Envirocare CONSULTANCY

2522

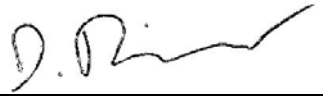
Caring for the environment and creating safer workplaces

# Report for the Periodic Monitoring of Emissions to Atmosphere

# Wyndeham Heron Ltd

| | |
|---|---|
| Operator: | Wyndeham Heron Ltd |
| Permit Number: | MLD/EPR/A2/001 |
| Installation: | Printworks |
| Monitoring Dates: | 15-16 October & 22 November 2012 |
| Site Address: | The Bethnal Complex<br>Colchester Road<br>Maldon<br>CM9 4NW |

| | |
|---|---|
| Report Number: | J 5319 |
| Version: | 2 |
| Date of Report: | 3 December 2012 |
| Report Author: | Mr M Ropka |
| MCERTS Registration N°: | MM 06 761 |
| MCERTS Level: | Level 2 (TE1, TE2, TE3, TE4) |

| | |
|---|---|
| Report Approved by: | Mr D Fisher |
| MCERTS Registration N°: | MM 08 963 |
| MCERTS Level: | MCERTS Level 2 (TE1, TE3, TE4) |
| Function: | Environmental Consultant |
| Signed: |  |

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# Part 1: Executive Summary

## 1.1 Monitoring Objectives

Wyndeham Heron operate several printing lines that have the potential to release controlled substances to atmosphere, and are subject to authorisation under the Environmental Permitting Regulations (EPR, 2010). Under the act, Local Authorities regulate the printing processes with guidance from the Sector Guidance Note SG6: Surface Treatment using Solvents.

In order for Wyndeham Heron to comply with its annual emission limits they have requested that Envirocare Technical Consultancy undertake a monitoring exercise on all of the thermal oxidiser abatement units and from the waste transport system compactor. The methodologies and results obtained form the basis of this report.

The three Rotoman presses have two print lines that run simultaneously and are located one above the other, each press has its own dryer, each with a duct exiting the dryer and emitting vertically alongside one another. The Lithoman 1 Press has a dedicated dryer.

**Emission Point Identification**

| Substances to Be Monitored | Rotoman 1 | | Rotoman 2 | | Rotoman 3 | | Lithoman 1 | Compactor |
|---|---|---|---|---|---|---|---|---|
| | Lower | Upper | Lower | Upper | Lower | Upper | | |
| CO | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| NOx | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| VOCs | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Moisture (for correction) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Total Particulate Matter | | | | | | | | ✓ |
| **Special requirements** | None | | | | | | | |

Opinions and interpretations expressed within this report are outside the scope of Envirocare Technical Consultancies MCERTS and UKAS accreditation.

## 1.2 Monitoring Results

| Emission Point Reference | Substance to be Monitored | Emission Limit Value | Periodic Monitoring Result | Units | Uncertainty as % of ELV (95% confidence) | Reference Conditions | Date of Sampling | Start and End Times | Monitoring Method Reference | Accreditation for use of Method | Operating Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rotoman 1 Lower | Carbon Monoxide | 100 | 40.8 | mg/Nm$^3$ | 2.8% | 273K, 101.3kPa, WET | 15/10/12 | 14:00-15:05 | BS EN 15058 | MCERTS | Normal |
| | Oxides of Nitrogen (as $NO_2$) | 100 | 57.2 | mg/Nm$^3$ | 2.5% | 273K, 101.3kPa, WET | 15/10/12 | 14:00-15:05 | BS EN 14792 | MCERTS | Normal |
| | Total VOC's | 20 | 4.9 | mg/Nm$^3$ | 11.2% | 273K, 101.3kPa, WET | 15/10/12 | 14:00-15:05 | BS EN 12619 | MCERTS | Normal |
| | Moisture Content | None | 5.7 | % | - | 273K, 101.3kPa | 15/10/12 | 14:37-15:07 | US EPA M4 | ISO 17025 | Normal |
| | Volumetric Flowrate | None | 4628.9 | Nm$^3$/Hr | - | 273K, 101.3kPa | 22/11/12 | ~09:00 | BS EN 13284 | MCERTS | Normal |

| Emission Point Reference | Substance to be Monitored | Emission Limit Value | Periodic Monitoring Result | Units | Uncertainty as % of ELV (95% confidence) | Reference Conditions | Date of Sampling | Start and End Times | Monitoring Method Reference | Accreditation for use of Method | Operating Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rotoman 1 Upper | Carbon Monoxide | 100 | 35.6 | mg/Nm$^3$ | 2.6% | 273K, 101.3kPa, WET | 15/10/12 | 15:36-18:04 | BS EN 15058 | MCERTS | Normal |
| | Oxides of Nitrogen (as $NO_2$) | 100 | 74.6 | mg/Nm$^3$ | 2.9% | 273K, 101.3kPa, WET | 15/10/12 | 15:36-18:04 | BS EN 14792 | MCERTS | Normal |
| | Total VOC's | 20 | 7.5 | mg/Nm$^3$ | 11.2% | 273K, 101.3kPa, WET | 15/10/12 | 15:36-18:04 | BS EN 12619 | MCERTS | Normal |
| | Moisture Content | None | 4.8 | % | - | 273K, 101.3kPa | 15/10/12 | 17:07-17:29 | US EPA M4 | ISO 17025 | Normal |
| | Volumetric Flowrate | None | 4473.9 | Nm$^3$/Hr | - | 273K, 101.3kPa | 22/11/12 | ~09:20 | BS EN 13284 | MCERTS | Normal |

| Emission Point Reference | Substance to be Monitored | Emission Limit Value | Periodic Monitoring Result | Units | Uncertainty as % of ELV (95% confidence) | Reference Conditions | Date of Sampling | Start and End Times | Monitoring Method Reference | Accreditation for use of Method | Operating Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rotoman 2 Lower | Carbon Monoxide | 100 | 47.2 | $mg/Nm^3$ | 2.4% | 273K, 101.3kPa, WET | 16/10/12 | 10:40-13:00 | BS EN 15058 | MCERTS | Normal |
| | Oxides of Nitrogen (as $NO_2$) | 100 | 59.1 | $mg/Nm^3$ | 2.2% | 273K, 101.3kPa, WET | 16/10/12 | 10:40-13:00 | BS EN 14792 | MCERTS | Normal |
| | Total VOC's | 20 | 3.0 | $mg/Nm^3$ | 4.3% | 273K, 101.3kPa, WET | 16/10/12 | 10:40-13:00 | BS EN 12619 | MCERTS | Normal |
| | Moisture Content | None | 5.1 | % | - | 273K, 101.3kPa | 16/10/12 | 14:20-14:46 | US EPA M4 | ISO 17025 | Normal |
| | Volumetric Flowrate | None | 3338.1 | $Nm^3/Hr$ | - | 273K, 101.3kPa | 22/11/12 | ~09:40 | BS EN 13284 | MCERTS | Normal |

| Emission Point Reference | Substance to be Monitored | Emission Limit Value | Periodic Monitoring Result | Units | Uncertainty as % of ELV (95% confidence) | Reference Conditions | Date of Sampling | Start and End Times | Monitoring Method Reference | Accreditation for use of Method | Operating Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rotoman 2 Upper | Carbon Monoxide | 100 | 55.3 | $mg/Nm^3$ | 2.7% | 273K, 101.3kPa, WET | 16/10/12 | 13:09-15:19 | BS EN 15058 | MCERTS | Normal |
| | Oxides of Nitrogen (as $NO_2$) | 100 | 53.5 | $mg/Nm^3$ | 2.0% | 273K, 101.3kPa, WET | 16/10/12 | 13:09-15:19 | BS EN 14792 | MCERTS | Normal |
| | Total VOC's | 20 | 5.1 | $mg/Nm^3$ | 4.3% | 273K, 101.3kPa, WET | 16/10/12 | 13:09-15:19 | BS EN 12619 | MCERTS | Normal |
| | Moisture Content | None | 6.4 | % | - | 273K, 101.3kPa | 16/10/12 | 15:10-15:40 | US EPA M4 | ISO 17025 | Normal |
| | Volumetric Flowrate | None | 2320.6 | $Nm^3/Hr$ | - | 273K, 101.3kPa | 22/11/12 | ~10:00 | BS EN 13284 | MCERTS | Normal |

| Emission Point Reference | Substance to be Monitored | Emission Limit Value | Periodic Monitoring Result | Units | Uncertainty as % of ELV (95% confidence) | Reference Conditions | Date of Sampling | Start and End Times | Monitoring Method Reference | Accreditation for use of Method | Operating Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rotoman 3 Lower | Carbon Monoxide | 100 | 59.3 | $mg/Nm^3$ | 2.8% | 273K, 101.3kPa, WET | 16/10/12 | 11:40-12:40 | BS EN 15058 | MCERTS | Normal |
| | Oxides of Nitrogen (as $NO_2$) | 100 | 51.7 | $mg/Nm^3$ | 1.9% | 273K, 101.3kPa, WET | 16/10/12 | 11:40-12:40 | BS EN 14792 | MCERTS | Normal |
| | Total VOC's | 20 | 1.9 | $mg/Nm^3$ | 5.5% | 273K, 101.3kPa, WET | 16/10/12 | 11:40-12:40 | BS EN 12619 | MCERTS | Normal |
| | Moisture Content | None | 7.2 | % | - | 273K, 101.3kPa | 16/10/12 | 11:39-12:09 | US EPA M4 | ISO 17025 | Normal |
| | Volumetric Flowrate | None | 3991.6 | $Nm^3/Hr$ | - | 273K, 101.3kPa | 22/11/12 | ~10:20 | BS EN 13284 | MCERTS | Normal |

| Emission Point Reference | Substance to be Monitored | Emission Limit Value | Periodic Monitoring Result | Units | Uncertainty as % of ELV (95% confidence) | Reference Conditions | Date of Sampling | Start and End Times | Monitoring Method Reference | Accreditation for use of Method | Operating Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rotoman 3 Upper | Carbon Monoxide | 100 | 60.5 | $mg/Nm^3$ | 2.9% | 273K, 101.3kPa, WET | 16/10/12 | 13:00-14:00 | BS EN 15058 | MCERTS | Normal |
| | Oxides of Nitrogen (as $NO_2$) | 100 | 53.2 | $mg/Nm^3$ | 2.0% | 273K, 101.3kPa, WET | 16/10/12 | 13:00-14:00 | BS EN 14792 | MCERTS | Normal |
| | Total VOC's | 20 | 1.9 | $mg/Nm^3$ | 5.5% | 273K, 101.3kPa, WET | 16/10/12 | 13:00-14:00 | BS EN 12619 | MCERTS | Normal |
| | Moisture Content | None | 7.2 | % | - | 273K, 101.3kPa | 16/10/12 | 12:24-12:54 | US EPA M4 | ISO 17025 | Normal |
| | Volumetric Flowrate | None | 3853.2 | $Nm^3/Hr$ | - | 273K, 101.3kPa | 22/11/12 | ~10:40 | BS EN 13284 | MCERTS | Normal |

| Emission Point Reference | Substance to be Monitored | Emission Limit Value | Periodic Monitoring Result | Units | Uncertainty as % of ELV (95% confidence) | Reference Conditions | Date of Sampling | Start and End Times | Monitoring Method Reference | Accreditation for use of Method | Operating Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lithoman 1 | Carbon Monoxide | 100 | 64.8 | $mg/Nm^3$ | 3.4% | 273K, 101.3kPa, WET | 15/10/12 | 16:31-18:20 | BS EN 15058 | MCERTS | Normal |
| | Oxides of Nitrogen (as $NO_2$) | 100 | 50.5 | $mg/Nm^3$ | 2.0% | 273K, 101.3kPa, WET | 15/10/12 | 16:31-18:20 | BS EN 14792 | MCERTS | Normal |
| | Total VOC's | 20 | 0.0 | $mg/Nm^3$ | 5.5% | 273K, 101.3kPa, WET | 15/10/12 | 16:31-18:20 | BS EN 12619 | MCERTS | Normal |
| | Moisture Content | None | 8.7 | % | - | 273K, 101.3kPa | 15/10/12 | 18:20-18:40 | US EPA M4 | ISO 17025 | Normal |
| | Volumetric Flowrate | None | 5910.3 | $Nm^3/Hr$ | - | 273K, 101.3kPa | 22/11/12 | ~8:40 | BS EN 13284 | MCERTS | Normal |

| Emission Point Reference | Substance to be Monitored | Emission Limit Value | Periodic Monitoring Result | Units | Uncertainty as % of ELV (95% confidence) | Reference Conditions | Date of Sampling | Start and End Times | Monitoring Method Reference | Accreditation for use of Method | Operating Status |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Compactor | Total Particulate Matter | 50* | 1.9 | $mg/Nm^3$ | - | 273K, 101.3kPa | 12/10/11 | 10:35 – 13:54 | MDHS 14/3 | None | Normal |

*Assumed

## 1.3 Operating Information

| Emission Point Reference | Date | Process Type | Process Duration | Fuel | Feedstock | Abatement | Press Speed | Comparison of Operator CEMS and Periodic Monitoring Results | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Substance | CEMS Results | Periodic Monitoring Results | Units |
| Rotoman 1 Lower | 15/10/12 | Offset Lithographic Printing | Batch. | Natural Gas | Paper and Ink | Thermal Oxidiser | 37,000 cph | N/A | N/A | N/A | N/A |
| Rotoman 1 Upper | 15/10/12 | Offset Lithographic Printing | Batch. | Natural Gas | Paper and Ink | Thermal Oxidiser | 26,000 cph | N/A | N/A | N/A | N/A |
| Rotoman 2 Lower | 16/10/12 | Offset Lithographic Printing | Batch. | Natural Gas | Paper and Ink | Thermal Oxidiser | 43,000 cph | N/A | N/A | N/A | N/A |
| Rotoman 2 Upper | 16/10/12 | Offset Lithographic Printing | Batch. | Natural Gas | Paper and Ink | Thermal Oxidiser | Unknown | N/A | N/A | N/A | N/A |
| Rotoman 3 Lower | 16/10/12 | Offset Lithographic Printing | Batch. | Natural Gas | Paper and Ink | Thermal Oxidiser | Unknown | N/A | N/A | N/A | N/A |
| Rotoman 3 Upper | 16/10/12 | Offset Lithographic Printing | Batch. | Natural Gas | Paper and Ink | Thermal Oxidiser | Unknown | N/A | N/A | N/A | N/A |
| Lithoman 1 | 15/10/12 | Offset Lithographic Printing | Batch. | Natural Gas | Paper and Ink | Thermal Oxidiser | Unknown | N/A | N/A | N/A | N/A |
| Compactor | 16/10/12 | Collection of offcuts from binding | Continuous | None | Paper offcuts | Bag Filter | N/A | N/A | N/A | N/A | N/A |

## 1.4 Monitoring Deviations

| Emission Point Reference | Substance Deviations | Monitoring Deviations | Other Relevant Issues |
|---|---|---|---|
| Rotoman 1 Lower | None | None | None |
| Rotoman 1 Upper | None | None | None |
| Rotoman 2 Lower | None | None | None |
| Rotoman 2 Upper | None | None | None |
| Rotoman 3 Lower | None | None | None |
| Rotoman 3 Upper | None | None | None |
| Lithoman 1 | None | None | None |
| Compactor | None | None | None |

# Part 2: Supporting Information

## 2.1 Appendix 1: General Information

### 2.1.1 Monitoring organisation staff details

| Personnel | Function in monitoring campaign | MCERTS Level | MCERTS Number |
|---|---|---|---|
| Mr M Ropka | Team Leader | MCERTS Level 2 (TE1, TE2, TE3, TE4) | MM 06 761 |
| Mr D Fisher | Technician | MCERTS Level 2 (TE1, TE3, TE4) | MM 08 963 |
| Mr C G Mann | Team Leader | MCERTS Level 2 (TE1, TE2, TE3, TE4) | MM 06 695 |
| Mr A R May | Technician | MCERTS Level 2 (TE1, TE3, TE4) | MM 05 626 |

### 2.1.2 Monitoring Methods

| Pollutant Species | Standard | Technique | Envirocare Internal Procedure |
|---|---|---|---|
| Total VOC's | BS EN 12619 | FID | ETC-M-03 |
| Carbon Monoxide | BS EN 15058 | NDIR | ETC-M-25 |
| Oxides of Nitrogen | BS EN 14792 | Chemiluminescence | ETC-M-25 |
| Particulates | MDHS 14/3 | Gravimetric | SM-05 |
| Stack Temperature + Velocity | BS EN 13284 | Pitot Tube + Thermocouple | ETC-M-46 |

### 2.1.3 Equipment Checklist

| Equipment ID | Model Number | Purpose |
|---|---|---|
| Horiba 1 | Horiba PG250 | Multi component gas analyser |
| Horiba 2 | Horiba PG250 | Multi component gas analyser |
| Sig 1 | Signal 3030pm | Flame Ionisation Detector |
| Sig 3 | Signal 3030pm | Flame Ionisation Detector |
| HL3 | Signal Heated Line | PTFE Cored heated sample line |
| HL6 | - | PTFE Cored heated sample line |
| HL7 | - | PTFE Cored heated sample line |
| HL8 | - | PTFE Cored heated sample line |
| GPU4 | MAK10 | Sample gas conditioner |
| GPU5 | MAK10 | Sample gas conditioner |

# 2.2 Appendix 2: Rotoman 1 Lower Results and Calculations

## 2.2.1 Photograph of the sampling location and positions

## 2.2.2 Flow criteria measurements

**Stack reference:** **Rotoman 1 Lower** **Date:** **22/11/2012**

**Duct dimensions:** **60.0** **cm**

**Local barometric pressure:** **1017** **mbar**

**Ambient Temperature:** **23** **°C** Pitot Coefficient = 0.822

Micromanometer Calibration (K; mbar) = 289 1000

| Sample port (A) | Traverse point | Traverse position (D) | Distance (cm) | Velocity (m/s) Uncorrd. | Velocity (m/s) Corrd. | Temp (°C) |
|---|---|---|---|---|---|---|
| **Single** | A1 | 0.05 | 3.0 | 8.2 | 9.7 | 336 |
| | A2 | 0.15 | 9.0 | 8.6 | 10.2 | 336 |
| | A3 | 0.25 | 15.0 | 8.3 | 9.8 | 336 |
| | A4 | 0.35 | 21.0 | 8.0 | 9.5 | 336 |
| | A5 | 0.45 | 27.0 | 8.6 | 10.2 | 336 |
| | A6 | 0.55 | 33.0 | 9.0 | 10.6 | 336 |
| | A7 | 0.65 | 39.0 | 9.1 | 10.8 | 336 |
| | A8 | 0.75 | 45.0 | 8.9 | 10.5 | 336 |
| | A9 | 0.85 | 51.0 | 8.4 | 9.9 | 336 |
| | A10 | 0.95 | 57.0 | 8.3 | 9.8 | 336 |

**Velocity readings (m/s)**

**Duct Mean m/s** **10.1**

Highest(a) 10.8 Lowest (b) 9.5

**Temperature readings**

**Duct Mean °C** **336**

Duct Mean K 609

Highest(a) 336.0 Lowest (b) 336.0

**Volumetic flow rate**

| | | |
|---|---|---|
| Duct dimensions | 60.0 | (cm) |
| Duct area | 0.283 | ($m^2$) |
| Mean duct velocity | 10.1 | (m/s) |
| Mean duct temperature | 336 | ($^oC$) |
| Ambient pressure | 1017 | (mbar) |
| **Vol. Flow rate at stack conditions** | **10285** | **($m^3$/hr)** |
| **Vol flow rate corrd.** | **4628.9** | **($Nm^3$/hr)** |

### 2.2.3 Water vapour measurements

**MOISTURE TEST FORM**

**Client Name:** Wyndeham Heron **Date:** 15/10/2012
**Job Number:** 5319

**Stack Reference:** Rotoman 1 Lower

| | | | | |
|---|---|---|---|---|
| **Ambient Pressure (mbar):** | | 1005 | **Gas Meter Temperature (°C):** | |
| **Stack Temperature (°C):** | | 342 | **Start:** | 20 |
| **Gasmeter Coefficient:** | | 1.000 | **End:** | 30 |
| **Equipment used:** | | Pump 59 | **Mean:** | 25 |
| **Leak Check (l/min)** | **Before:** | 0.1 | | |
| | **After:** | 0.1 | | |

| | | | |
|---|---|---|---|
| **Start Flow Reading (l/min)** | 1.682 | **Start Time** | 14:37:00 |
| **End Flow Reading (l/min)** | 1.636 | **End Time** | 15:07:00 |
| **Volume Sampled (l)** | 49.8 | **Total Time (min)** | 30 |
| **Corrected Volume Sampled (l)** | 45.2 | | |
| **Sampling Rate (l/min)** | 1.659 | | |

| | **IMPINGER** | |
|---|---|---|
| | **1** | **2** |
| **Start Weight of Impingers (g)** | 90.0 | 91.1 |
| **End Weight of Impingers (g)** | 92.3 | 91 |
| **Weight Gain (g)** | 2.3 | -0.1 |

| | |
|---|---|
| **Total Weight Gain (1+2+3+4) (g)** | 2.2 |
| **Total Weight Gain in litres (l)** | 2.74 |

| | |
|---|---|
| **Moisture Content of Gases (g/Nm$^3$)** | 48.6 |
| **Moisture Content of Gases (%)** | **5.71** |

### 2.2.4 Manual monitoring method - results – calculations
Not applicable.

### 2.2.5 Analysis results
Not applicable.

## 2.2.6 Instrumental gas analyser site calibration measurements

**ANALYSER CALIBRATIONS**

**Combustion Gas and VOC Emissions from Rotoman 1 (15/10/12)**

**Data entered by:** MR

**Horiba Analyser:** Hor 1

**Signal Analyser:** Sig 1

| Type of Gas | CO | | NO | | VOCs | |
|---|---|---|---|---|---|---|
| Certified Calibration Values | 80.7 | ppm +/-2% | 49.1 | ppm +/-2% | 10.13 | ppm +/-2% |
| Response Time T90 | 8.0 | seconds | 11.0 | seconds | 4.00 | seconds |
| Period | | | | | | |
| Span PreCal direct to analyser | 80.9 | ppm | 49.2 | ppm | - | ppm |
| Zero PreCal through sample line | -0.2 | ppm | 0.0 | ppm | 0.0 | ppm |
| Span PreCal through sample line | 80.4 | ppm | 48.9 | ppm | 10.1 | ppm |
| Zero PostCal through sample line | 0.5 | ppm | 0.1 | ppm | -1.2 | ppm |
| Span PostCal through sample line | 79.3 | ppm | 48.3 | ppm | 10.3 | ppm |
| Span Drift | 1.4 | % | 1.2 | % | | |
| Zero Drift | -0.9 | % | -0.2 | % | | |
| Is data valid without adjustment | YES | | YES | | | |
| Does data require adjustment | NO | | NO | | | |
| Is data invalid | NO | | NO | | | |

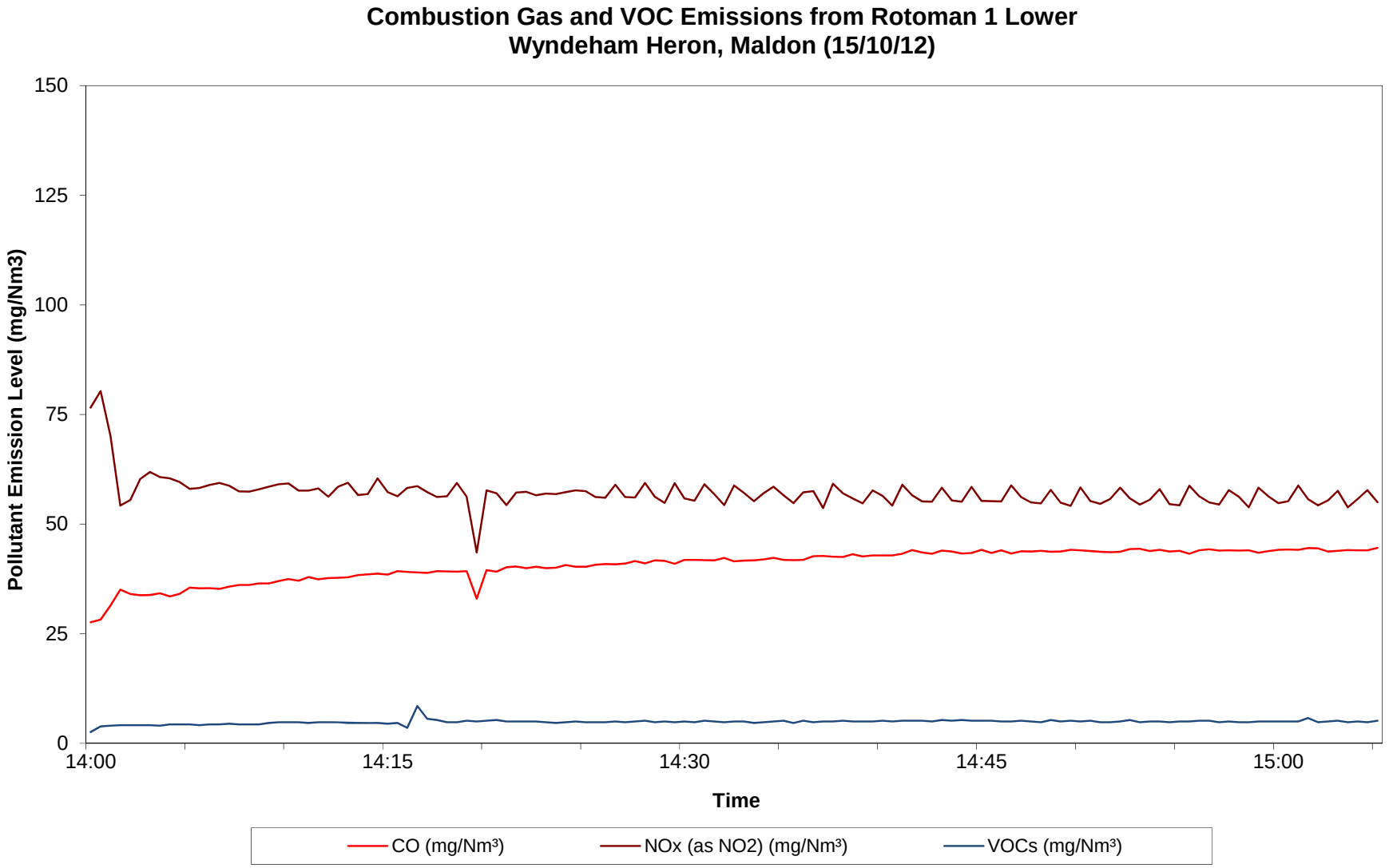
## 2.2.7 Instrumental gas analyser results

**Gaseous Analysis using Horiba PG 250 & Signal 3030PM Analysers**

Wyndeham Heron, Maldon

**Combustion Gas and VOC Emissions from Rotoman 1 Lower (15/10/12)**

| | Carbon Monoxide CO (ppm) | Oxides of Nitrogen NOx (ppm) | VOCs (ppm) | Conversion from ppm to mg/Nm³ WET | | |
|---|---|---|---|---|---|---|
| | | | | CO (mg/Nm³) | NOx (as $NO_2$) (mg/Nm³) | VOCs (mg/Nm³) |
| **Average** | **34.6** | **29.6** | **3.0** | **40.8** | **57.2** | **4.9** |
| **Maximum** | **37.8** | **41.5** | **5.3** | **44.6** | **80.3** | **8.5** |
| **Minimum** | **23.4** | **22.5** | **1.6** | **27.6** | **43.6** | **2.6** |


Combustion Gas and VOC Emissions from Rotoman 1 Lower
Wyndeham Heron, Maldon (15/10/12)
Pollutant Emission Level (mg/Nm3)
150
125
100
75
50
25
0
14:00
14:15
14:30
14:45
15:00
Time
CO (mg/Nm³)
NOx (as NO2) (mg/Nm³)
VOCs (mg/Nm³)

## 2.2.8 Uncertainty calculations

**UNCERTAINTY OF CARBON MONOXIDE BY HORIBA 1**

| | | |
|---|---|---|
| Reading = | 34.6 | ppm |
| Span Gas Certified Value = | 80.7 | ppm +/-2% |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.3460 | 0.1197 |
| Zero Drift/Lower limit of detection (ppm) | -0.70 | Rectangular | 1.732 | -0.4042 | 0.1633 |
| Span Drift (ppm) | 1.10 | Rectangular | 1.732 | 0.6351 | 0.4034 |
| Linearity (% of value) | 1.01 | Rectangular | 1.732 | 0.2018 | 0.0407 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0865 | 0.0075 |
| Interference (% of value) | 2.9 | Rectangular | 1.732 | 0.5793 | 0.3356 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.4659 | 0.2171 |
| | | | | Sum U^2 | 1.29 |
| | | | | **Combined Standard Uncertainty (ppm]** | 1.13 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 2.22 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 6.4 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.78 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.8 |

**UNCERTAINTY OF OXIDES OF NITROGEN BY HORIBA 1**

| | | |
|---|---|---|
| Reading = | 29.6 | ppm |
| Span Gas Certified Value = | 49.1 | ppm |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.2960 | 0.0876 |
| Zero Drift/Lower limit of detection (ppm) | -0.10 | Rectangular | 1.732 | -0.0577 | 0.0033 |
| Span Drift (ppm) | 0.60 | Rectangular | 1.732 | 0.3464 | 0.1200 |
| Linearity (% of value) | 1.41 | Rectangular | 1.732 | 0.2410 | 0.0581 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0740 | 0.0055 |
| Interference (% of value) | 1.2 | Rectangular | 1.732 | 0.2051 | 0.0421 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.2835 | 0.0804 |
| | | | | Sum U^2 | 0.40 |
| | | | | **Combined Standard Uncertainty (ppm)** | 0.63 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 1.23 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 4.2 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.53 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.5 |

**UNCERTAINTY OF VOC BY SIGNAL 1**

| | | |
|---|---|---|
| Reading = | 3.1 | ppm as C3H8 |
| Span Gas= | 10.13 | ppm+/-2% |
| Emission Limit Value | 20 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.0310 | 0.0010 |
| Zero Drift/ Detection threshold | 1.20 | Rectangular | 1.732 | 0.6928 | 0.4800 |
| Span Drift (ppm) | -0.20 | Rectangular | 1.732 | -0.1155 | 0.0133 |
| Noise (ppm) | 0.1 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Linearity (% of value) | 1.65 | Rectangular | 1.732 | 0.0295 | 0.0009 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0078 | 0.0001 |
| Temperature Drift (% of value) | 1 | Rectangular | 1.732 | 0.0179 | 0.0003 |
| Span Gas (% of value) | 1 | Rectangular | 1.732 | 0.0585 | 0.0034 |
| | | | | Sum U^2 | 0.50 |
| | | | | **Combined Standard Uncertainty (ppm as C3H8]** | 0.71 |
| | | | | **Expanded Total Uncertainty (ppm as C3H8] (95% Confidence)** | 1.39 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 44.8 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$ as carbon) (95% Confidence)** | 2.23 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 11.2 |

# 2.3 Appendix 3: Rotoman 1 Upper Results and Calculations

## 2.3.1 Photograph of the sampling location and positions

## 2.3.2 Flow criteria measurements

**Stack reference:** **Rotoman 1 Upper** **Date:** **22/11/2012**

**Duct dimensions:** **60.0** **cm**

**Local barometric pressure:** **1017** **mbar**

**Ambient Temperature:** **23** **°C** Pitot Coefficient = 0.822

Micromanometer Calibration (K; mbar) = 289 1000

| Sample port (A) | Traverse point | Traverse position (D) | Distance (cm) | Velocity (m/s) Uncorrd. | Velocity (m/s) Corrd. | Temp (°C) |
|---|---|---|---|---|---|---|
| **Single** | A1 | 0.05 | 3.0 | 12.0 | 14.1 | 331 |
| | A2 | 0.15 | 9.0 | 11.9 | 14.0 | 331 |
| | A3 | 0.25 | 15.0 | 10.7 | 12.6 | 331 |
| | A4 | 0.35 | 21.0 | 9.8 | 11.5 | 331 |
| | A5 | 0.45 | 27.0 | 8.7 | 10.3 | 331 |
| | A6 | 0.55 | 33.0 | 7.0 | 8.2 | 331 |
| | A7 | 0.65 | 39.0 | 6.4 | 7.5 | 331 |
| | A8 | 0.75 | 45.0 | 5.2 | 6.1 | 331 |
| | A9 | 0.85 | 51.0 | 5.2 | 6.1 | 331 |
| | A10 | 0.95 | 57.0 | 5.3 | 6.2 | 331 |

**Velocity readings (m/s)**

**Duct Mean m/s** **9.7**

Highest(a) 14.1 Lowest (b) 6.1

**Temperature readings**

**Duct Mean °C** **331**

Duct Mean K 604

Highest(a) 331.0 Lowest (b) 331.0

**Volumetic flow rate**

| | | |
|---|---|---|
| Duct dimensions | 60.0 | (cm) |
| Duct area | 0.283 | ($m^2$) |
| Mean duct velocity | 9.7 | (m/s) |
| Mean duct temperature | 331 | ($^oC$) |
| Ambient pressure | 1017 | (mbar) |
| **Vol. Flow rate at stack conditions** | **9859** | **($m^3$/hr)** |
| **Vol flow rate corrd.** | **4473.9** | **($Nm^3$/hr)** |

### 2.3.3 Water vapour measurements

**MOISTURE TEST FORM**

| | | | | |
|---|---|---|---|---|
| **Client Name:** | Wyndeham Heron | | **Date:** | 15/10/2012 |
| **Job Number:** | 5319 | | | |
| **Stack Reference:** | Rotoman 1 Upper | | | |
| **Ambient Pressure (mbar):** | | 1005 | **Gas Meter Temperature (°C):** | |
| **Stack Temperature (°C):** | | 347 | **Start:** | 20 |
| **Gasmeter Coefficient:** | | 1.000 | **End:** | 30 |
| **Equipment used:** | | Pump 59 | **Mean:** | 25 |
| **Leak Check (l/min)** | **Before:** | 0.1 | | |
| | **After:** | 0.1 | | |

| | | | |
|---|---|---|---|
| **Start Flow Reading (l/min)** | 1.596 | **Start Time** | 17:07:00 |
| **End Flow Reading (/minl)** | 1.621 | **End Time** | 17:29:00 |
| **Volume Sampled (l)** | 35.4 | **Total Time (min)** | 22 |
| **Corrected Volume Sampled (l)** | 32.2 | | |
| **Sampling Rate (l/min)** | 1.609 | | |

| | **IMPINGER** | |
|---|---|---|
| | **1** | **2** |
| **Start Weight of Impingers (g)** | 91.1 | 92.3 |
| **End Weight of Impingers (g)** | 92.7 | 92 |
| **Weight Gain (g)** | 1.6 | -0.3 |

| | |
|---|---|
| **Total Weight Gain (1+2+3+4) (g)** | 1.3 |
| **Total Weight Gain in litres (l)** | 1.62 |

| | |
|---|---|
| **Moisture Content of Gases (g/Nm$^3$)** | 40.4 |
| **Moisture Content of Gases (%)** | **4.79** |

### 2.3.4 Manual monitoring method - results – calculations

Not applicable.

### 2.3.5 Analysis results

Not applicable.

## 2.3.6 Instrumental gas analyser site calibration measurements

**ANALYSER CALIBRATIONS**

**Combustion Gas and VOC Emissions from Rotoman 1 Upper (15/10/12)**

**Data entered by:** MR

**Horiba Analyser:** Hor 1

**Signal Analyser:** Sig 1

| Type of Gas | CO | | NO | | VOCs | |
|---|---|---|---|---|---|---|
| Certified Calibration Values | 80.7 | ppm +/-2% | 49.1 | ppm +/-2% | 10.13 | ppm +/-2% |
| Response Time T90 | 8.0 | seconds | 11.0 | seconds | 4.00 | seconds |
| Period | | | | | | |
| Span PreCal direct to analyser | 80.9 | ppm | 49.2 | ppm | - | ppm |
| Zero PreCal through sample line | -0.2 | ppm | 0.0 | ppm | 0.0 | ppm |
| Span PreCal through sample line | 80.4 | ppm | 48.9 | ppm | 10.1 | ppm |
| Zero PostCal through sample line | 0.5 | ppm | 0.1 | ppm | -1.2 | ppm |
| Span PostCal through sample line | 79.3 | ppm | 48.3 | ppm | 10.3 | ppm |
| Span Drift | 1.4 | % | 1.2 | % | | |
| Zero Drift | -0.9 | % | -0.2 | % | | |
| Is data valid without adjustment | YES | | YES | | | |
| Does data require adjustment | NO | | NO | | | |
| Is data invalid | NO | | NO | | | |

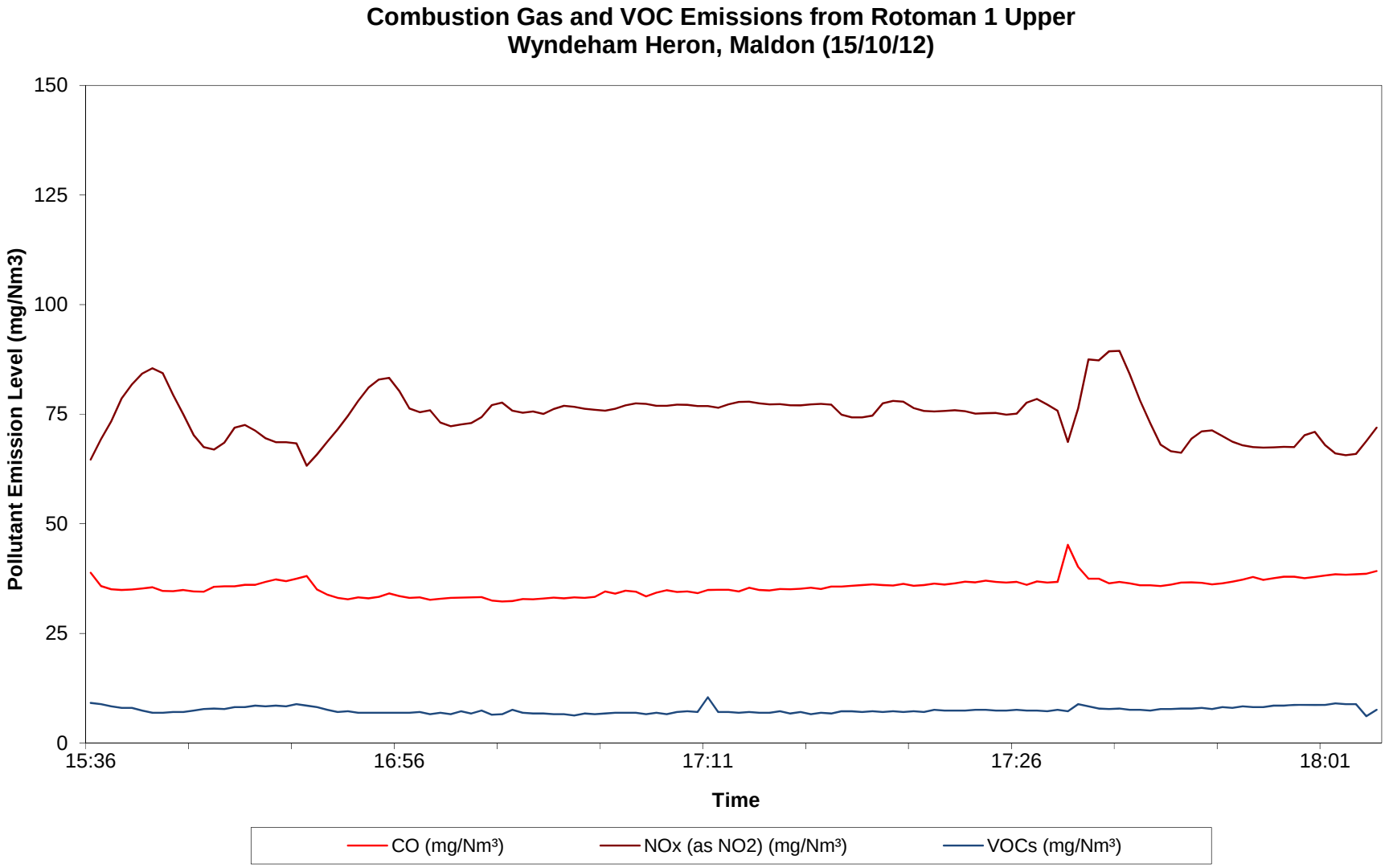
## 2.3.7 Instrumental gas analyser results

**Gaseous Analysis using Horiba PG 250 & Signal 3030PM Analysers**

Wyndeham Heron, Maldon

**Combustion Gas and VOC Emissions from Rotoman 1 Upper (15/10/12)**

| | Carbon Monoxide CO (ppm) | Oxides of Nitrogen NOx (ppm) | VOCs (ppm) | Conversion from ppm to mg/Nm³ WET | | |
|---|---|---|---|---|---|---|
| | | | | CO (mg/Nm³) | NOx (as $NO_2$) (mg/Nm³) | VOCs (mg/Nm³) |
| **Average** | **29.9** | **38.2** | **4.7** | **35.6** | **74.6** | **7.5** |
| **Maximum** | **38.0** | **45.8** | **6.5** | **45.2** | **89.5** | **10.4** |
| **Minimum** | **27.1** | **32.4** | **3.8** | **32.3** | **63.2** | **6.1** |


Combustion Gas and VOC Emissions from Rotoman 1 Upper
Wyndeham Heron, Maldon (15/10/12)
Pollutant Emission Level (mg/Nm3)
150
125
100
75
50
25
0
15:36
16:56
17:11
17:26
18:01
Time
CO (mg/Nm³)
NOx (as NO2) (mg/Nm³)
VOCs (mg/Nm³)

## 2.3.8 Uncertainty calculations

**UNCERTAINTY OF CARBON MONOXIDE BY HORIBA 1**

| | | |
|---|---|---|
| Reading = | 29.9 | ppm |
| Span Gas Certified Value = | 80.7 | ppm +/-2% |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.2990 | 0.0894 |
| Zero Drift/Lower limit of detection (ppm) | -0.70 | Rectangular | 1.732 | -0.4042 | 0.1633 |
| Span Drift (ppm) | 1.10 | Rectangular | 1.732 | 0.6351 | 0.4034 |
| Linearity (% of value) | 1.01 | Rectangular | 1.732 | 0.1744 | 0.0304 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0748 | 0.0056 |
| Interference (% of value) | 2.9 | Rectangular | 1.732 | 0.5006 | 0.2506 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.4659 | 0.2171 |
| | | | | Sum U^2 | 1.16 |
| | | | | **Combined Standard Uncertainty (ppm]** | 1.08 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 2.11 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 7.1 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.64 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.6 |

**UNCERTAINTY OF OXIDES OF NITROGEN BY HORIBA 1**

| | | |
|---|---|---|
| Reading = | 38.2 | ppm |
| Span Gas Certified Value = | 49.1 | ppm |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.3820 | 0.1459 |
| Zero Drift/Lower limit of detection (ppm) | -0.10 | Rectangular | 1.732 | -0.0577 | 0.0033 |
| Span Drift (ppm) | 0.60 | Rectangular | 1.732 | 0.3464 | 0.1200 |
| Linearity (% of value) | 1.41 | Rectangular | 1.732 | 0.3110 | 0.0967 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0955 | 0.0091 |
| Interference (% of value) | 1.2 | Rectangular | 1.732 | 0.2647 | 0.0700 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.2835 | 0.0804 |
| | | | | Sum U^2 | 0.53 |
| | | | | **Combined Standard Uncertainty (ppm)** | 0.72 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 1.42 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 3.7 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.92 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.9 |

**UNCERTAINTY OF VOC BY SIGNAL 1**

| | | |
|---|---|---|
| Reading = | 4.7 | ppm as C3H8 |
| Span Gas= | 10.13 | ppm+/-2% |
| Emission Limit Value | 20 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.0470 | 0.0022 |
| Zero Drift/ Detection threshold | 1.20 | Rectangular | 1.732 | 0.6928 | 0.4800 |
| Span Drift (ppm) | -0.20 | Rectangular | 1.732 | -0.1155 | 0.0133 |
| Noise (ppm) | 0.1 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Linearity (% of value) | 1.65 | Rectangular | 1.732 | 0.0448 | 0.0020 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0118 | 0.0001 |
| Temperature Drift (% of value) | 1 | Rectangular | 1.732 | 0.0271 | 0.0007 |
| Span Gas (% of value) | 1 | Rectangular | 1.732 | 0.0585 | 0.0034 |
| | | | | Sum U^2 | 0.51 |
| | | | | **Combined Standard Uncertainty (ppm as C3H8]** | 0.71 |
| | | | | **Expanded Total Uncertainty (ppm as C3H8] (95% Confidence)** | 1.39 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 29.6 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$ as carbon) (95% Confidence)** | 2.24 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 11.2 |

# 2.4 Appendix 4: Rotoman 2 Lower Results and Calculations

## 2.4.1 Photograph of the sampling location and positions

## 2.4.2 Flow criteria measurements

**Stack reference:** **Rotoman 2 Lower** **Date:** **22/11/2012**

**Duct dimensions:** **50.0** **cm**

**Local barometric pressure:** **1017** **mbar**

**Ambient Temperature:** **23** **°C** Pitot Coefficient = 0.822

Micromanometer Calibration (K; mbar) = 289 1000

| Sample port (A) | Traverse point | Traverse position (D) | Distance (cm) | Velocity (m/s) Uncorrd. | Velocity (m/s) Corrd. | Temp (°C) |
|---|---|---|---|---|---|---|
| **Single** | A1 | 0.05 | 2.5 | 9.3 | 11.2 | 357 |
| | A2 | 0.15 | 7.5 | 9.6 | 11.6 | 357 |
| | A3 | 0.25 | 12.5 | 9.4 | 11.3 | 357 |
| | A4 | 0.35 | 17.5 | 9.1 | 11.0 | 357 |
| | A5 | 0.45 | 22.5 | 8.5 | 10.2 | 357 |
| | A6 | 0.55 | 27.5 | 7.8 | 9.4 | 357 |
| | A7 | 0.65 | 32.5 | 9.3 | 11.2 | 357 |
| | A8 | 0.75 | 37.5 | 9.7 | 11.7 | 357 |
| | A9 | 0.85 | 42.5 | 9.3 | 11.2 | 357 |
| | A10 | 0.95 | 47.5 | 8.2 | 9.9 | 357 |

**Velocity readings (m/s)**

**Duct Mean m/s** **10.9**

Highest(a) 11.7 Lowest (b) 9.4

**Temperature readings**

**Duct Mean °C** **357**

Duct Mean K 630

Highest(a) 357.0 Lowest (b) 357.0

**Volumetic flow rate**

| | | |
|---|---|---|
| Duct dimensions | 50.0 | (cm) |
| Duct area | 0.196 | ($m^2$) |
| Mean duct velocity | 10.9 | (m/s) |
| Mean duct temperature | 357 | ($^oC$) |
| Ambient pressure | 1017 | (mbar) |
| **Vol. Flow rate at stack conditions** | **7673** | **($m^3$/hr)** |
| **Vol flow rate corrd.** | **3338.1** | **($Nm^3$/hr)** |

### 2.4.3 Water vapour measurements

**MOISTURE TEST FORM**

| | | | | |
|---|---|---|---|---|
| **Client Name:** | Wyndeham Heron | | **Date:** | 16/10/2012 |
| **Job Number:** | 5319 | | | |
| **Stack Reference:** | Rotoman 2 Lower | | | |
| **Ambient Pressure (mbar):** | | 1005 | **Gas Meter Temperature (°C):** | |
| **Stack Temperature (°C):** | | 310 | **Start:** | 20 |
| **Gasmeter Coefficient:** | | 1.000 | **End:** | 30 |
| **Equipment used:** | | Pump 59 | **Mean:** | 25 |
| **Leak Check (l/min)** | **Before:** | 0.1 | | |
| | **After:** | 0.1 | | |

| | | | |
|---|---|---|---|
| **Start Flow Reading (l/min)** | 1.744 | **Start Time** | 14:20:00 |
| **End Flow Reading (/minl)** | 1.614 | **End Time** | 14:26:00 |
| **Volume Sampled (l)** | 43.7 | **Total Time (min)** | 26 |
| **Corrected Volume Sampled (l)** | 39.7 | | |
| **Sampling Rate (l/min)** | 1.679 | | |

| | **IMPINGER** | |
|---|---|---|
| | **1** | **2** |
| **Start Weight of Impingers (g)** | 89.5 | 93.2 |
| **End Weight of Impingers (g)** | 91.2 | 93.2 |
| **Weight Gain (g)** | 1.7 | 0.0 |

| | |
|---|---|
| **Total Weight Gain (1+2+3+4) (g)** | 1.7 |
| **Total Weight Gain in litres (l)** | 2.12 |

| | |
|---|---|
| **Moisture Content of Gases (g/Nm$^3$)** | 42.8 |
| **Moisture Content of Gases (%)** | **5.07** |

### 2.4.4 Manual monitoring method - results – calculations

Not applicable.

### 2.4.5 Analysis results

Not applicable.

## 2.4.6 Instrumental gas analyser site calibration measurements

**ANALYSER CALIBRATIONS**

**Combustion Gas and VOC Emissions from Rotoman 2 (16/10/12)**

**Data entered by:** MR

**Horiba Analyser:** Hor 1

**Signal Analyser:** Sig 1

| Type of Gas | CO | | NO | | VOCs | |
|---|---|---|---|---|---|---|
| Certified Calibration Values | 80.7 | ppm +/-2% | 49.1 | ppm +/-2% | 10.13 | ppm +/-2% |
| Response Time T90 | 11.0 | seconds | 11.0 | seconds | 4.00 | seconds |
| Period | | | | | | |
| Span PreCal direct to analyser | 79.9 | ppm | 49.0 | ppm | - | ppm |
| Zero PreCal through sample line | 1.0 | ppm | 0.1 | ppm | 0.0 | ppm |
| Span PreCal through sample line | 80.7 | ppm | 48.9 | ppm | 10.1 | ppm |
| Zero PostCal through sample line | 1.0 | ppm | 0.2 | ppm | 0.4 | ppm |
| Span PostCal through sample line | 80.3 | ppm | 48.9 | ppm | 10.3 | ppm |
| Span Drift | 0.5 | % | 0.0 | % | | |
| Zero Drift | 0.0 | % | -0.2 | % | | |
| Is data valid without adjustment | YES | | YES | | | |
| Does data require adjustment | NO | | NO | | | |
| Is data invalid | NO | | NO | | | |

## 2.4.7 Instrumental gas analyser results

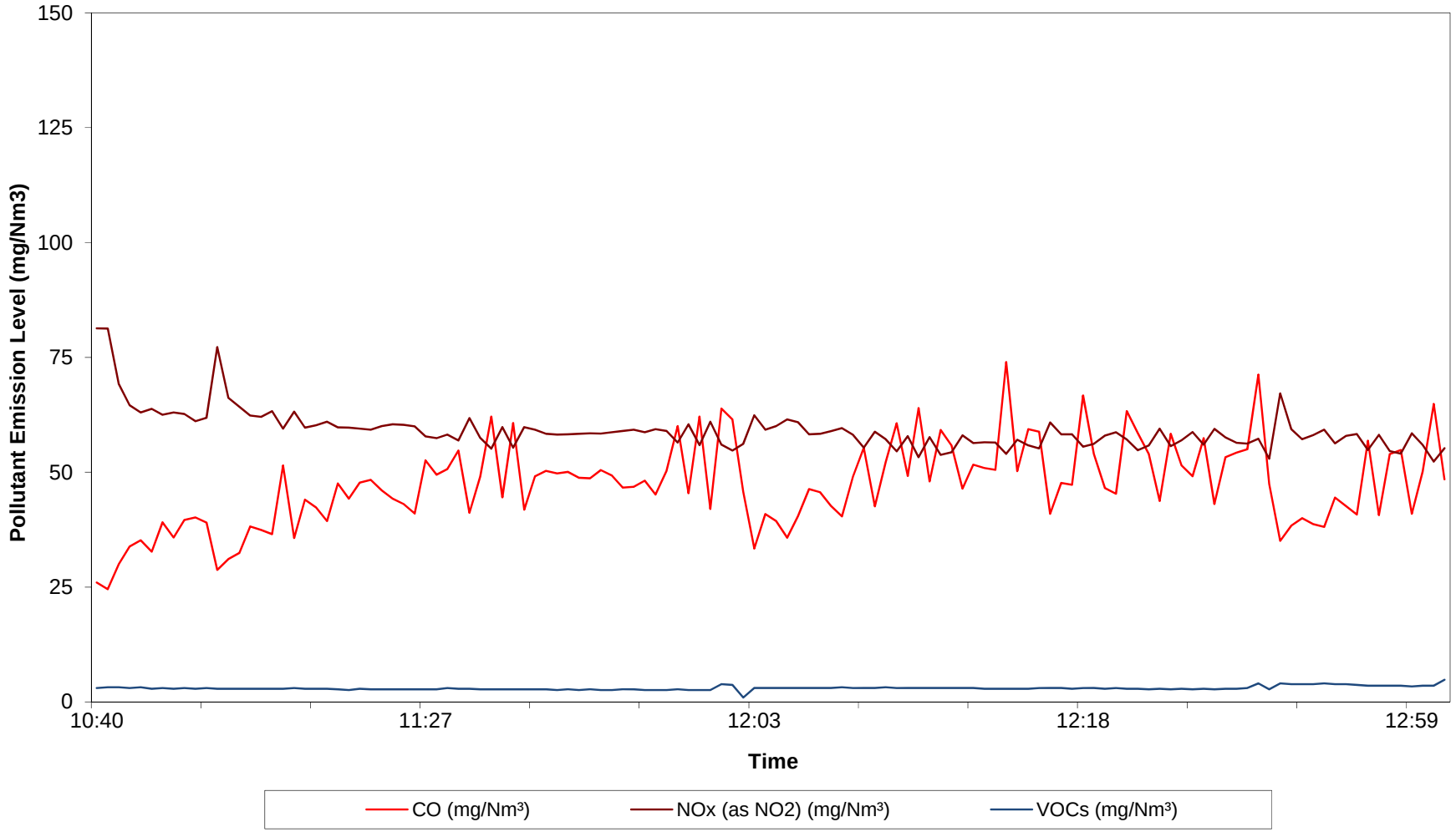
**Gaseous Analysis using Horiba PG 250 & Signal 3030PM Analysers**

Wyndeham Heron, Maldon

**Combustion Gas and VOC Emissions from Rotoman 2 Lower (16/10/12)**

| | Carbon Monoxide CO (ppm) | Oxides of Nitrogen NOx (ppm) | VOCs (ppm) | Conversion from ppm to mg/Nm³ WET | | |
|---|---|---|---|---|---|---|
| | | | | CO (mg/Nm³) | NOx (as $NO_2$) (mg/Nm³) | VOCs (mg/Nm³) |
| **Average** | **39.8** | **30.3** | **1.9** | **47.2** | **59.1** | **3.0** |
| **Maximum** | **62.4** | **41.7** | **3.0** | **74.0** | **81.3** | **4.8** |
| **Minimum** | **20.7** | **26.8** | **0.6** | **24.5** | **52.3** | **1.0** |

## Combustion Gas and VOC Emissions from Rotoman 2 Lower Wyndeham Heron, Maldon (16/10/12)



## 2.4.8 Uncertainty calculations

**UNCERTAINTY OF CARBON MONOXIDE BY HORIBA 1**

| | | |
|---|---|---|
| Reading = | 39.8 | ppm |
| Span Gas Certified Value = | 80.7 | ppm +/-2% |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.3980 | 0.1584 |
| Zero Drift/Lower limit of detection (ppm) | 0.00 | Rectangular | 1.732 | 0.0000 | 0.0000 |
| Span Drift (ppm) | 0.40 | Rectangular | 1.732 | 0.2309 | 0.0533 |
| Linearity (% of value) | 1.01 | Rectangular | 1.732 | 0.2321 | 0.0539 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0995 | 0.0099 |
| Interference (% of value) | 2.9 | Rectangular | 1.732 | 0.6664 | 0.4441 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.4659 | 0.2171 |
| | | | | Sum U^2 | 0.94 |
| | | | | **Combined Standard Uncertainty (ppm]** | 0.97 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 1.90 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 4.8 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.37 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.4 |

**UNCERTAINTY OF OXIDES OF NITROGEN BY HORIBA 1**

| | | |
|---|---|---|
| Reading = | 30.3 | ppm |
| Span Gas Certified Value = | 49.1 | ppm |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.3030 | 0.0918 |
| Zero Drift/Lower limit of detection (ppm) | -0.10 | Rectangular | 1.732 | -0.0577 | 0.0033 |
| Span Drift (ppm) | 0.00 | Rectangular | 1.732 | 0.0000 | 0.0000 |
| Linearity (% of value) | 1.41 | Rectangular | 1.732 | 0.2467 | 0.0608 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0758 | 0.0057 |
| Interference (% of value) | 1.2 | Rectangular | 1.732 | 0.2099 | 0.0441 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.2835 | 0.0804 |
| | | | | Sum U^2 | 0.29 |
| | | | | **Combined Standard Uncertainty (ppm)** | 0.53 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 1.05 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 3.5 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.15 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.2 |

**UNCERTAINTY OF VOC BY SIGNAL 1**

| | | |
|---|---|---|
| Reading = | 1.9 | ppm as C3H8 |
| Span Gas= | 10.13 | ppm+/-2% |
| Emission Limit Value | 20 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.0190 | 0.0004 |
| Zero Drift/ Detection threshold | -0.40 | Rectangular | 1.732 | -0.2309 | 0.0533 |
| Span Drift (ppm) | -0.20 | Rectangular | 1.732 | -0.1155 | 0.0133 |
| Noise (ppm) | 0.1 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Linearity (% of value) | 1.65 | Rectangular | 1.732 | 0.0181 | 0.0003 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0048 | 0.0000 |
| Temperature Drift (% of value) | 1 | Rectangular | 1.732 | 0.0110 | 0.0001 |
| Span Gas (% of value) | 1 | Rectangular | 1.732 | 0.0585 | 0.0034 |
| | | | | Sum U^2 | 0.07 |
| | | | | **Combined Standard Uncertainty (ppm as C3H8]** | 0.27 |
| | | | | **Expanded Total Uncertainty (ppm as C3H8] (95% Confidence)** | 0.53 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 28.1 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$ as carbon) (95% Confidence)** | 0.86 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 4.3 |

# 2.5 Appendix 5: Rotoman 2 Upper Results and Calculations

## 2.5.1 Photograph of the sampling location and positions

## 2.5.2 Flow criteria measurements

**Stack reference:** **Rotoman 2 Upper** **Date:** **22/11/2012**

**Duct dimensions:** **50.0** **cm**

**Local barometric pressure:** **1017** **mbar**

**Ambient Temperature:** **23** **°C** Pitot Coefficient = 0.822

Micromanometer Calibration (K; mbar) = 289 1000

| Sample port (A) | Traverse point | Traverse position (D) | Distance (cm) | Velocity (m/s) Uncorrd. | Velocity (m/s) Corrd. | Temp (°C) |
|---|---|---|---|---|---|---|
| **Single** | A1 | 0.05 | 2.5 | 9.2 | 10.9 | 333 |
| | A2 | 0.15 | 7.5 | 9.1 | 10.7 | 333 |
| | A3 | 0.25 | 12.5 | 5.5 | 6.5 | 333 |
| | A4 | 0.35 | 17.5 | 5.4 | 6.4 | 333 |
| | A5 | 0.45 | 22.5 | 5.8 | 6.8 | 333 |
| | A6 | 0.55 | 27.5 | 6.0 | 7.1 | 333 |
| | A7 | 0.65 | 32.5 | 5.5 | 6.5 | 333 |
| | A8 | 0.75 | 37.5 | 4.9 | 5.8 | 333 |
| | A9 | 0.85 | 42.5 | 4.9 | 5.8 | 333 |
| | A10 | 0.95 | 47.5 | 5.2 | 6.1 | 333 |

**Velocity readings (m/s)**

**Duct Mean m/s** **7.3**

Highest(a) 10.9 Lowest (b) 5.8

**Temperature readings**

**Duct Mean °C** **333**

Duct Mean K 606

Highest(a) 333.0 Lowest (b) 333.0

**Volumetic flow rate**

| | | |
|---|---|---|
| Duct dimensions | 50.0 | (cm) |
| Duct area | 0.196 | ($m^2$) |
| Mean duct velocity | 7.3 | (m/s) |
| Mean duct temperature | 333 | ($^oC$) |
| Ambient pressure | 1017 | (mbar) |
| **Vol. Flow rate at stack conditions** | **5131** | **($m^3$/hr)** |
| **Vol flow rate corrd.** | **2320.6** | **($Nm^3$/hr)** |

### 2.5.3 Water vapour measurements

**MOISTURE TEST FORM**

| | | | | |
|---|---|---|---|---|
| **Client Name:** | Wyndeham Heron | | **Date:** | 16/10/2012 |
| **Job Number:** | 5319 | | | |
| **Stack Reference:** | Rotoman 2 Upper | | | |
| **Ambient Pressure (mbar):** | | 1005 | **Gas Meter Temperature (°C):** | |
| **Stack Temperature (°C):** | | 341 | **Start:** | 20 |
| **Gasmeter Coefficient:** | | 1.000 | **End:** | 30 |
| **Equipment used:** | | Pump 59 | **Mean:** | 25 |
| **Leak Check (l/min)** | **Before:** | 0.1 | | |
| | **After:** | 0.1 | | |

| | | | |
|---|---|---|---|
| **Start Flow Reading (l/min)** | 1.648 | **Start Time** | 15:10:00 |
| **End Flow Reading (/minl)** | 1.684 | **End Time** | 15:40:00 |
| **Volume Sampled (l)** | 50.0 | **Total Time (min)** | 30 |
| **Corrected Volume Sampled (l)** | 45.4 | | |
| **Sampling Rate (l/min)** | 1.666 | | |

| | **IMPINGER** | |
|---|---|---|
| | **1** | **2** |
| **Start Weight of Impingers (g)** | 93.2 | 91.2 |
| **End Weight of Impingers (g)** | 95.5 | 91.4 |
| **Weight Gain (g)** | 2.3 | 0.2 |

| | |
|---|---|
| **Total Weight Gain (1+2+3+4) (g)** | 2.5 |
| **Total Weight Gain in litres (l)** | 3.11 |

| | |
|---|---|
| **Moisture Content of Gases (g/Nm$^3$)** | 55.0 |
| **Moisture Content of Gases (%)** | **6.41** |

### 2.5.4 Manual monitoring method - results – calculations

Not applicable.

### 2.5.5 Analysis results

Not applicable.

## 2.5.6 Instrumental gas analyser site calibration measurements

**ANALYSER CALIBRATIONS**

**Combustion Gas and VOC Emissions from Rotoman 2 (16/10/12)**

**Data entered by:** MR

**Horiba Analyser:** Hor 1

**Signal Analyser:** Sig 1

| Type of Gas | CO | | NO | | VOCs | |
|---|---|---|---|---|---|---|
| Certified Calibration Values | 80.7 | ppm +/-2% | 49.1 | ppm +/-2% | 10.13 | ppm +/-2% |
| Response Time T90 | 11.0 | seconds | 11.0 | seconds | 4.00 | seconds |
| Period | | | | | | |
| Span PreCal direct to analyser | 79.9 | ppm | 49.0 | ppm | - | ppm |
| Zero PreCal through sample line | 1.0 | ppm | 0.1 | ppm | 0.0 | ppm |
| Span PreCal through sample line | 80.7 | ppm | 48.9 | ppm | 10.1 | ppm |
| Zero PostCal through sample line | 1.0 | ppm | 0.2 | ppm | 0.4 | ppm |
| Span PostCal through sample line | 80.3 | ppm | 48.9 | ppm | 10.3 | ppm |
| Span Drift | 0.5 | % | 0.0 | % | | |
| Zero Drift | 0.0 | % | -0.2 | % | | |
| Is data valid without adjustment | YES | | YES | | | |
| Does data require adjustment | NO | | NO | | | |
| Is data invalid | NO | | NO | | | |

## 2.5.7 Instrumental gas analyser results

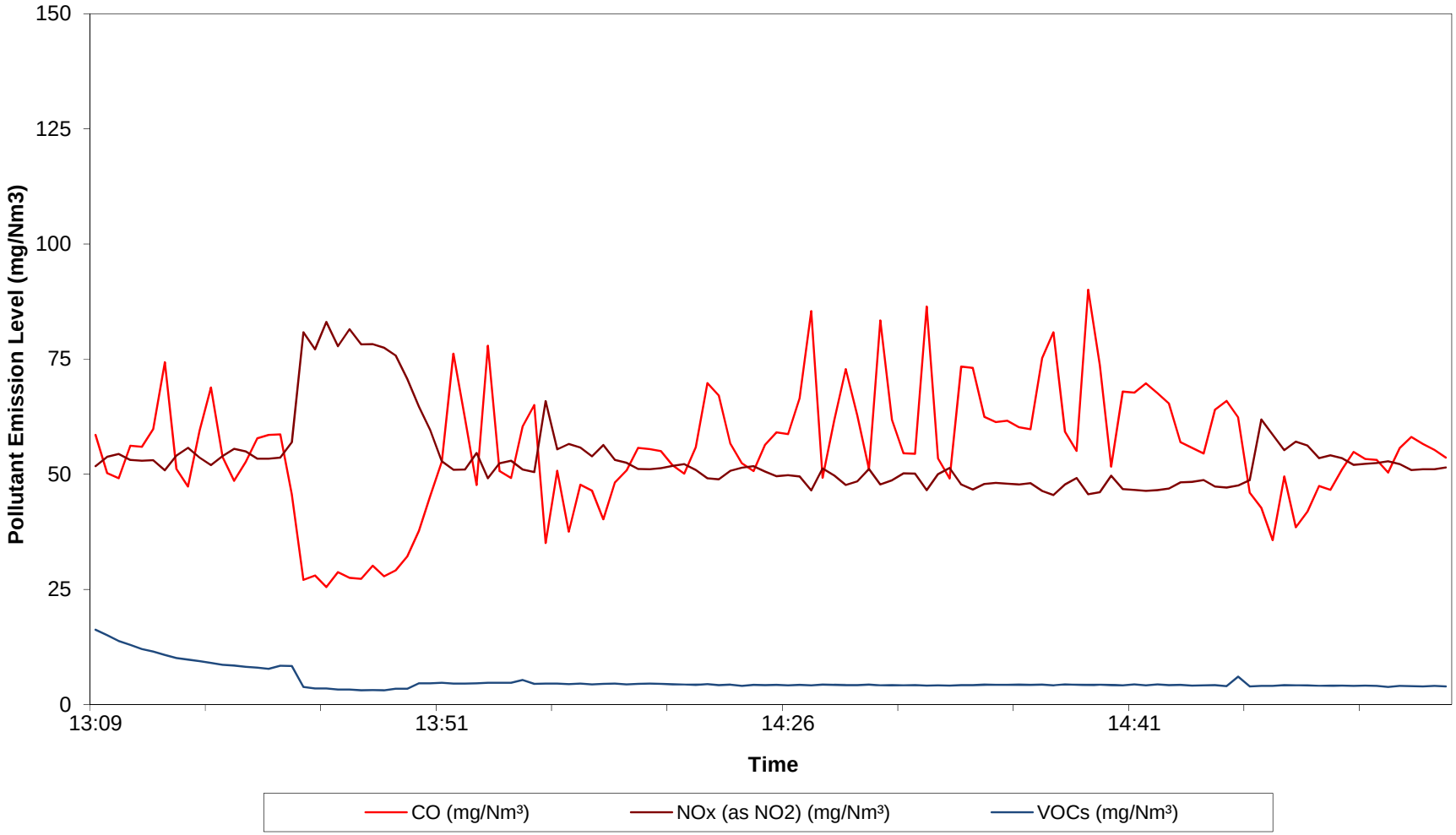
**Gaseous Analysis using Horiba PG 250 & Signal 3030PM Analysers**

Wyndeham Heron, Maldon

**Combustion Gas and VOC Emissions from Rotoman 2 Upper (16/10/12)**

| | Carbon Monoxide CO (ppm) | Oxides of Nitrogen NOx (ppm) | VOCs (ppm) | Conversion from ppm to mg/Nm³ WET | | |
|---|---|---|---|---|---|---|
| | | | | CO (mg/Nm³) | NOx (as $NO_2$) (mg/Nm³) | VOCs (mg/Nm³) |
| **Average** | **47.3** | **27.9** | **3.2** | **55.3** | **53.5** | **5.1** |
| **Maximum** | **77.0** | **43.2** | **10.1** | **90.1** | **83.1** | **16.2** |
| **Minimum** | **21.8** | **23.7** | **1.9** | **25.5** | **45.5** | **3.1** |

## Combustion Gas and VOC Emissions from Rotoman 2 Upper Wyndeham Heron, Maldon (16/10/12)



## 2.5.8 Uncertainty calculations

**UNCERTAINTY OF CARBON MONOXIDE BY HORIBA 1**

| | | |
|---|---|---|
| Reading = | 47.3 | ppm |
| Span Gas Certified Value = | 80.7 | ppm +/-2% |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.4730 | 0.2237 |
| Zero Drift/Lower limit of detection (ppm) | 0.00 | Rectangular | 1.732 | 0.0000 | 0.0000 |
| Span Drift (ppm) | 0.40 | Rectangular | 1.732 | 0.2309 | 0.0533 |
| Linearity (% of value) | 1.01 | Rectangular | 1.732 | 0.2758 | 0.0761 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.1183 | 0.0140 |
| Interference (% of value) | 2.9 | Rectangular | 1.732 | 0.7920 | 0.6272 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.4659 | 0.2171 |
| | | | | Sum U^2 | 1.21 |
| | | | | **Combined Standard Uncertainty (ppm]** | 1.10 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 2.16 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 4.6 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.70 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.7 |

**UNCERTAINTY OF OXIDES OF NITROGEN BY HORIBA 1**

| | | |
|---|---|---|
| Reading = | 27.9 | ppm |
| Span Gas Certified Value = | 49.1 | ppm |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.2790 | 0.0778 |
| Zero Drift/Lower limit of detection (ppm) | -0.10 | Rectangular | 1.732 | -0.0577 | 0.0033 |
| Span Drift (ppm) | 0.00 | Rectangular | 1.732 | 0.0000 | 0.0000 |
| Linearity (% of value) | 1.41 | Rectangular | 1.732 | 0.2271 | 0.0516 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0698 | 0.0049 |
| Interference (% of value) | 1.2 | Rectangular | 1.732 | 0.1933 | 0.0374 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.2835 | 0.0804 |
| | | | | Sum U^2 | 0.26 |
| | | | | **Combined Standard Uncertainty (ppm)** | 0.51 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 0.99 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 3.5 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.03 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.0 |

**UNCERTAINTY OF VOC BY SIGNAL 1**

| | | |
|---|---|---|
| Reading = | 3.2 | ppm as C3H8 |
| Span Gas= | 10.13 | ppm+/-2% |
| Emission Limit Value | 20 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.0320 | 0.0010 |
| Zero Drift/ Detection threshold | -0.40 | Rectangular | 1.732 | -0.2309 | 0.0533 |
| Span Drift (ppm) | -0.20 | Rectangular | 1.732 | -0.1155 | 0.0133 |
| Noise (ppm) | 0.1 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Linearity (% of value) | 1.65 | Rectangular | 1.732 | 0.0305 | 0.0009 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0080 | 0.0001 |
| Temperature Drift (% of value) | 1 | Rectangular | 1.732 | 0.0185 | 0.0003 |
| Span Gas (% of value) | 1 | Rectangular | 1.732 | 0.0585 | 0.0034 |
| | | | | Sum U^2 | 0.08 |
| | | | | **Combined Standard Uncertainty (ppm as C3H8]** | 0.28 |
| | | | | **Expanded Total Uncertainty (ppm as C3H8] (95% Confidence)** | 0.54 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 16.9 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$ as carbon) (95% Confidence)** | 0.87 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 4.3 |

# 2.6 Appendix 6: Rotoman 3 Lower Results and Calculations

## 2.6.1 Photograph of the sampling location and positions

## 2.6.2 Flow criteria measurements

**Stack reference:** **Rotoman 3 Lower** **Date:** **22/11/2012**

**Duct dimensions:** **50.0** **cm**

**Local barometric pressure:** **1017** **mbar**

**Ambient Temperature:** **23** **°C** Pitot Coefficient = 0.822

Micromanometer Calibration (K; mbar) = 289 1000

| Sample port (A) | Traverse point | Traverse position (D) | Distance (cm) | Velocity (m/s) Uncorrd. | Velocity (m/s) Corrd. | Temp (°C) |
|---|---|---|---|---|---|---|
| **Single** | A1 | 0.05 | 2.5 | 10.9 | 13.1 | 354 |
| | A2 | 0.15 | 7.5 | 11.4 | 13.7 | 354 |
| | A3 | 0.25 | 12.5 | 11.2 | 13.4 | 354 |
| | A4 | 0.35 | 17.5 | 11.0 | 13.2 | 354 |
| | A5 | 0.45 | 22.5 | 10.9 | 13.1 | 354 |
| | A6 | 0.55 | 27.5 | 10.8 | 13.0 | 354 |
| | A7 | 0.65 | 32.5 | 10.9 | 13.1 | 354 |
| | A8 | 0.75 | 37.5 | 10.4 | 12.5 | 354 |
| | A9 | 0.85 | 42.5 | 10.2 | 12.2 | 354 |
| | A10 | 0.95 | 47.5 | 9.9 | 11.9 | 354 |

**Velocity readings (m/s)**

**Duct Mean m/s** **12.9**

Highest(a) 13.7 Lowest (b) 11.9

**Temperature readings**

**Duct Mean °C** **354**

Duct Mean K 627

Highest(a) 354.0 Lowest (b) 354.0

**Volumetic flow rate**

| | | |
|---|---|---|
| Duct dimensions | 50.0 | (cm) |
| Duct area | 0.196 | ($m^2$) |
| Mean duct velocity | 12.9 | (m/s) |
| Mean duct temperature | 354 | ($^oC$) |
| Ambient pressure | 1017 | (mbar) |
| **Vol. Flow rate at stack conditions** | **9131** | **($m^3$/hr)** |
| **Vol flow rate corrd.** | **3991.6** | **($Nm^3$/hr)** |

### 2.6.3 Water vapour measurements

**MOISTURE TEST FORM**

| | | | | |
|---|---|---|---|---|
| **Client Name:** | Wyndeham Heron | | **Date:** | 16/10/2012 |
| **Job Number:** | 5319 | | | |
| **Stack Reference:** | Rotoman 3 Lower | | | |
| **Ambient Pressure (mbar):** | | 1005 | **Gas Meter Temperature (°C):** | |
| **Stack Temperature (°C):** | | 360 | **Start:** | 20 |
| **Gasmeter Coefficient:** | | 1.000 | **End:** | 30 |
| **Equipment used:** | | Pump 59 | **Mean:** | 25 |
| **Leak Check (l/min)** | **Before:** | 0.1 | | |
| | **After:** | 0.1 | | |

| | | | |
|---|---|---|---|
| **Start Flow Reading (l/min)** | 1.65 | **Start Time** | 11:39:00 |
| **End Flow Reading (/minl)** | 1.64 | **End Time** | 12:09:00 |
| **Volume Sampled (l)** | 49.4 | **Total Time (min)** | 30 |
| **Corrected Volume Sampled (l)** | 44.9 | | |
| **Sampling Rate (l/min)** | 1.645 | | |

| | **IMPINGER** | |
|---|---|---|
| | **1** | **2** |
| **Start Weight of Impingers (g)** | 91.8 | 92.7 |
| **End Weight of Impingers (g)** | 94.6 | 92.7 |
| **Weight Gain (g)** | 2.8 | 0.0 |

| | |
|---|---|
| **Total Weight Gain (1+2+3+4) (g)** | 2.8 |
| **Total Weight Gain in litres (l)** | 3.49 |

| | |
|---|---|
| **Moisture Content of Gases (g/Nm$^3$)** | 62.4 |
| **Moisture Content of Gases (%)** | **7.21** |

### 2.6.4 Manual monitoring method - results – calculations

Not applicable.

### 2.6.5 Analysis results

Not applicable.

## 2.6.6 Instrumental gas analyser site calibration measurements

**ANALYSER CALIBRATIONS**

**Combustion Gas and VOC Emissions from Rotoman 3 (16/10/12)**

**Data entered by:** MR

**Horiba Analyser:** Hor 2

**Signal Analyser:** Sig 3

| Type of Gas | CO | | NO | | VOCs | |
|---|---|---|---|---|---|---|
| Certified Calibration Values | 80.7 | ppm +/-2% | 49.1 | ppm +/-2% | 10.13 | ppm +/-2% |
| Response Time T90 | 15.0 | seconds | 15.0 | seconds | 4.00 | seconds |
| Period | | | | | | |
| Span PreCal direct to analyser | 81.1 | ppm | 49.3 | ppm | - | ppm |
| Zero PreCal through sample line | -0.1 | ppm | 0.1 | ppm | 0.0 | ppm |
| Span PreCal through sample line | 81.0 | ppm | 48.5 | ppm | 10.1 | ppm |
| Zero PostCal through sample line | 0.3 | ppm | 0.0 | ppm | -0.5 | ppm |
| Span PostCal through sample line | 80.8 | ppm | 48.4 | ppm | 9.8 | ppm |
| Span Drift | 0.2 | % | 0.2 | % | | |
| Zero Drift | -0.5 | % | 0.2 | % | | |
| Is data valid without adjustment | YES | | YES | | | |
| Does data require adjustment | NO | | NO | | | |
| Is data invalid | NO | | NO | | | |

## 2.6.7 Instrumental gas analyser results

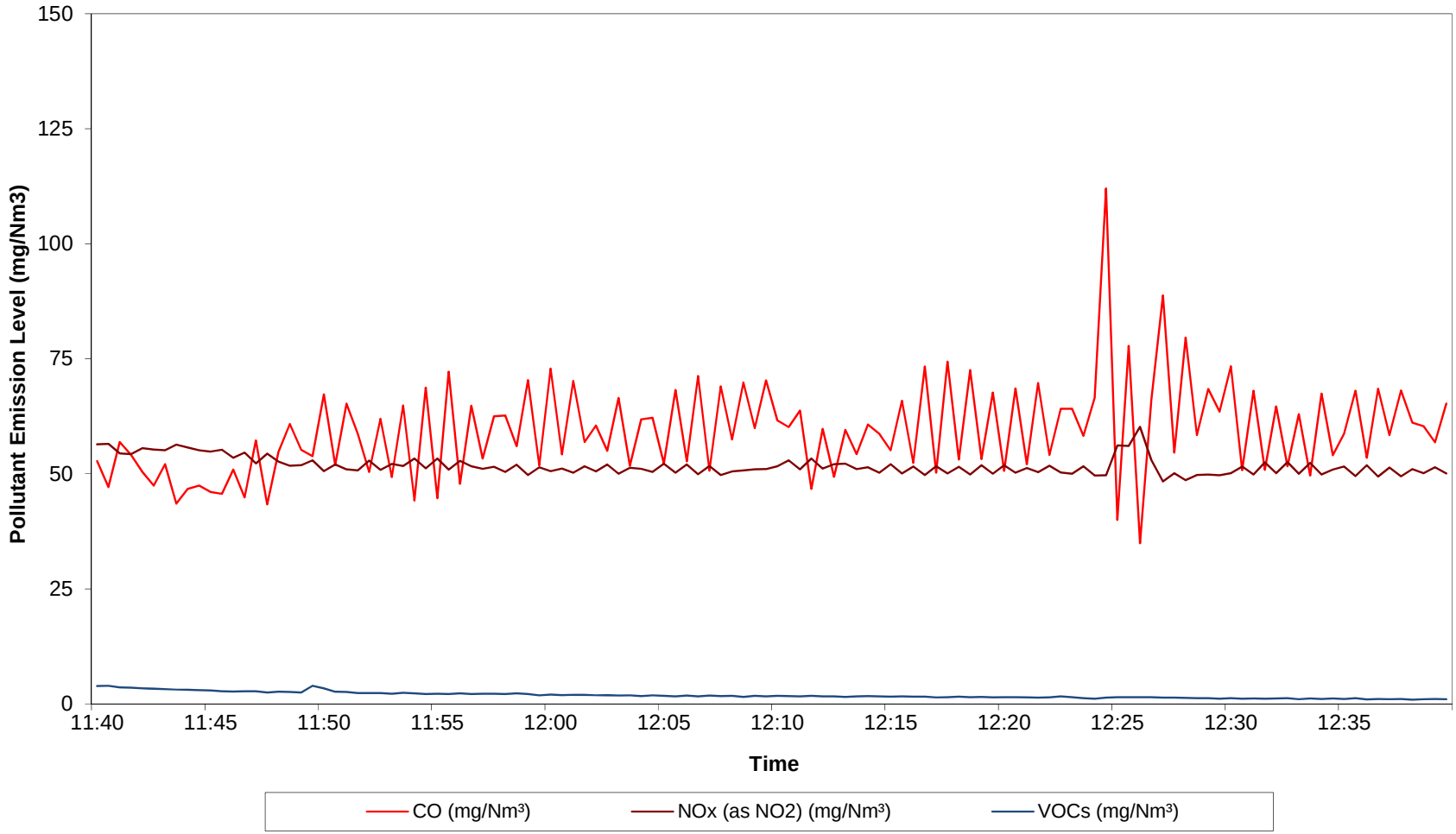
**Gaseous Analysis using Horiba PG 250 & Signal 3030PM Analysers**

Wyndeham Heron, Maldon

**Combustion Gas and VOC Emissions from Rotoman 3 Lower (16/10/12)**

| | Carbon Monoxide CO (ppm) | Oxides of Nitrogen NOx (ppm) | VOCs (ppm) | Conversion from ppm to mg/Nm³ WET | | |
|---|---|---|---|---|---|---|
| | | | | CO (mg/Nm³) | NOx (as $NO_2$) (mg/Nm³) | VOCs (mg/Nm³) |
| **Average** | **51.1** | **27.2** | **1.2** | **59.3** | **51.7** | **1.9** |
| **Maximum** | **96.6** | **31.6** | **2.4** | **112.0** | **60.2** | **3.9** |
| **Minimum** | **30.1** | **25.4** | **0.6** | **34.9** | **48.4** | **0.9** |

## Combustion Gas and VOC Emissions from Rotoman 3 Lower Wyndeham Heron, Maldon (16/10/12)



## 2.6.8 Uncertainty calculations

**UNCERTAINTY OF CARBON MONOXIDE BY HORIBA 2**

| | | |
|---|---|---|
| Reading = | 51.1 | ppm |
| Span Gas Certified Value = | 80.7 | ppm +/-2% |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.5110 | 0.2611 |
| Zero Drift/Lower limit of detection (ppm) | -0.40 | Rectangular | 1.732 | -0.2309 | 0.0533 |
| Span Drift (ppm) | 0.20 | Rectangular | 1.732 | 0.1155 | 0.0133 |
| Linearity (% of value) | 0.54 | Rectangular | 1.732 | 0.1593 | 0.0254 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.1278 | 0.0163 |
| Interference (% of value) | 2.9 | Rectangular | 1.732 | 0.8556 | 0.7321 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.4659 | 0.2171 |
| | | | | Sum U^2 | 1.32 |
| | | | | **Combined Standard Uncertainty (ppm)** | 1.15 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 2.25 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 4.4 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.81 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.8 |

**UNCERTAINTY OF OXIDES OF NITROGEN BY HORIBA 2**

| | | |
|---|---|---|
| Reading = | 27.2 | ppm |
| Span Gas Certified Value = | 49.1 | ppm |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.2720 | 0.0740 |
| Zero Drift/Lower limit of detection (ppm) | 0.10 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Span Drift (ppm) | 0.10 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Linearity (% of value) | 1.16 | Rectangular | 1.732 | 0.1822 | 0.0332 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0680 | 0.0046 |
| Interference (% of value) | 1.2 | Rectangular | 1.732 | 0.1885 | 0.0355 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.2835 | 0.0804 |
| | | | | Sum U^2 | 0.23 |
| | | | | **Combined Standard Uncertainty (ppm)** | 0.48 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 0.95 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 3.5 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 1.95 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 1.9 |

**UNCERTAINTY OF VOC BY SIGNAL3**

| | | |
|---|---|---|
| Reading = | 1.2 | ppm as C3H8 |
| Span Gas= | 10.13 | ppm+/-2% |
| Emission Limit Value | 20 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.0120 | 0.0001 |
| Zero Drift/ Detection threshold | 0.50 | Rectangular | 1.732 | 0.2887 | 0.0833 |
| Span Drift (ppm) | 0.30 | Rectangular | 1.732 | 0.1732 | 0.0300 |
| Noise (ppm) | 0.1 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Linearity (% of value) | 0.85 | Rectangular | 1.732 | 0.0059 | 0.0000 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0030 | 0.0000 |
| Temperature Drift (% of value) | 1 | Rectangular | 1.732 | 0.0069 | 0.0000 |
| Span Gas (% of value) | 1 | Rectangular | 1.732 | 0.0585 | 0.0034 |
| | | | | Sum U^2 | 0.12 |
| | | | | **Combined Standard Uncertainty (ppm as C3H8)** | 0.35 |
| | | | | **Expanded Total Uncertainty (ppm as C3H8) (95% Confidence)** | 0.68 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 56.7 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$ as carbon) (95% Confidence)** | 1.09 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 5.5 |

# 2.7 Appendix 7: Rotoman 3 Upper Results and Calculations

## 2.7.1 Photograph of the sampling location and positions

## 2.7.2 Flow criteria measurements

**Stack reference:** **Rotoman 3 Upper** **Date:** **22/11/2012**

**Duct dimensions:** **50.0** **cm**

**Local barometric pressure:** **1017** **mbar**

**Ambient Temperature:** **23** **°C** Pitot Coefficient = 0.822

Micromanometer Calibration (K; mbar) = 289 1000

| Sample port (A) | Traverse point | Traverse position (D) | Distance (cm) | Velocity (m/s) Uncorrd. | Velocity (m/s) Corrd. | Temp (°C) |
|---|---|---|---|---|---|---|
| **Single** | A1 | 0.05 | 2.5 | 13.6 | 16.4 | 358 |
| | A2 | 0.15 | 7.5 | 13.0 | 15.7 | 358 |
| | A3 | 0.25 | 12.5 | 12.6 | 15.2 | 358 |
| | A4 | 0.35 | 17.5 | 9.9 | 11.9 | 358 |
| | A5 | 0.45 | 22.5 | 8.9 | 10.7 | 358 |
| | A6 | 0.55 | 27.5 | 9.0 | 10.8 | 358 |
| | A7 | 0.65 | 32.5 | 8.8 | 10.6 | 358 |
| | A8 | 0.75 | 37.5 | 9.4 | 11.3 | 358 |
| | A9 | 0.85 | 42.5 | 9.3 | 11.2 | 358 |
| | A10 | 0.95 | 47.5 | 9.7 | 11.7 | 358 |

**Velocity readings (m/s)**

**Duct Mean m/s** **12.6**

Highest(a) 16.4 Lowest (b) 10.6

**Temperature readings**

**Duct Mean °C** **358**

Duct Mean K 631

Highest(a) 358.0 Lowest (b) 358.0

**Volumetic flow rate**

| | | |
|---|---|---|
| Duct dimensions | 50.0 | (cm) |
| Duct area | 0.196 | ($m^2$) |
| Mean duct velocity | 12.6 | (m/s) |
| Mean duct temperature | 358 | ($^oC$) |
| Ambient pressure | 1017 | (mbar) |
| **Vol. Flow rate at stack conditions** | **8871** | **($m^3$/hr)** |
| **Vol flow rate corrd.** | **3853.2** | **($Nm^3$/hr)** |

### 2.7.3 Water vapour measurements

**MOISTURE TEST FORM**

| | | | | |
|---|---|---|---|---|
| **Client Name:** | Wyndeham Heron | | **Date:** | 16/10/2012 |
| **Job Number:** | 5319 | | | |
| **Stack Reference:** | Rotoman 3 Upper | | | |
| **Ambient Pressure (mbar):** | | 1005 | **Gas Meter Temperature (°C):** | |
| **Stack Temperature (°C):** | | 365 | **Start:** | 20 |
| **Gasmeter Coefficient:** | | 1.000 | **End:** | 30 |
| **Equipment used:** | | Pump 59 | **Mean:** | 25 |
| **Leak Check (l/min)** | **Before:** | 0.1 | | |
| | **After:** | 0.1 | | |

| | | | |
|---|---|---|---|
| **Start Flow Reading (l/min)** | 1.594 | **Start Time** | 12:24:00 |
| **End Flow Reading (/minl)** | 1.606 | **End Time** | 12:54:00 |
| **Volume Sampled (l)** | 48.0 | **Total Time (min)** | 30 |
| **Corrected Volume Sampled (l)** | 43.6 | | |
| **Sampling Rate (l/min)** | 1.600 | | |

| | **IMPINGER** | |
|---|---|---|
| | **1** | **2** |
| **Start Weight of Impingers (g)** | 91.6 | 92.7 |
| **End Weight of Impingers (g)** | 93.8 | 93.2 |
| **Weight Gain (g)** | 2.2 | 0.5 |

| | |
|---|---|
| **Total Weight Gain (1+2+3+4) (g)** | 2.7 |
| **Total Weight Gain in litres (l)** | 3.36 |

| | |
|---|---|
| **Moisture Content of Gases (g/Nm$^3$)** | 61.9 |
| **Moisture Content of Gases (%)** | **7.16** |

### 2.7.4 Manual monitoring method - results – calculations

Not applicable.

### 2.7.5 Analysis results

Not applicable.

## 2.7.6 Instrumental gas analyser site calibration measurements

**ANALYSER CALIBRATIONS**

**Combustion Gas and VOC Emissions from Rotoman 3 (16/10/12)**

**Data entered by:** MR

**Horiba Analyser:** Hor 2

**Signal Analyser:** Sig 3

| Type of Gas | CO | | NO | | VOCs | |
|---|---|---|---|---|---|---|
| Certified Calibration Values | 80.7 | ppm +/-2% | 49.1 | ppm +/-2% | 10.13 | ppm +/-2% |
| Response Time T90 | 15.0 | seconds | 15.0 | seconds | 4.00 | seconds |
| Period | | | | | | |
| Span PreCal direct to analyser | 81.1 | ppm | 49.3 | ppm | - | ppm |
| Zero PreCal through sample line | -0.1 | ppm | 0.1 | ppm | 0.0 | ppm |
| Span PreCal through sample line | 81.0 | ppm | 48.5 | ppm | 10.1 | ppm |
| Zero PostCal through sample line | 0.3 | ppm | 0.0 | ppm | -0.5 | ppm |
| Span PostCal through sample line | 80.8 | ppm | 48.4 | ppm | 9.8 | ppm |
| Span Drift | 0.2 | % | 0.2 | % | | |
| Zero Drift | -0.5 | % | 0.2 | % | | |
| Is data valid without adjustment | YES | | YES | | | |
| Does data require adjustment | NO | | NO | | | |
| Is data invalid | NO | | NO | | | |

## 2.7.7 Instrumental gas analyser results

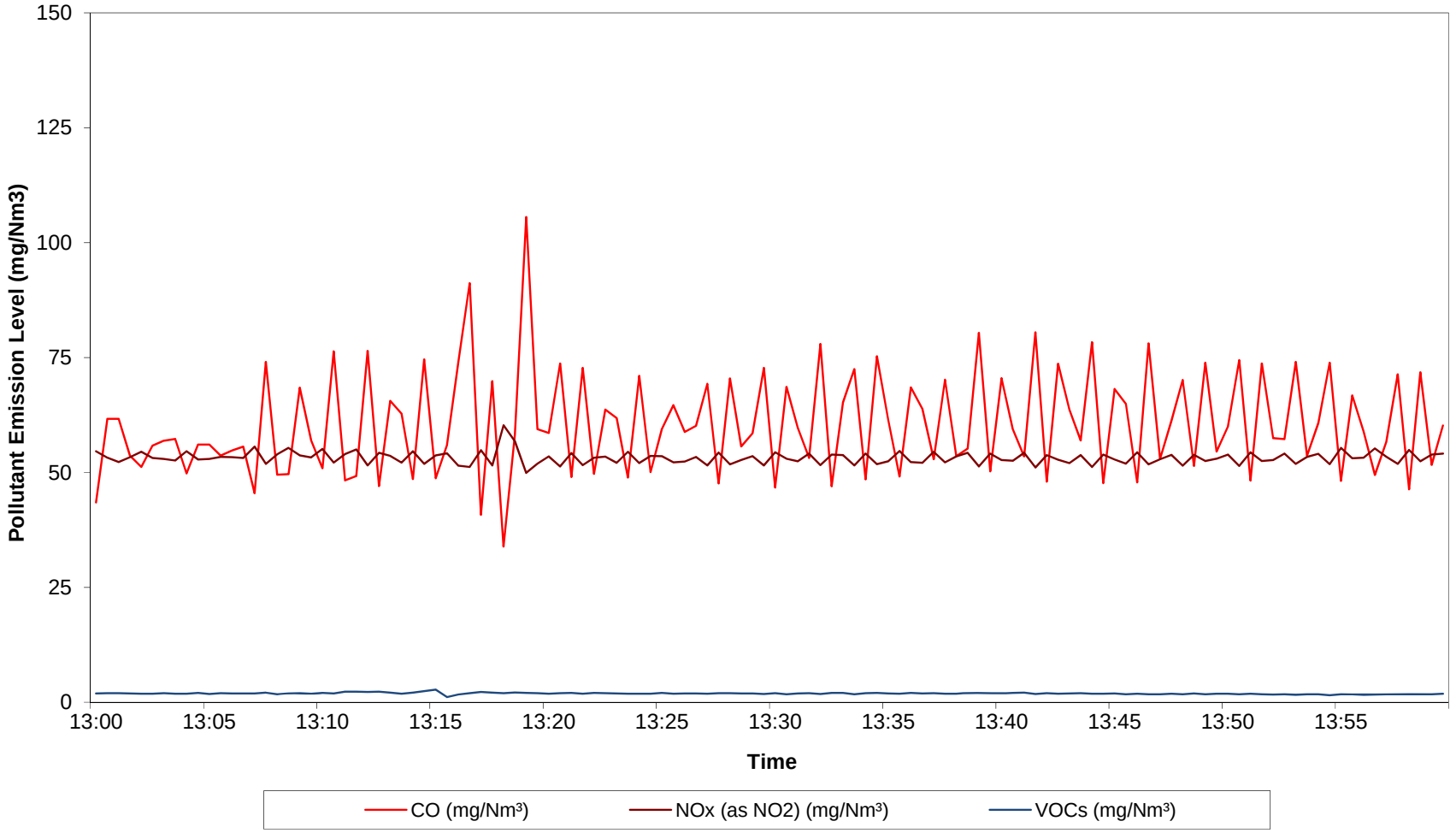
**Gaseous Analysis using Horiba PG 250 & Signal 3030PM Analysers**

Wyndeham Heron, Maldon

**Combustion Gas and VOC Emissions from Rotoman 3 Upper (16/10/12)**

| | Carbon Monoxide CO (ppm) | Oxides of Nitrogen NOx (ppm) | VOCs (ppm) | Conversion from ppm to mg/Nm³ WET | | |
|---|---|---|---|---|---|---|
| | | | | CO (mg/Nm³) | NOx (as $NO_2$) (mg/Nm³) | VOCs (mg/Nm³) |
| **Average** | **52.1** | **27.9** | **1.2** | **60.5** | **53.2** | **1.9** |
| **Maximum** | **91.0** | **31.6** | **1.7** | **105.6** | **60.3** | **2.8** |
| **Minimum** | **29.2** | **26.2** | **0.7** | **33.9** | **49.9** | **1.1** |

## Combustion Gas and VOC Emissions from Rotoman 3 Upper Wyndeham Heron, Maldon (16/10/12)



## 2.7.8 Uncertainty calculations

**UNCERTAINTY OF CARBON MONOXIDE BY HORIBA 2**

| | | |
|---|---|---|
| Reading = | 52.1 | ppm |
| Span Gas Certified Value = | 80.7 | ppm +/-2% |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.5210 | 0.2714 |
| Zero Drift/Lower limit of detection (ppm) | -0.40 | Rectangular | 1.732 | -0.2309 | 0.0533 |
| Span Drift (ppm) | 0.20 | Rectangular | 1.732 | 0.1155 | 0.0133 |
| Linearity (% of value) | 0.54 | Rectangular | 1.732 | 0.1624 | 0.0264 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.1303 | 0.0170 |
| Interference (% of value) | 2.9 | Rectangular | 1.732 | 0.8723 | 0.7610 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.4659 | 0.2171 |
| | | | | Sum U^2 | 1.36 |
| | | | | **Combined Standard Uncertainty (ppm)** | 1.17 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 2.29 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 4.4 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.86 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.9 |

**UNCERTAINTY OF OXIDES OF NITROGEN BY HORIBA 2**

| | | |
|---|---|---|
| Reading = | 27.9 | ppm |
| Span Gas Certified Value = | 49.1 | ppm |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.2790 | 0.0778 |
| Zero Drift/Lower limit of detection (ppm) | 0.10 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Span Drift (ppm) | 0.10 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Linearity (% of value) | 1.16 | Rectangular | 1.732 | 0.1869 | 0.0349 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0698 | 0.0049 |
| Interference (% of value) | 1.2 | Rectangular | 1.732 | 0.1933 | 0.0374 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.2835 | 0.0804 |
| | | | | Sum U^2 | 0.24 |
| | | | | **Combined Standard Uncertainty (ppm)** | 0.49 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 0.96 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 3.5 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 1.98 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.0 |

**UNCERTAINTY OF VOC BY SIGNAL3**

| | | |
|---|---|---|
| Reading = | 1.2 | ppm as C3H8 |
| Span Gas= | 10.13 | ppm+/-2% |
| Emission Limit Value | 20 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.0120 | 0.0001 |
| Zero Drift/ Detection threshold | 0.50 | Rectangular | 1.732 | 0.2887 | 0.0833 |
| Span Drift (ppm) | 0.30 | Rectangular | 1.732 | 0.1732 | 0.0300 |
| Noise (ppm) | 0.1 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Linearity (% of value) | 0.85 | Rectangular | 1.732 | 0.0059 | 0.0000 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0030 | 0.0000 |
| Temperature Drift (% of value) | 1 | Rectangular | 1.732 | 0.0069 | 0.0000 |
| Span Gas (% of value) | 1 | Rectangular | 1.732 | 0.0585 | 0.0034 |
| | | | | Sum U^2 | 0.12 |
| | | | | **Combined Standard Uncertainty (ppm as C3H8)** | 0.35 |
| | | | | **Expanded Total Uncertainty (ppm as C3H8) (95% Confidence)** | 0.68 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 56.7 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$ as carbon) (95% Confidence)** | 1.09 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 5.5 |

# 2.8 Appendix 8: Lithoman 1 Results and Calculations

## 2.8.1 Photograph of the sampling location and positions

## 2.8.2 Flow criteria measurements

**Stack reference:** **Lithoman 1** **Date:** **22/11/2012**

**Duct dimensions:** **60.0** **cm**

**Local barometric pressure:** **1017** **mbar**

**Ambient Temperature:** **23** **°C** Pitot Coefficient = 0.997

Micromanometer Calibration (K; mbar) = 289 1000

| Sample port (A) | Traverse point | Traverse position (D) | Distance (cm) | Velocity (m/s) Uncorrd. | Velocity (m/s) Corrd. | Temp (°C) |
|---|---|---|---|---|---|---|
| **Single** | A1 | 0.05 | 3.0 | 10.1 | 14.8 | 362 |
| | A2 | 0.15 | 9.0 | 10.5 | 15.4 | 362 |
| | A3 | 0.25 | 15.0 | 11.7 | 17.1 | 362 |
| | A4 | 0.35 | 21.0 | 13.3 | 19.5 | 362 |
| | A5 | 0.45 | 27.0 | 13.1 | 19.2 | 362 |
| | A6 | 0.55 | 33.0 | 10.3 | 15.1 | 362 |
| | A7 | 0.65 | 39.0 | 7.6 | 11.1 | 362 |
| | A8 | 0.75 | 45.0 | 2.8 | 4.1 | 362 |
| | A9 | 0.85 | 51.0 | 0.0 | 0.0 | 362 |
| | A10 | 0.95 | 57.0 | 12.4 | 18.2 | 362 |

**Velocity readings (m/s)**

**Duct Mean m/s** **13.5**

Highest(a) 19.5 Lowest (b) 0.0

**Temperature readings**

**Duct Mean °C** **362**

Duct Mean K 635

Highest(a) 362.0 Lowest (b) 362.0

**Volumetic flow rate**

| | | |
|---|---|---|
| Duct dimensions | 60.0 | (cm) |
| Duct area | 0.283 | ($m^2$) |
| Mean duct velocity | 13.5 | (m/s) |
| Mean duct temperature | 362 | ($^oC$) |
| Ambient pressure | 1017 | (mbar) |
| **Vol. Flow rate at stack conditions** | **13693** | **($m^3$/hr)** |
| **Vol flow rate corrd.** | **5910.3** | **($Nm^3$/hr)** |

### 2.8.3 Water vapour measurements

**MOISTURE TEST FORM**

**Client Name:** Wyndeham Heron **Date:** 15/10/2012
**Job Number:** 5319

**Stack Reference:** Lithoman 1

| | | | | |
|---|---|---|---|---|
| **Ambient Pressure (mbar):** | | 1006 | **Gas Meter Temperature (°C):** | |
| **Stack Temperature (°C):** | | 270 | **Start:** | 20 |
| **Gasmeter Coefficient:** | | 1.000 | **End:** | 30 |
| **Equipment used:** | | Pump 59 | **Mean:** | 25 |
| **Leak Check (l/min)** | **Before:** | 0.1 | | |
| | **After:** | 0.1 | | |

| | | | |
|---|---|---|---|
| **Start Flow Reading (l/min)** | 1.561 | **Start Time** | 18:20:00 |
| **End Flow Reading (l/min)** | 1.609 | **End Time** | 18:40:00 |
| **Volume Sampled (l)** | 31.7 | **Total Time (min)** | 20 |
| **Corrected Volume Sampled (l)** | 28.8 | | |
| **Sampling Rate (l/min)** | 1.585 | | |

| | **IMPINGER** | |
|---|---|---|
| | **1** | **2** |
| **Start Weight of Impingers (g)** | 90.0 | 91.1 |
| **End Weight of Impingers (g)** | 92.3 | 91 |
| **Weight Gain (g)** | 2.3 | -0.1 |

| | |
|---|---|
| **Total Weight Gain (1+2+3+4) (g)** | 2.2 |
| **Total Weight Gain in litres (l)** | 2.74 |

| | |
|---|---|
| **Moisture Content of Gases (g/Nm$^3$)** | 76.3 |
| **Moisture Content of Gases (%)** | **8.67** |

### 2.8.4 Manual monitoring method - results – calculations
Not applicable.

### 2.8.5 Analysis results
Not applicable.

## 2.8.6 Instrumental gas analyser site calibration measurements

**ANALYSER CALIBRATIONS**

**Combustion Gas and VOC Emissions from Lithoman 1 (15/10/12)**

**Data entered by:** MR

**Horiba Analyser:** Hor 2

**Signal Analyser:** Sig 3

| Type of Gas | CO | | NO | | VOCs | |
|---|---|---|---|---|---|---|
| Certified Calibration Values | 80.7 | ppm +/-2% | 49.1 | ppm +/-2% | 10.10 | ppm +/-2% |
| Response Time T90 | 11.0 | seconds | 11.0 | seconds | 4.00 | seconds |
| Period | | | | | | |
| Span PreCal direct to analyser | 81.2 | ppm | 49.2 | ppm | - | ppm |
| Zero PreCal through sample line | 0.1 | ppm | 0.1 | ppm | 0.3 | ppm |
| Span PreCal through sample line | 80.8 | ppm | 48.7 | ppm | 10.2 | ppm |
| Zero PostCal through sample line | 0.5 | ppm | 0.1 | ppm | 0.0 | ppm |
| Span PostCal through sample line | 81.8 | ppm | 48.4 | ppm | 9.7 | ppm |
| Span Drift | -1.2 | % | 0.6 | % | | |
| Zero Drift | -0.5 | % | 0.0 | % | | |
| Is data valid without adjustment | YES | | YES | | | |
| Does data require adjustment | NO | | NO | | | |
| Is data invalid | NO | | NO | | | |

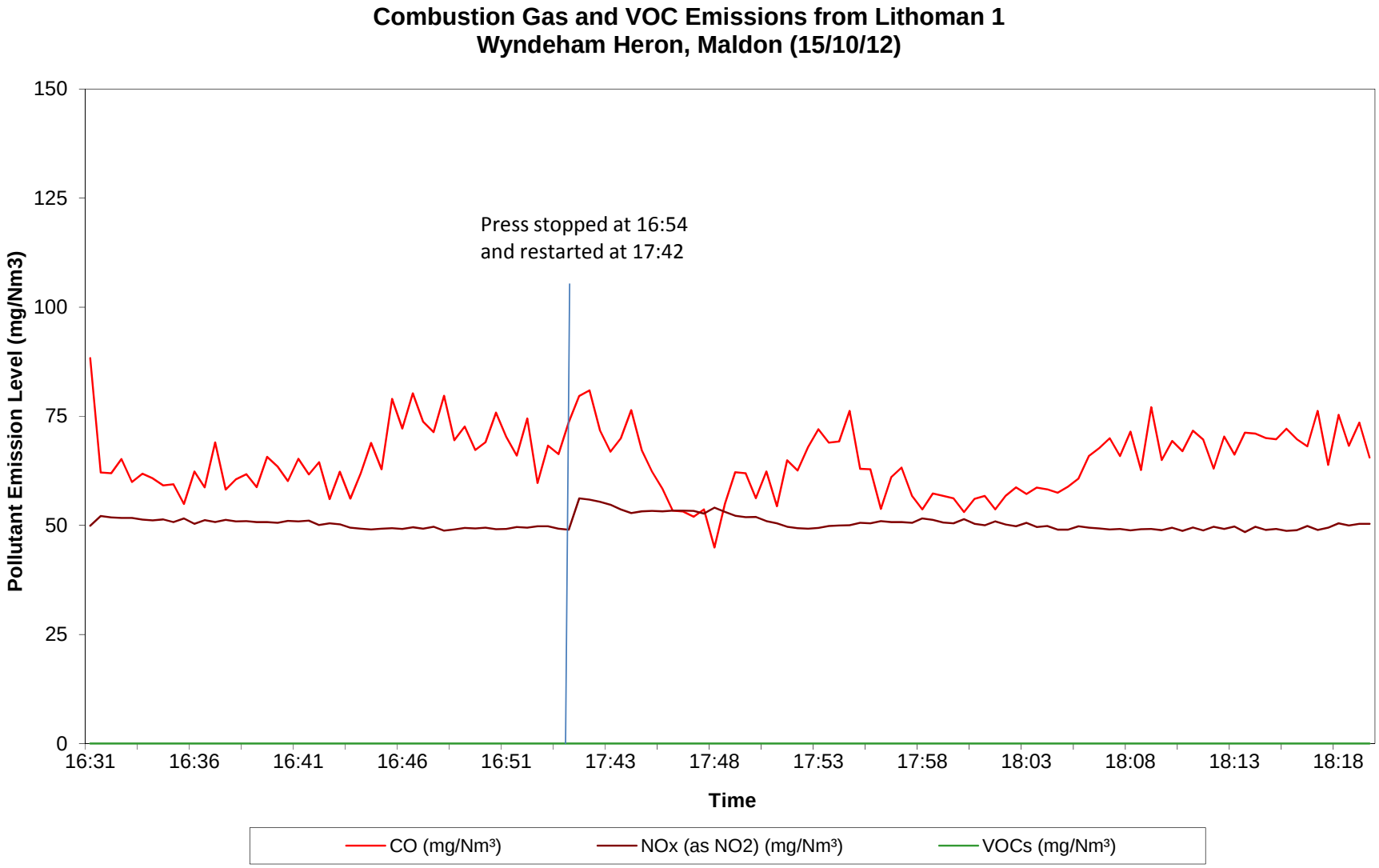
## 2.8.7 Instrumental gas analyser results

**Gaseous Analysis using Horiba PG 250 & Signal 3030PM Analysers**

Wyndeham Heron, Maldon

**Combustion Gas and VOC Emissions from Lithoman 1 (15/10/12)**

| | Carbon Monoxide CO (ppm) | Oxides of Nitrogen NOx (ppm) | VOCs (ppm) | Conversion from ppm to mg/Nm³ WET | | |
|---|---|---|---|---|---|---|
| | | | | CO (mg/Nm³) | NOx (as $NO_2$) (mg/Nm³) | VOCs (mg/Nm³) |
| **Average** | **56.8** | **27.0** | **0.0** | **64.8** | **50.5** | **0.0** |
| **Maximum** | **77.4** | **30.0** | **0.0** | **88.4** | **56.2** | **0.0** |
| **Minimum** | **39.4** | **25.9** | **0.0** | **45.0** | **48.4** | **0.0** |


Combustion Gas and VOC Emissions from Lithoman 1
Wyndeham Heron, Maldon (15/10/12)
Press stopped at 16:54
and restarted at 17:42
Pollutant Emission Level (mg/Nm3)
150
125
100
75
50
25
0
16:31
16:36
16:41
16:46
16:51
17:43
17:48
17:53
17:58
18:03
18:08
18:13
18:18
Time
CO (mg/Nm³)
NOx (as NO2) (mg/Nm³)
VOCs (mg/Nm³)

## 2.8.8 Uncertainty calculations

**UNCERTAINTY OF CARBON MONOXIDE BY HORIBA 2**

| | | |
|---|---|---|
| Reading = | 56.8 | ppm |
| Span Gas Certified Value = | 80.7 | ppm +/-2% |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.5680 | 0.3226 |
| Zero Drift/Lower limit of detection (ppm) | -0.40 | Rectangular | 1.732 | -0.2309 | 0.0533 |
| Span Drift (ppm) | -1.00 | Rectangular | 1.732 | -0.5774 | 0.3334 |
| Linearity (% of value) | 0.54 | Rectangular | 1.732 | 0.1771 | 0.0314 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.1420 | 0.0202 |
| Interference (% of value) | 2.9 | Rectangular | 1.732 | 0.9510 | 0.9045 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.4659 | 0.2171 |
| | | | | Sum U^2 | 1.88 |
| | | | | **Combined Standard Uncertainty (ppm]** | 1.37 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 2.69 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 4.7 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 3.36 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 3.4 |

**UNCERTAINTY OF OXIDES OF NITROGEN BY HORIBA 2**

| | | |
|---|---|---|
| Reading = | 27.0 | ppm |
| Span Gas Certified Value = | 49.1 | ppm |
| Emission Limit Value | 100 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.2700 | 0.0729 |
| Zero Drift/Lower limit of detection (ppm) | 0.00 | Rectangular | 1.732 | 0.0000 | 0.0000 |
| Span Drift (ppm) | 0.30 | Rectangular | 1.732 | 0.1732 | 0.0300 |
| Linearity (% of value) | 1.16 | Rectangular | 1.732 | 0.1808 | 0.0327 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0675 | 0.0046 |
| Interference (% of value) | 1.2 | Rectangular | 1.732 | 0.1871 | 0.0350 |
| Span Gas (% of span gasvalue) | 1 | Rectangular | 1.732 | 0.2835 | 0.0804 |
| | | | | Sum U^2 | 0.26 |
| | | | | **Combined Standard Uncertainty (ppm)** | 0.51 |
| | | | | **Expanded Total Uncertainty (ppm) (95% Confidence)** | 0.99 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 3.7 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$) (95% Confidence)** | 2.03 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 2.0 |

**UNCERTAINTY OF VOC BY SIGNAL3**

| | | |
|---|---|---|
| Reading = | 0.1 | ppm as C3H8 |
| Span Gas= | 10.13 | ppm+/-2% |
| Emission Limit Value | 20 | mg/Nm³ |

| Parameter | Uncertainty criteria | Probability distribution | Divisor | U | U^2 |
|---|---|---|---|---|---|
| Repeatability (% of value) | 1 | Normal | 1 | 0.0010 | 0.0000 |
| Zero Drift/ Detection threshold | 0.30 | Rectangular | 1.732 | 0.1732 | 0.0300 |
| Span Drift (ppm) | 0.50 | Rectangular | 1.732 | 0.2887 | 0.0833 |
| Noise (ppm) | 0.1 | Rectangular | 1.732 | 0.0577 | 0.0033 |
| Linearity (% of value) | 0.85 | Rectangular | 1.732 | 0.0005 | 0.0000 |
| Setting Gas Divider (% of value) | 0.25 | Normal | 1 | 0.0003 | 0.0000 |
| Temperature Drift (% of value) | 1 | Rectangular | 1.732 | 0.0006 | 0.0000 |
| Span Gas (% of value) | 1 | Rectangular | 1.732 | 0.0585 | 0.0034 |
| | | | | Sum U^2 | 0.12 |
| | | | | **Combined Standard Uncertainty (ppm as C3H8]** | 0.35 |
| | | | | **Expanded Total Uncertainty (ppm as C3H8] (95% Confidence)** | 0.68 |
| | | | | **Expanded Total Uncertainty as a percentage of emission concentration(95% Confidence)** | 679.2 |
| | | | | **Expanded Total Uncertainty (mg/Nm$^3$ as carbon) (95% Confidence)** | 1.09 |
| | | | | **Expanded Total Uncertainty as a percentage of ELV (95% Confidence )** | 5.5 |

# 2.9 Appendix 9: Compactor Results and Calculations

### 2.9.1 Photograph of the sampling location and positions

### 2.9.2 Flow criteria measurements
Not applicable.

### 2.9.3 Water vapour measurements
Not applicable.

### 2.9.4 Analysis results
Not applicable.

### 2.9.5 Instrumental gas analyser site calibration measurements
Not applicable.

### 2.9.6 Instrumental gas analyser results
Not applicable.

## 2.9.7 Manual monitoring method - results – calculations

**Wyndeham Heron**
**PARTICULATE MATTER EMISSIONS TO ATMOSPHERE DATA (MDHS 14 METHOD)**

Site: **Wyndeham Heron** Duct: **Compactor**
Atmospheric Press: 1005 mbar

| | PARTICULATE MONITORING (MDHS-14) Duct Reference | Pump No. | Filter No. | Flow Checks Start (l/min) | Flow Checks Finish (l/min) | Average Flow (l/min) | Time ON (hr:m:s) | Time OFF (hr:m:s) | Elapsed Time (hr:m:s) | Elapsed Time (min) | Air Volume Sampled ($m^3$) | Filter Masses Initial (mg) | Filter Masses Final (mg) | Filter Masses Difference (mg) | Concn. Partic. Matter ($mg/m^3$) | Corr. Part.Matt. Concn. ($mg/Nm^3$) | Air Temp. (°C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | Compactor | 29 | **6** | 1.00 | 0.00 | 0.50 | 11:22:00 | 15:28:00 | 04:06:00 | 246.00 | 0.12 | 1187.58 | 1188.02 | 0.44 | 3.58 | **3.2** | 27 |
| **2** | | 32 | **92** | 2.00 | 2.00 | 2.00 | 11:22:00 | 15:28:00 | 04:06:00 | 246.00 | 0.49 | 5166.87 | 5167.81 | 0.94 | 1.91 | **1.7** | 27 |
| **3** | | 26 | **8** | 2.00 | 2.00 | 2.00 | 11:22:00 | 15:28:00 | 04:06:00 | 246.00 | 0.49 | 1830.97 | 1831.58 | 0.61 | 1.24 | **1.1** | 27 |
| **4** | | 22 | **9** | 1.50 | 0.00 | 0.75 | 11:22:00 | 15:28:00 | 04:06:00 | 246.00 | 0.18 | 1842.43 | 1842.77 | 0.34 | 1.84 | **1.7** | 27 |

### 2.9.8 Uncertainty calculations

Not applicable.