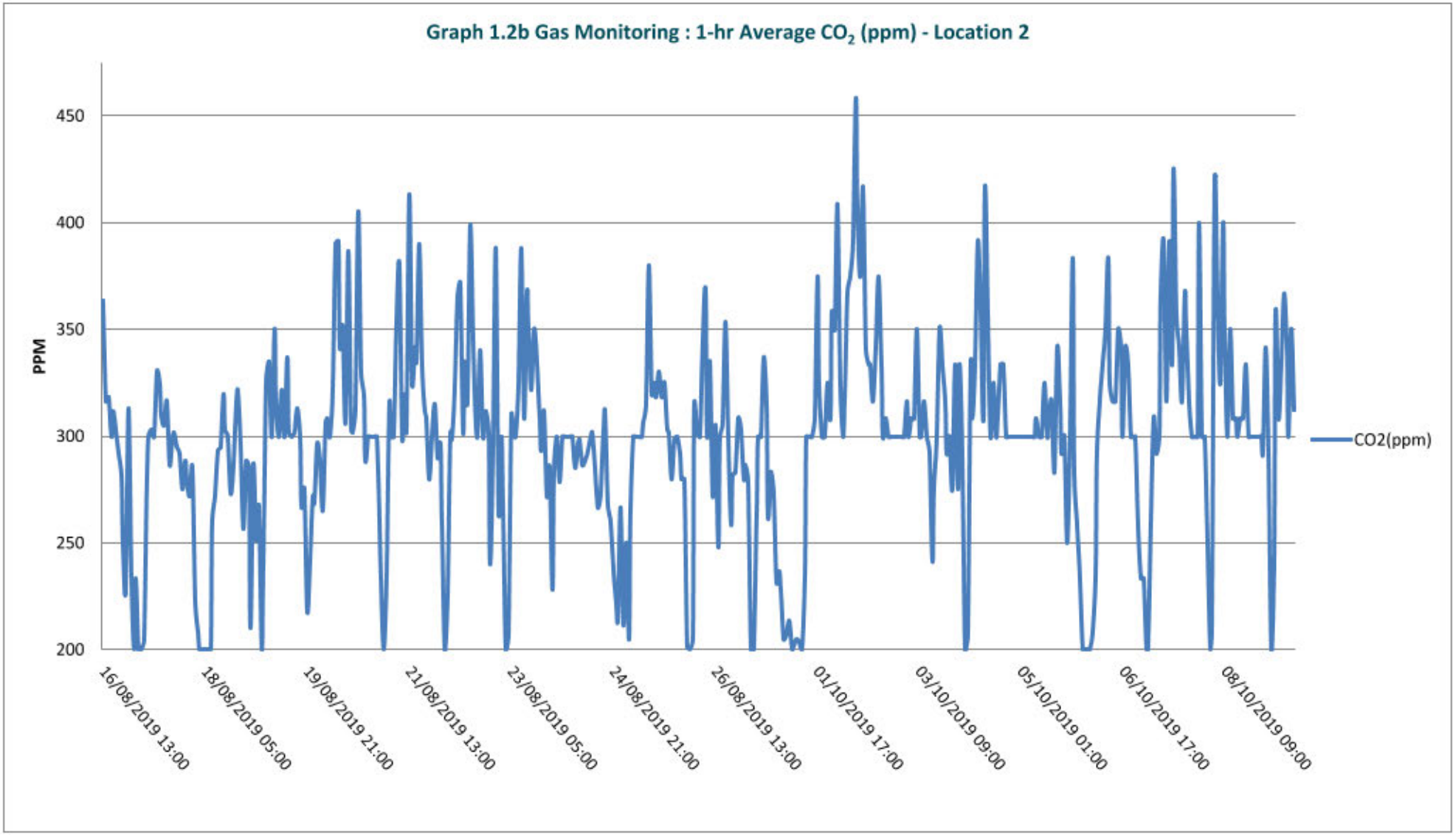


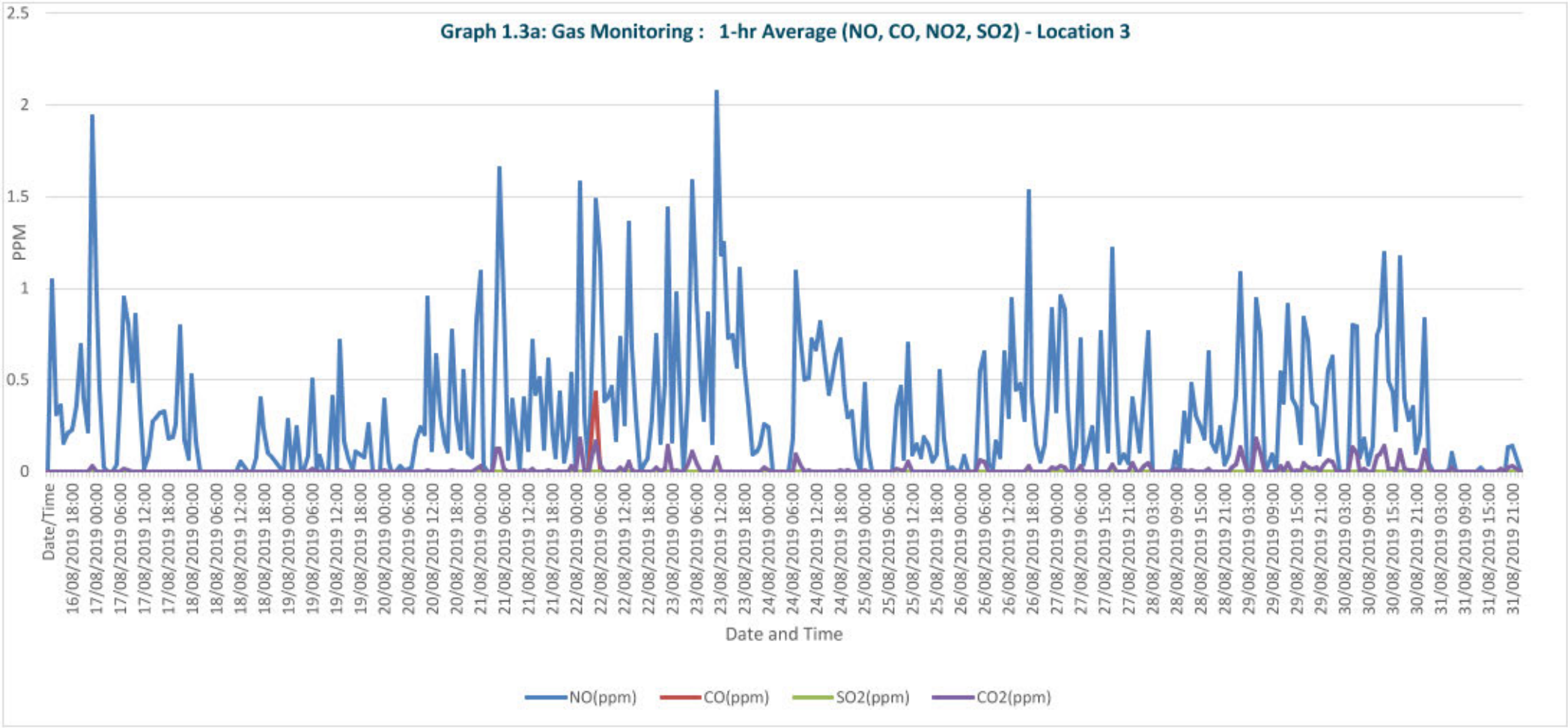

Graph 1.1b Gas Monitoring : 1-hr Average CO2 (ppm) - Location 1
400
350
300
250
200
150
100
50
0
01/10/2019 00:00
02/10/2019 00:00
03/10/2019 00:00
04/10/2019 00:00
05/10/2019 00:00
06/10/2019 00:00
07/10/2019 00:00
08/10/2019 00:00
09/10/2019 00:00
Date and time
CO2(ppm)

Graph 1.2a: Gas Monitoring : 1-hr Average (NO, CO, NO_2, SO_2) - Location 2



Graph 1.2b Gas Monitoring : 1-hr Average CO_2 (ppm) - Location 2




Graph 1.3a: Gas Monitoring : 1-hr Average (NO, CO, NO2, SO2) - Location 3
2.5
2
1.5
1
0.5
0
PPM
Date/Time
16/08/2019 18:00
17/08/2019 00:00
17/08/2019 06:00
17/08/2019 12:00
17/08/2019 18:00
18/08/2019 00:00
18/08/2019 06:00
18/08/2019 12:00
18/08/2019 18:00
19/08/2019 00:00
19/08/2019 06:00
19/08/2019 12:00
19/08/2019 18:00
20/08/2019 00:00
20/08/2019 06:00
20/08/2019 12:00
20/08/2019 18:00
21/08/2019 00:00
21/08/2019 06:00
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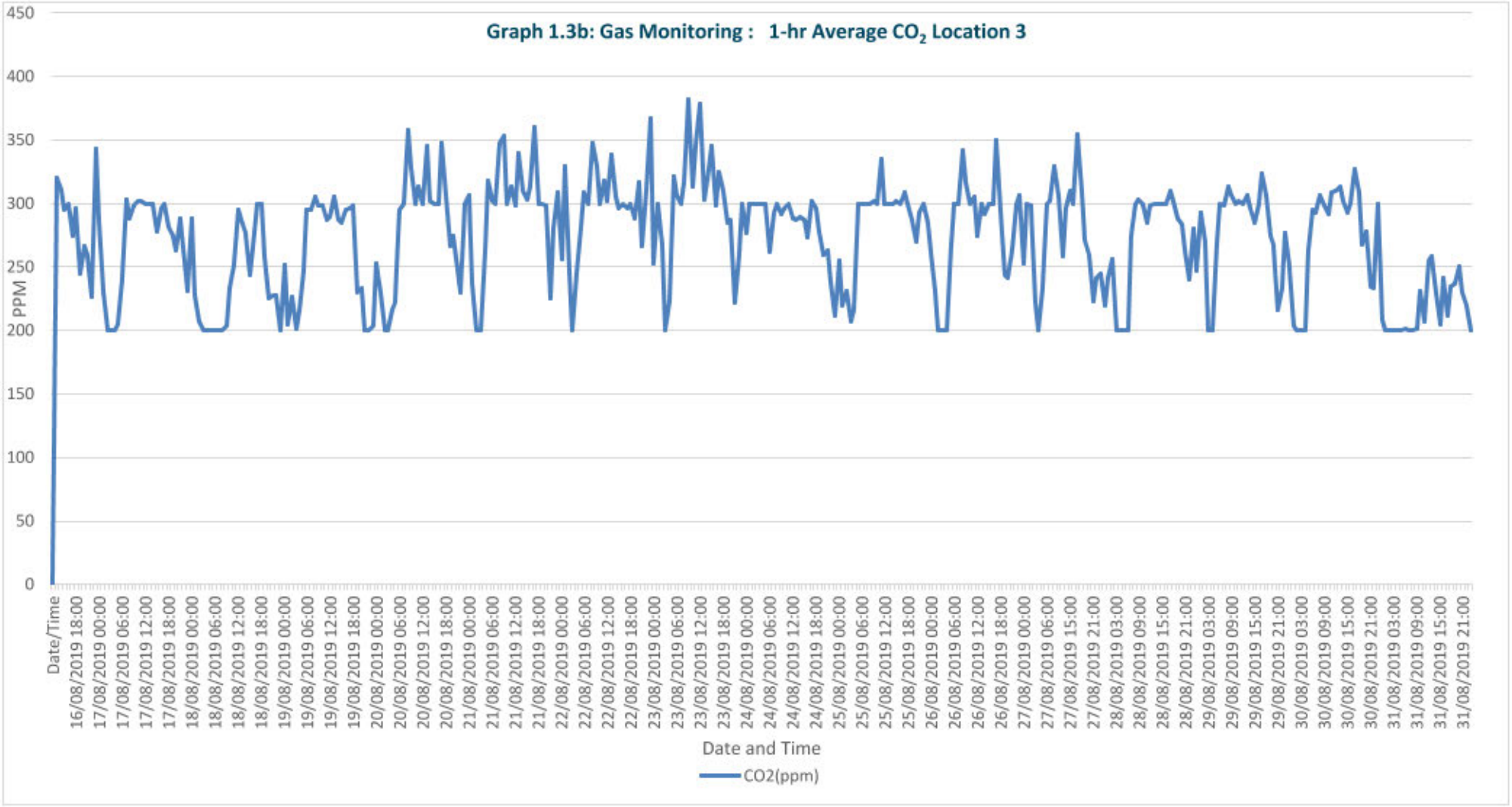
26/08/2019 00:00
26/08/2019 06:00
26/08/2019 12:00
26/08/2019 18:00
27/08/2019 00:00
27/08/2019 06:00
27/08/2019 15:00
27/08/2019 21:00
28/08/2019 03:00
28/08/2019 09:00
28/08/2019 15:00
28/08/2019 21:00
29/08/2019 03:00
29/08/2019 09:00
29/08/2019 15:00
29/08/2019 21:00
30/08/2019 03:00
30/08/2019 09:00
30/08/2019 15:00
30/08/2019 21:00
31/08/2019 03:00
31/08/2019 09:00
31/08/2019 15:00
31/08/2019 21:00
Date and Time
NO(ppm)
CO(ppm)
SO2(ppm)
CO2(ppm)


Graph 1.3b: Gas Monitoring : 1-hr Average CO_2 Location 3
PPM
450
400
350
300
250
200
150
100
50
0
Date/Time
16/08/2019 18:00
17/08/2019 00:00
17/08/2019 06:00
17/08/2019 12:00
17/08/2019 18:00
18/08/2019 00:00
18/08/2019 06:00
18/08/2019 12:00
18/08/2019 18:00
19/08/2019 00:00
19/08/2019 06:00
19/08/2019 12:00
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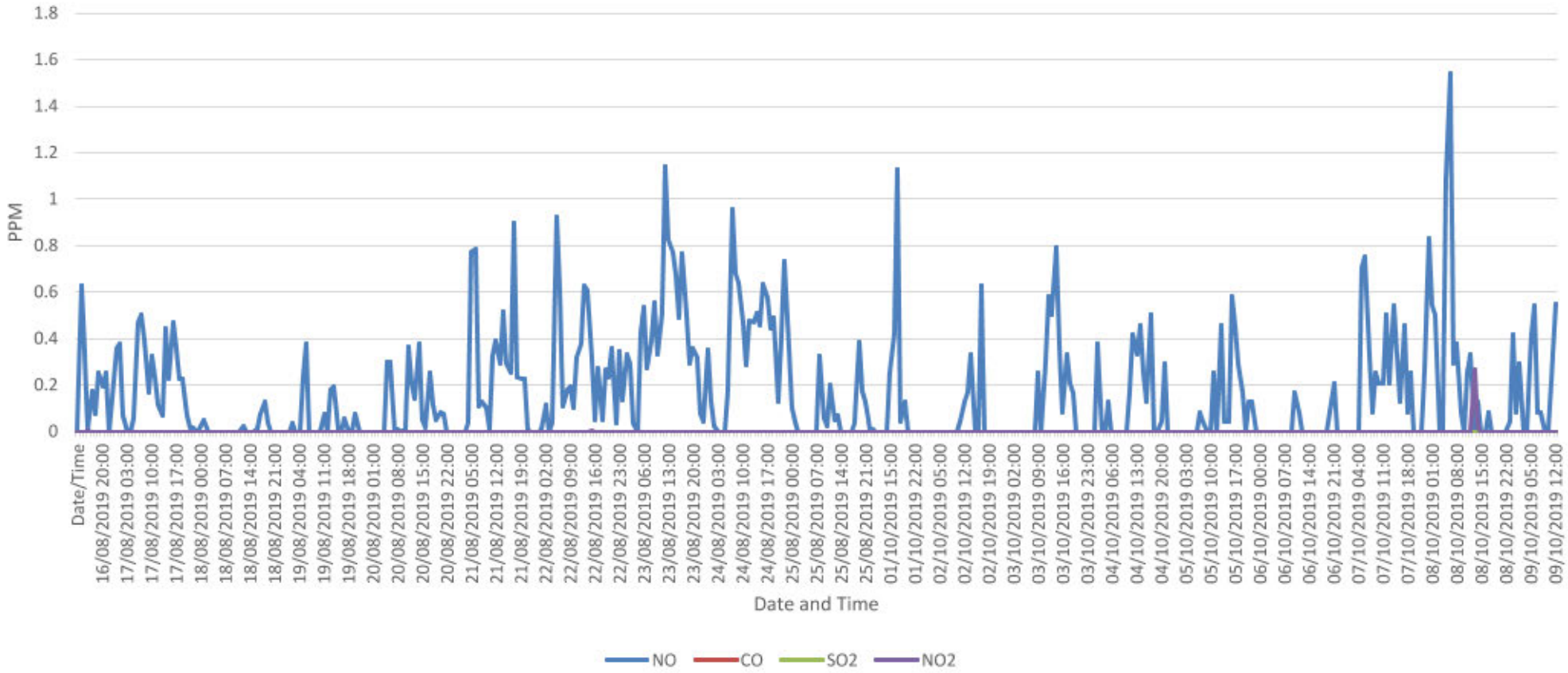
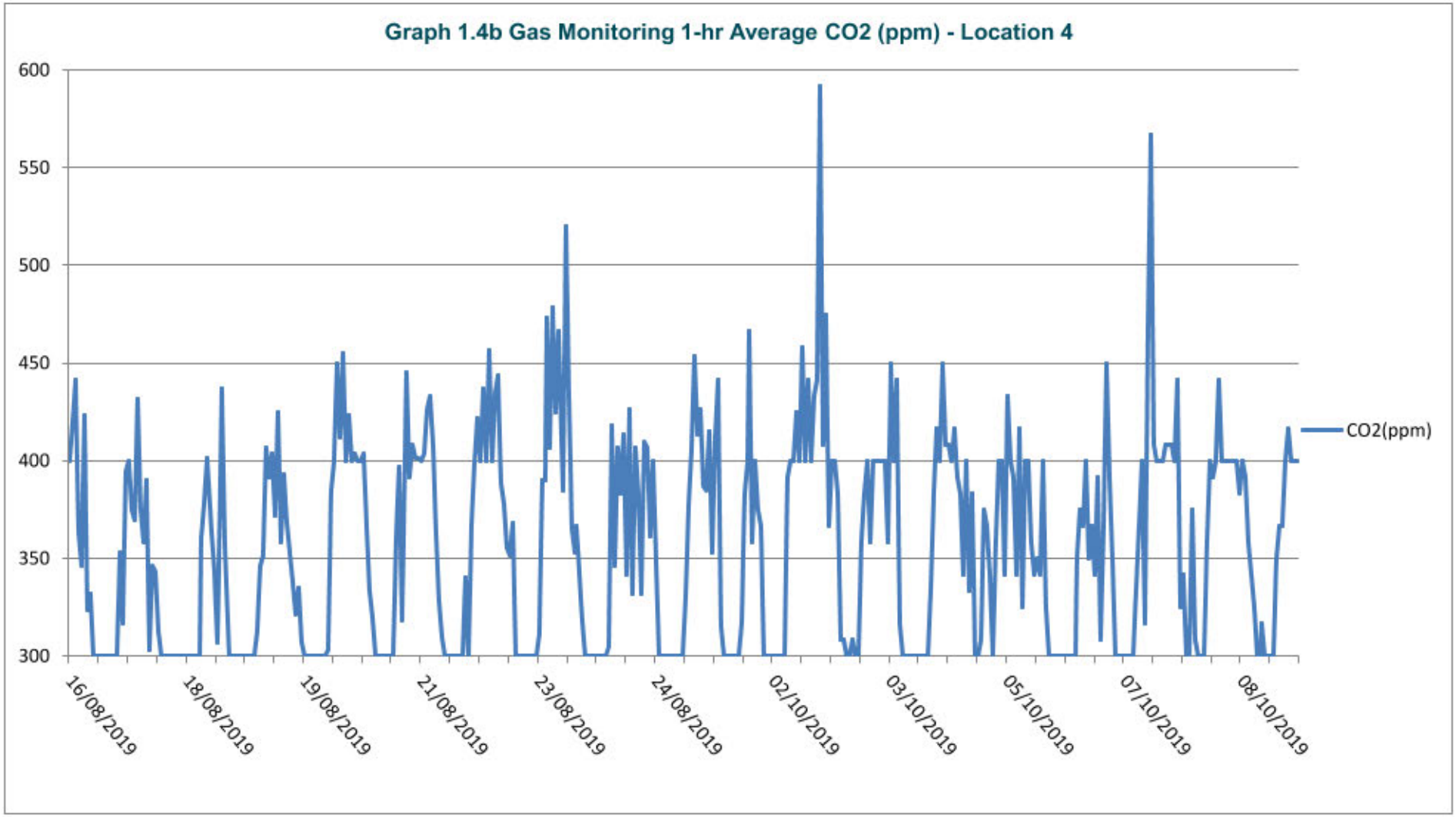
27/08/2019 06:00
27/08/2019 15:00
27/08/2019 21:00
28/08/2019 03:00
28/08/2019 09:00
28/08/2019 15:00
28/08/2019 21:00
29/08/2019 03:00
29/08/2019 09:00
29/08/2019 15:00
29/08/2019 21:00
30/08/2019 03:00
30/08/2019 09:00
30/08/2019 15:00
30/08/2019 21:00
31/08/2019 03:00
31/08/2019 09:00
31/08/2019 15:00
31/08/2019 21:00
Date and Time
CO2(ppm)

Graph 1.4a. Gas Monitoring : 1-hr Average (NO, CO, NO_2, SO_2) - Location 4




Graph 1.4b Gas Monitoring 1-hr Average CO2 (ppm) - Location 4
600
550
500
450
400
350
300
16/08/2019
18/08/2019
19/08/2019
21/08/2019
23/08/2019
24/08/2019
02/10/2019
03/10/2019
05/10/2019
07/10/2019
08/10/2019
CO2(ppm)

Appendix C

Equipment Specification and Calibration Certificates

SKC CERTIFICATE OF CONFORMITY

Sidekick Air Sampling Pump

This certifies that the product listed below has been processed, inspected and tested fully within the controls detailed in our ISO 9001:2008 (certified by BSI, certificate number: FM 24816) and ISO/IEC 80079-34:2011 (certified by Sira, QAN number: SIRA 01 ATEX M108) Quality Management System, and is in accordance with factory specifications. SKC test equipment is calibrated in accordance with ISO/IEC 17025 with traceability to UK national standards.

Model Number	Serial Number	Date of Manufacture
224-52MTX	18542110	12/04/2018

Functional Checks					
Test	**Pass**	**Test**	**Pass**	**Test**	**Pass**
Display	✓	Flow Adjustment	✓	Maximum Flow	✓
Leak	✓	Flow Fault	✓	Battery	✓

Flow Compensation Performance				
Settings		**Acceptance Criteria**		
Flow Rate ml/min	**Back Pressure inches of water**	**Minimum ml/min**	**Maximum ml/min**	**Pass**
750	5	750	750	✓
	25	712.5	787.5	✓
1000	5	1000	1000	✓
	25	950	1050	✓
2000	0	2000	2000	✓
	25	1900	2100	✓
3000	0	3000	3000	✓
	15	2850	3150	✓

Test Equipment								
Pneumatic Test Kit	0PI03B		0PI03C	✓				

Authorised By	Name	Position
[redacted]	[redacted]	Director

SKC Limited 11 Sunrise Park, Higher Shaftesbury Road, Blandford Forum, Dorset DT11 8ST **United Kingdom**
T: +44 (0) 1258 480188 F: +44 (0) 1258 480184 E: info@skcltd.com W: www.skcltd.com
Registered in England No. 1658380. Registered Office as above.

Mass Flowmeter Calibration Certificate

Model: 4146
Serial Number: 41460643002
Verification date: 21-Nov-2018

Rev: D

Summary Status	
☐ As-Found	☒ In Tolerance
☒ As-Left	☐ Out of Tolerance

Environmental Conditions
Pressure: 99.3 kPa
Temperature: 21.6°C

Air Flow

Tolerance: ±(1.75% of reading or 0.005 SLPM*)

Reference (SLPM)	Measured (SLPM)	Allowable Range Min	Allowable Range Max
0.053	0.052	0.048	0.058
0.160	0.164	0.155	0.165
0.285	0.286	0.280	0.290
0.427	0.426	0.419	0.434
0.999	0.996	0.981	1.016
2.014	2.020	1.979	2.049
3.784	3.742	3.717	3.850
7.468	7.465	7.337	7.598
15.00	15.00	14.74	15.26
PASS			

Temperature

Tolerance: ±1.000 °C

Reference (°C)	Measured (°C)	Allowable Range Min	Allowable Range Max
21.52	21.31	20.52	22.52
PASS			

Pressure

Tolerance: ±0.110 psia

Reference (psia)	Measured (psia)	Allowable Range Min	Allowable Range Max
14.41	14.40	14.30	14.52
22.51	22.51	22.40	22.62
PASS			

Internal Calibration Reference(s)		
Measurement Type	Reference (FC10)	Due for Calibration
Flow	UKFC10	20-Feb-2019
Pressure	UKFC10P	20-Feb-2019
Temperature	UKFC10T	20-Feb-2019

TSI Std Conditions: 70 °F (21.11 °C) and 14.7 psia

Verified by: [redacted]

TSI Instruments Ltd.
Stirling Road
High Wycombe, Bucks HP12 3ST UK

*Tolerance specified: whichever is greater

TSI does hereby certify that this flowmeter has been calibrated using TSI procedure 10000021269. The calibration of the reference standards maintain national laboratory traceability to members of the European co-operation for Accreditation (EA).

SKC

Operating Instructions

863 Valley View Road, Eighty Four, PA 15330 USA
Tel: 724-941-9701 Fax: 724-941-1369 www.skcinc.com

Soap Film Flowmeter
Cat. No. 303

SKC primary standard flowmeters are designed, manufactured, and tested for accuracy; no calibration is needed. Read the operating instructions thoroughly before operating the flowmeter.

Principle of Operation

The air sampling pump to be calibrated is connected to and pulls air through the flowmeter's volumetric glass tube where a flat soap bubble (film) is interposed into the flow path. As the airflow causes the film to move up the volume marks, travel time is measured using a stopwatch. Flow rate can be calculated using the travel time and known tube volume. The 303 Portable Flowmeter Kit is calibrated to a primary standard ± 2% of the volumes marked on the flowmeter.

Assembly

SKC Model 303 is shipped ready to use. Film solution is supplied as well as a length of rubber tubing to connect the flowmeter to the pump.

Preparing for Operation

1. Remove the flowmeter from the case, and place it upright on a level surface.
2. Remove the large rubber stopper from the top of the flowmeter.
3. Tip the flowmeter at an angle, and pour a small amount of film solution into the top of the glass tube. The liquid should run down into the rubber bulb at the bottom.
4. Continue adding film solution until it completely fills the bulb and rises to just below the side arm inlet. Squeeze the rubber bulb occasionally to release trapped air.
5. Replace the stopper on top of the flowmeter.

Wetting the Walls of the Tube

The interior walls of the flowmeter must be wet for the film to travel without rupture. There are two methods:

Method 1

1. Tip the flowmeter to a horizontal position. Allow the film solution to run out of the rubber bulb and into the tube.
2. Maintaining the horizontal position, rotate the flowmeter so that film solution coats the entire inside surface of the glass. **Caution:** Do not allow the solution to enter the metal tube in the rubber stopper at the top of the flowmeter.
3. Return the flowmeter to an upright position and allow the liquid to flow back down into the rubber bulb. Squeeze the bulb occasionally to release trapped air.

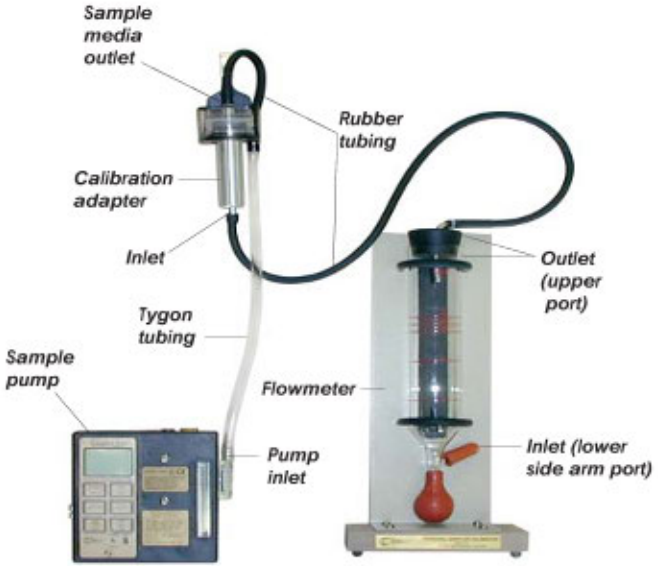
Method 2

1. Connect a pump to the flowmeter (see Connecting a Pump).
2. Turn on the pump. Each successive film that rises up the tube will wet the glass. The walls are sufficiently wet when the film bubbles successfully reach the highest volume mark on the flowmeter.

Connecting the Pump

Note: If the pump to be calibrated **draws** air, connect it to the rubber tubing on the flowmeter's top rubber stopper. If the pump **blows** air, use rubber tubing to connect it to the lower side arm near the base of the flowmeter.

1. Remove the rubber cap from the side arm inlet near the base of the flowmeter.
2. Using rubber tubing, connect one end to the appropriate port on the flowmeter and the other end to the inlet of the sampling medium to be used (if applicable).
3. Using flexible tubing, connect the outlet of the sampling medium to the inlet of the pump.



Measuring the Flow

1. Turn on the pump.
2. Squeeze the rubber bulb on the flowmeter to force the liquid above the inlet. Bubbles (film) will form.
3. Using a stopwatch, start timing the film as it passes the zero line and stop timing as the bubble reaches the 100 ml line. For best results, form several bubbles, five to six seconds apart, and time the last bubble.

Caution: Do not squeeze the bulb continuously. This causes froth to form on the walls making timing difficult.

The flow rate can be determined from the Flow Chart on the back page, or calculated using the following equation:

$$\text{Flow (ml/min)} = \frac{60 \times \text{(volume traveled)}}{\text{Time (in seconds)}}$$

Storage or Transport

Disconnect the pump and replace the rubber cap on the lower inlet of the flowmeter. The instrument can be placed in any position without solution loss. SKC recommends that it be transported in its case.

Volumetric Calibration of Hand Pumps

SKC Model 303 Flowmeter can be used to determine the volume of manual hand pumps such as the bellows or piston pumps used with detector tubes. Follow these procedures:

Bellows Pumps (i.e., Dräger®)

1. Connect a detector tube to the pump according to the manufacturer's instructions.
2. Connect the inlet of the tube to the rubber hose on top of the flowmeter.
3. Compress the bellows pump and release slowly. Squeeze the rubber bulb on the flowmeter. Bubbles (film) will begin to form.
4. When the film reaches the zero line on the flowmeter, compress the bellows pump completely and release. The film will move up the flowmeter and stop when the bellows pump is filled to capacity.
5. Record the point at which the film stops. Most bellows pumps are designed to draw 100 ml. Lines on the flowmeter are graduated at 90, 95, 100, 105, and 110 ml. Visually extrapolate the volume reading if the film stops between lines.
6. Calculate and record the volume.

Note: Pumps should be repaired if they fall outside of the 90 to 110 ml range.

Piston Pumps (i.e., Gastec®, MSA, Kitagawa)

1. Connect a standard detector tube to the piston pump according to the manufacturer's instructions.
2. Connect the inlet of the tube to the rubber hose on top of the film flowmeter.
3. While pulling the piston slowly back, squeeze the rubber bulb on the flowmeter until bubbles (film) form.
4. Watch the film movement closely. When the film is exactly at the zero line on the flowmeter, push the pump piston all the way in. Then, draw the piston out to full capacity and lock it in place. The film will move up the flowmeter and stop when the piston pump is filled to capacity.
5. Record the point at which the film stops. Most piston pumps are designed to draw 100 ml. Lines on the flowmeter are graduated at 90, 95, 100, 105, and 110 ml. Visually extrapolate the volume reading if the film stops between lines.
6. Calculate and record the volume.

Note: Pumps should be repaired if they fall outside the 90 to 110 ml range.

SKC Limited Warranty and Return Policy

SKC products are subject to the SKC Limited Warranty and Return Policy, which provides SKC's sole liability and the buyer's exclusive remedy. To view the complete SKC Limited Warranty and Return Policy, go to http://www.skcinc.com/warranty.asp.

Flow Chart for 303 Calibrator

100 ml line		100 ml line		100 ml line `		100 ml line `	
Time (sec)	Flow (ml/min)	Time (sec)	Flow (ml/min)	Time (sec)	Flow (ml/min)	Time (sec)	Flow (ml/min)
		43	139	90	67	83	36
12	500	44	137	92	65	85	35
13	462	45	133	94	64	87	34
14	429	46	130	96	62	90	33
15	400	47	128	98	61	93	32
16	375	48	125	100	60	96	31
17	353	49	122	102	59	100	30
18	333	50	120	104	58	104	29
19	316	51	118	106	57	108	28
20	300	52	115	108	56	112	27
21	286	53	113	110	55	116	26
22	273	55	111	112	54	120	25
23	261	55	109	114	53	125	24
24	250	56	107	116	52	130	23
25	240	57	105	118	51	135	22
26	231	58	103	120	50	140	21
27	222	59	101	50 ml line		150	20
28	214	60	100	Time	Flow	160	19
29	207	62	97	(sec)	(ml/min)	170	18
30	200	64	94	60	50	180	17
31	193	66	91	61	49	190	16
32	187	68	88	62	49	200	15
33	182	70	86	63	47	210	14
34	176	72	83	65	46	225	13
35	171	74	81	66	45	250	12
36	167	76	79	68	44	275	11
37	162	78	77	70	43	300	10
38	158	80	75	72	42	330	9
39	154	82	73	74	41	365	8
40	150	84	71	76	39	425	7
41	146	86	70	78	38	500	6
42	143	88	68	81	37	600	5

Accessories and Spare Parts

Description	Cat. No.
Film Solution, 1 pint, (473 ml)	302-4011
Precision Digital Stopwatch	303-01-1
Replacement Connecting Hose (2 pieces)	P3032101
Replacement Squeeze Bulb	P3032311
Replacement Flowmeter Sidearm Cap	P3032312

www.skcinc.com

Ribble Enviro Ltd
www.ribble-enviro.co.uk

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Certificate of Calibration

Customer:	*Verde Environmental Consultants Ltd*
Instrument:	Multi RAE LITE
Job:	Pre-Sale Service, Test & Calibration
Serial number:	M01C020103
Fleet Number:	-
Certificate no:	020103/020719
Next calibration due date:	02.01.2020
Tested on:	02.07.2019
Calibrated for:	Carbon Dioxide, Carbon Monoxide, Nitrogen Dioxide, Nitric Oxide, Sulphur Dioxide

Applied Gas Concentration:	Cylinder Reference:	Initial Sensor Reading	Final Sensor Reading	Accuracy Limits
CO2: 20000ppm	AGG1963-1-2	1.99%	2.00%	±5%
CO: 100ppm	10773/0716	100ppm	100ppm	±5%
NO2: 10ppm	AGG1818-11-1	9.7 ppm	10.0ppm	±5%
NO: 25ppm	AGG2061-9-1	25ppm	25ppm	±5%
SO2: 10ppm	AGG2568-16-1	10ppm	10ppm	±5%

The Instrument has been calibrated after Re-Zeroing & Introducing Span Calibration Gas, using gas that is traceable to national standards and has been prepared in accordance with BS EN ISO6145-6:2008

Calibration Engineer: [redacted]

Sign: [redacted]

Quality Assessed by (Print):	[redacted]	Sign:	[redacted]

Tel: 01200 445 804 **Fax:** 01200 445 809 **Email:** info@ribble-enviro.co.uk
Ribble Enviro Ltd., Unit 4, Gisburn Business Park, Gisburn, Nr Clitheroe, BB7 4JP, UK
Company Registered in England: 06140589 **VAT No.:** GB 906 6241 34

Ribble Enviro Ltd
www.ribble-enviro.co.uk

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Certificate of Calibration

Customer: *Verde Environmental Consultants Ltd*

Instrument: Multi RAE LITE

Job: Pre-Sale Service, Test & Calibration

Serial number: M01C020120

Fleet Number: -

Certificate no: 020120/020719

Next calibration due date: 02.01.2020

Tested on: 02.07.2019

Calibrated for: Carbon Dioxide, Carbon Monoxide, Nitrogen Dioxide, Nitric Oxide, Sulphur Dioxide

Applied Gas Concentration:	Cylinder Reference:	Initial Sensor Reading	Final Sensor Reading	Accuracy Limits
CO2: 20000ppm	AGG1963-1-2	1.99%	2.00%	±5%
CO: 100ppm	10773/0716	100ppm	100ppm	±5%
NO2: 10ppm	AGG1818-11-1	9.6ppm	10.1ppm	±5%
NO: 25ppm	AGG2061-9-1	25ppm	25ppm	±5%
SO2: 10ppm	AGG2568-16-1	10ppm	10ppm	±5%

The Instrument has been calibrated after Re-Zeroing & Introducing Span Calibration Gas, using gas that is traceable to national standards and has been prepared in accordance with BS EN ISO6145-6:2008

Calibration Engineer: [redacted]

Sign: [redacted]

Quality Assessed by (Print):	[redacted]	Sign:	[redacted]

Tel: 01200 445 804 **Fax:** 01200 445 809 **Email:** info@ribble-enviro.co.uk
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Company Registered in England: 06140589 **VAT No.:** GB 906 6241 34

Ribble Enviro Ltd
www.ribble-enviro.co.uk

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Certificate of Calibration

Customer:	*Verde Environmental Consultants Ltd*
Instrument:	Multi RAE LITE
Job:	Pre-Sale Service, Test & Calibration
Serial number:	M01C020131
Fleet Number:	-
Certificate no:	020131/020719
Next calibration due date:	02.01.2020
Tested on:	02.07.2019
Calibrated for:	Carbon Dioxide, Carbon Monoxide, Nitrogen Dioxide, Nitric Oxide, Sulphur Dioxide

Applied Gas Concentration:	Cylinder Reference:	Initial Sensor Reading	Final Sensor Reading	Accuracy Limits
CO2: 20000ppm	AGG1963-1-2	2.00%	2.00%	±5%
CO: 100ppm	10773/0716	100ppm	100ppm	±5%
NO2: 10ppm	AGG1818-11-1	9.8 ppm	10.0ppm	±5%
NO: 25ppm	AGG2061-9-1	25ppm	25ppm	±5%
SO2: 10ppm	AGG2568-16-1	10ppm	10ppm	±5%

The Instrument has been calibrated after Re-Zeroing & Introducing Span Calibration Gas, using gas that is traceable to national standards and has been prepared in accordance with BS EN ISO6145-6:2008

Calibration Engineer: [redacted]

Sign: [redacted]

Quality Assessed by (Print):	[redacted]	Sign:	[redacted]

Tel: 01200 445 804 **Fax:** 01200 445 809 **Email:** info@ribble-enviro.co.uk
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Company Registered in England: 06140589 VAT No.: GB 906 6241 34

Ribble Enviro Ltd
www.ribble-enviro.co.uk

...everything gas detection

Certificate of Calibration

Customer:	*Verde Environmental Consultants Ltd*
Instrument:	Multi RAE LITE
Job:	Pre-Sale Service, Test & Calibration
Serial number:	M01C020136
Fleet Number:	-
Certificate no:	020136/020719
Next calibration due date:	02.01.2020
Tested on:	02.07.2019
Calibrated for:	Carbon Dioxide, Carbon Monoxide, Nitrogen Dioxide, Nitric Oxide, Sulphur Dioxide

Applied Gas Concentration:	Cylinder Reference:	Initial Sensor Reading	Final Sensor Reading	Accuracy Limits
CO2: 20000ppm	AGG1963-1-2	1.99%	2.00%	±5%
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Calibration Engineer: [redacted]

Sign: [redacted]

Quality Assessed by (Print):	[redacted]	Sign:	[redacted]

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