Experts in Continuous Monitoring

Ambient Air Quality Monitoring Update, Kirby Misperton A Wellsite, KM8 Production Well.

20th November 2017 to 3rd December 2017

Prepared for:

Third Energy UK Gas Ltd.

For: Third Energy UK Gas Ltd.

Ref No.: GGS1197AQMU061217

Date: 06/12/2017

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CONTENTS

1 Outline of Monitoring

Third Energy has appointed GGS to conduct ambient air quality monitoring at the KMA wellsite before, during and after the hydraulic fracturing stimulation operations.

Ambient air quality monitoring undertaken before hydraulic fracturing stimulation operations commenced has established a baseline condition at the KMA wellsite (See Report Ref: GGS1197AQBR). This will allow Third Energy to benchmark results collected during the hydraulic fracturing stimulation operations, to determine whether Third Energy's operations have any significant effect on air quality.

GGS has been undertaking air quality monitoring at the KMA wellsite, following the baseline monitoring which ended on 4th October 2017, as part of the ongoing monitoring phase whilst operational activities take place at the KMA wellsite, namely the management of extractive waste as presented within Table S1.1 as activity A1 of the Environmental Permit. For clarity, the management of extractive waste did not commence until the extraction process of the mining waste begun. i.e. the bringing of waste streams to surface, which occurred on 16th October 2017.

The monitoring undertaken is designed to address both the Environment Agency's permit (reference: Decision Document EPR/DB3002HE) and North Yorkshire County Council planning permission conditions (reference: Decision Notice C3/15/00971/CPO). The ongoing monitoring undertaken by GGS includes the parameters listed in Table 1.

This report summarises the continuous and periodic monitoring results recorded between 20th November 2017 and 3rd December 2017, as well as the laboratory analysis results for the passive sampling undertaken between 7th November 2017 and 22nd November 2017.

Table 1. Required Ambient Air Quality Parameters.

Parameters	Monitoring frequency	Required By
Methane (CH_4)	Continuous monitoring and periodic monitoring every two weeks	Environment Agency / NYCC
Carbon Dioxide (CO_2)	Continuous monitoring and periodic monitoring every two weeks	Environment Agency
TSP, PM_{10}, $PM_{2.5}$, $PM_{1.0}$	Continuous monitoring	Environment Agency
Dust	2 week duration passive sampling	Environment Agency
BTEX	2 week duration passive sampling	Environment Agency
Top 10 VOC	2 week duration passive sampling	Environment Agency
Nitrogen dioxide (NO_2)	Continuous monitoring and passive sampling	Environment Agency
Nitric Oxide (NO)	Continuous monitoring and active sampling	Environment Agency
Hydrogen Sulphide (H_2S)	2 week duration passive sampling	NYCC – Planning Condition 25
Carbon Monoxide (CO)	Continuous monitoring and periodic monitoring every two weeks	NYCC – Planning Condition 25
Oxygen (O_2)	Continuous monitoring and periodic monitoring every two weeks	NYCC – Planning Condition 25
Ozone (O_3)	Continuous monitoring and passive sampling	GGS recommendation

2 Site Monitoring Locations

Four monitoring locations have been established around the site in order to capture a wide coverage of the ambient air quality at the site. Figure 1 below illustrates the monitoring locations.

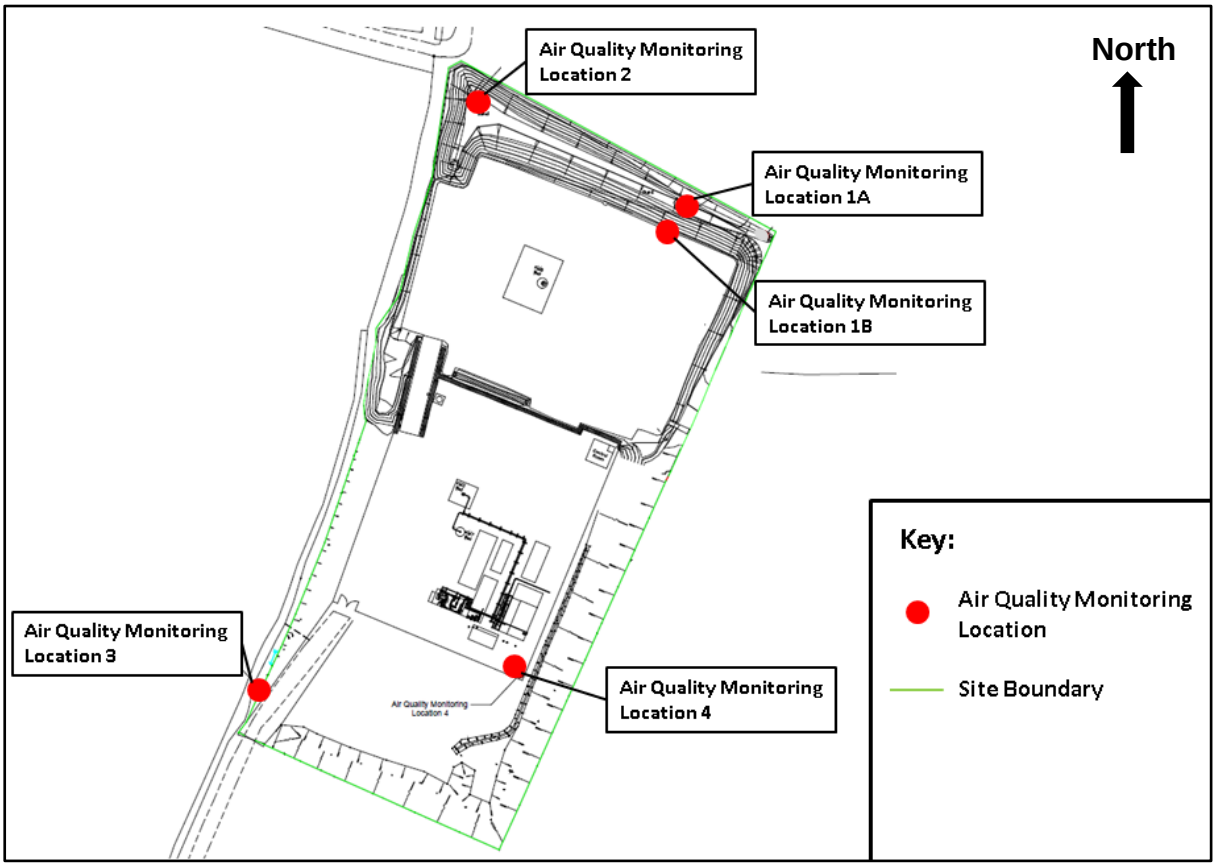

Figure 1. Ambient Air Quality Monitoring Locations.

Upon completion of the installation of the noise barriers on 12th October 2017, Monitoring Location 1A (on top of the existing soil mound) was relocated to 1B (raised platform at the top of the noise barriers) and Monitoring Location 2 was raised by approximately 6 metres above ground level using a telescopic mast.

3 Ongoing Monitoring

3.1 Methane (CH_4)

Methane is naturally occurring in the environment and arises from organic rich soils and ruminant cattle. It is present in the atmosphere at approximately 2 ppmv, but this can vary due to local influences. It is also the principle constituent of the target gas to be produced from the geological formations that are proposed to be hydraulically fractured. Monitoring of methane at the site is required by both the Environment Agency (EA) and North Yorkshire County Council (NYCC).

3.1.1 Methodology

Periodic monitoring of methane is undertaken over a 10-minute duration at the four monitoring locations at the site.

Continuous monitoring of methane at Location 1A began on 9th October 2017 (re-located to Location 1B on 12th October 2017) and readings are recorded at a frequency of 10 minutes.

3.1.2 Results

Table 3.1.1. Methane results from periodic monitoring.

Location	Unit	Range of Methane Concentrations 22nd November 2017
1B	ppm	1.8 – 2.0
2	ppm	1.9 – 2.1
3	ppm	1.7 – 1.9
4	ppm	1.8 – 2.0

Figure 2 Continuous methane monitoring results at Location 1B.

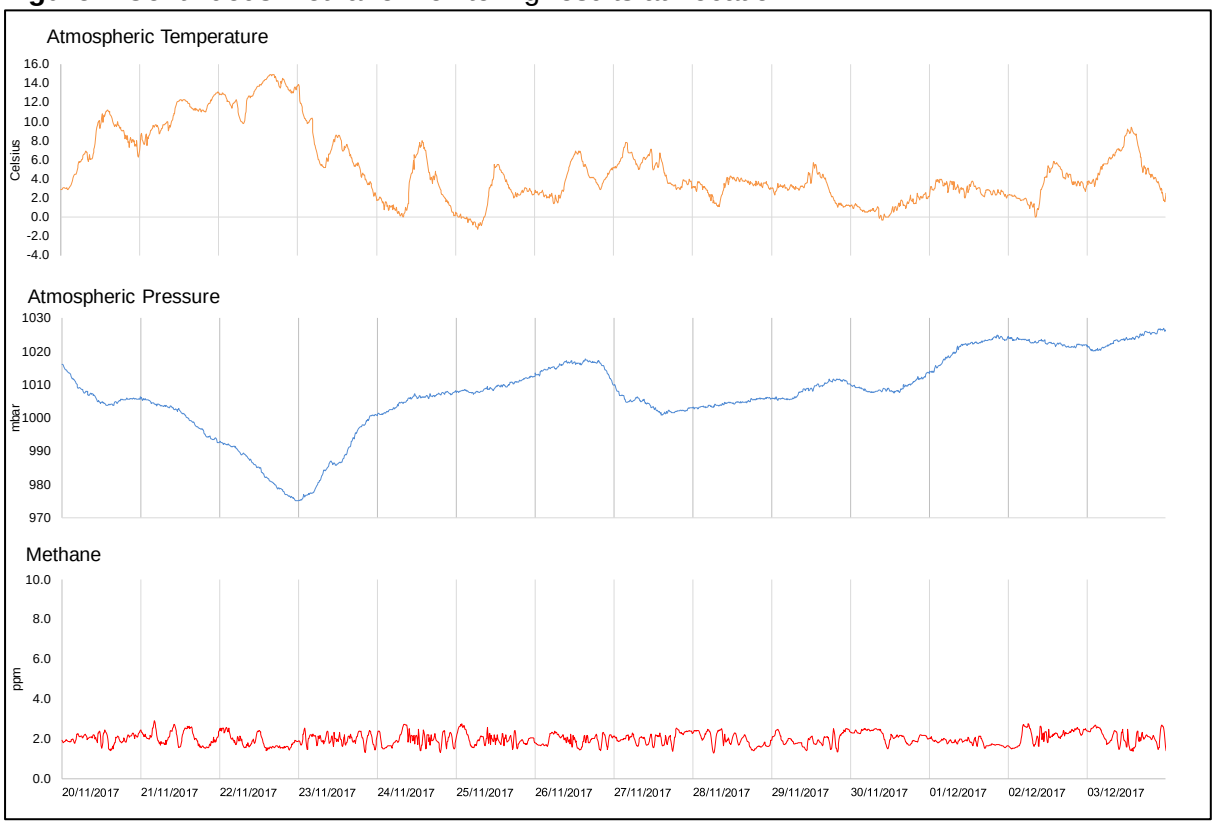

Table 3.1.2. Summary of methane results from continuous monitoring.

Location	Unit	Minimum Methane Concentrations	Average Methane Concentrations	Maximum Methane Concentrations
1B	ppm	1.28	2.00	2.89

Methane results recorded between 20th November 2017 and 3rd December 2017 are in line with baseline results observed at the site.

3.2 Carbon Dioxide (CO_2)

Carbon dioxide is a natural constituent of the atmosphere and is produced from both volcanic activity and animal respiration. It is currently present in the atmosphere at approximately 400ppmv. However this concentration varies seasonally and can be influenced by the local setting. Carbon dioxide is also produced by the combustion of petroleum based fuels. Monitoring of carbon dioxide at the site is required by the EA.

3.2.1 Methodology

Periodic monitoring of carbon dioxide is undertaken over a 10-minute duration at the four monitoring locations at the site.

Continuous carbon dioxide monitoring at Location 1B began on 25th October 2017 and readings are recorded at a frequency of 10 minutes.

3.2.2 Results

Table 3.2.1 Carbon dioxide results from periodic monitoring.

Location	Unit	Range of Carbon Dioxide Concentrations 22nd November 2017
1B	ppm	356 – 361
2	ppm	351 – 353
3	ppm	346 – 348
4	ppm	312 – 318

Figure 3 Continuous carbon dioxide monitoring results at Location 1B.

Table 3.2.2. Summary of carbon dioxide results from continuous monitoring.

Location	Unit	Minimum CO_2 Concentrations	Average CO_2 Concentrations	Maximum CO_2 Concentrations
1B	ppm	310	380	480

Carbon Dioxide results recorded between 20th November 2017 and 3rd December 2017 are in line with baseline results observed at the site.

3.3 Dust

Dust can be defined as all airborne particulate matter. It is present naturally in the atmosphere wherever there are particles present that may become suspended in the atmosphere due to air movement (i.e. wind). It is likely that dust will be generated on the site during operations and therefore monitoring of dust at the site is required by the EA.

3.3.1 Methodology

The latest rounds of passive dust monitoring were undertaken between 7th November 2017 and 15th November 2017, and between 15th November 2017 and 23rd November. The sampling media was dispatched to the laboratories by GGS on 16th November 2017 and 24th November 2017, respectively.

The dust samplers used were the DustScan DS100-D, which is a combined directional and deposited dust sampler. The directional and deposited dust sampler collects dust in horizontal flux from 360° around the sampling head as well as dust depositing out of the air. The collected dust is measured to determine dust coverage (AAC) and dust soiling (EAC); these measurements are expressed as percentages and are noted in the Institute of Air Quality Management (IAQM) guidance.

- AAC% is a measure of the dust coverage on a surface, irrespective of colour;
- EAC% is a measure of dust soiling, or obscuration, on a surface.

AAC and EAC can be combined to indicate possible annoyance caused by dust deposition.

3.3.2 Results

The laboratory results, including a dust impact risk assessment, can be provided to the EA upon request. A summary of the results is presented in the tables and figure below.

Table 3.3.1 Depositional Dust sampling and analysis results between 7th November 2017 and 15th November 2017

Location	Exposure Interval	AAC% / interval	EAC% / interval	AAC% / day	EAC% / day	Dust Impact Risk
1B	8 days	25.4	0.7	3.2	<0.1	Very Low
2	8 days	26.6	0.7	3.3	<0.1	Very Low
3	8 days	18.6	0.4	2.3	<0.1	Very Low
4	8 days	26.1	0.7	3.3	<0.1	Very Low

Table 3.3.2 Depositional Dust sampling and analysis results between 15th November 2017 and 23rd November 2017

Location	Exposure Interval	AAC% / interval	EAC% / interval	AAC% / day	EAC% / day	Dust Impact Risk
1B	8 days	32.8	0.9	4.1	0.1	Very Low
2	8 days	34.6	0.8	4.3	0.1	Very Low
3	8 days	25.9	0.5	3.2	<0.1	Very Low
4	8 days	30.9	0.8	3.9	0.1	Very Low

Table 3.3.3 Directional Dust Flux sampling and analysis results between 7th November 2017 and 15th November 2017

Location	Exposure Interval	AAC% / interval	EAC% / interval	AAC% / day	EAC% / day	Maximum Dust Impact Risk
1B	20 days	12.3	0.2	1.5	0.0	Very Low
2	20 days	14.1	0.3	1.8	0.0	Very Low
3	20 days	10.5	0.2	1.3	0.0	Very Low
4	20 days	12.4	0.2	1.5	0.0	Very Low

Table 3.3.4 Directional Dust Flux sampling and analysis results between 15th November 2017 and 23rd November 2017

Location	Exposure Interval	AAC% / interval	EAC% / interval	AAC% / day	EAC% / day	Maximum Dust Impact Risk
1B	20 days	17.6	0.3	2.2	0.0	Very Low
2	20 days	30.2	0.7	3.8	0.1	Very Low
3	20 days	28.1	0.7	3.5	0.1	Very Low
4	20 days	21.2	0.5	2.7	0.1	Very Low

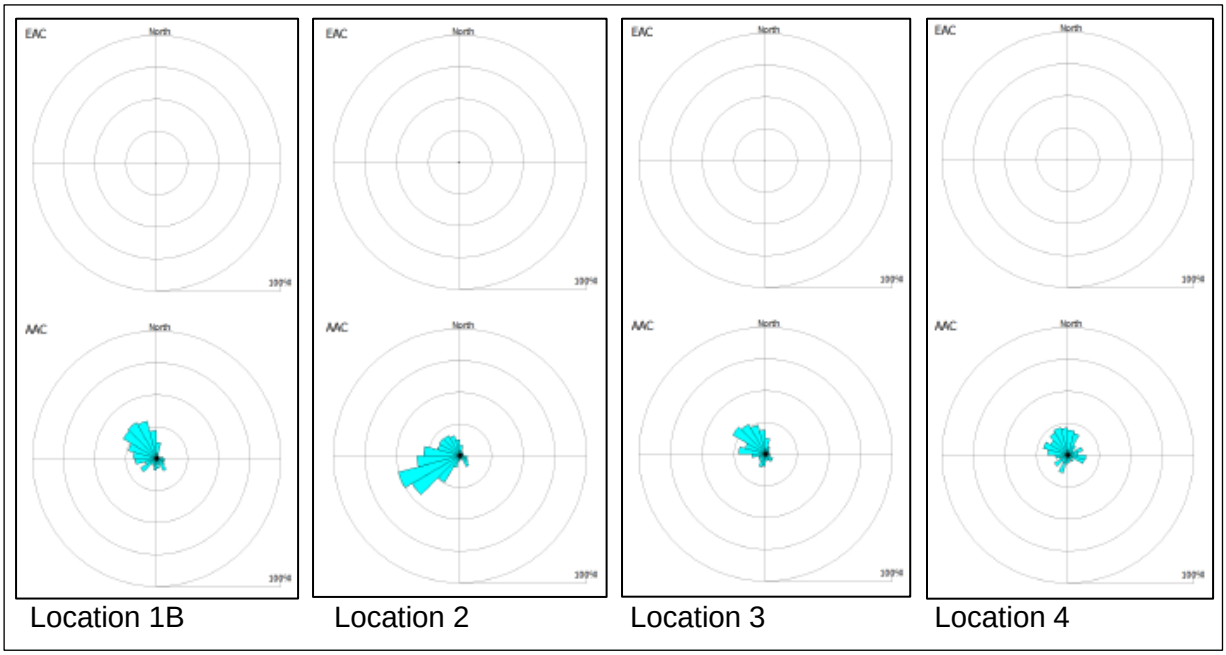

Figure 2 Directional Dust rose diagrams for period between 7th November 2017 and 15th November 2017

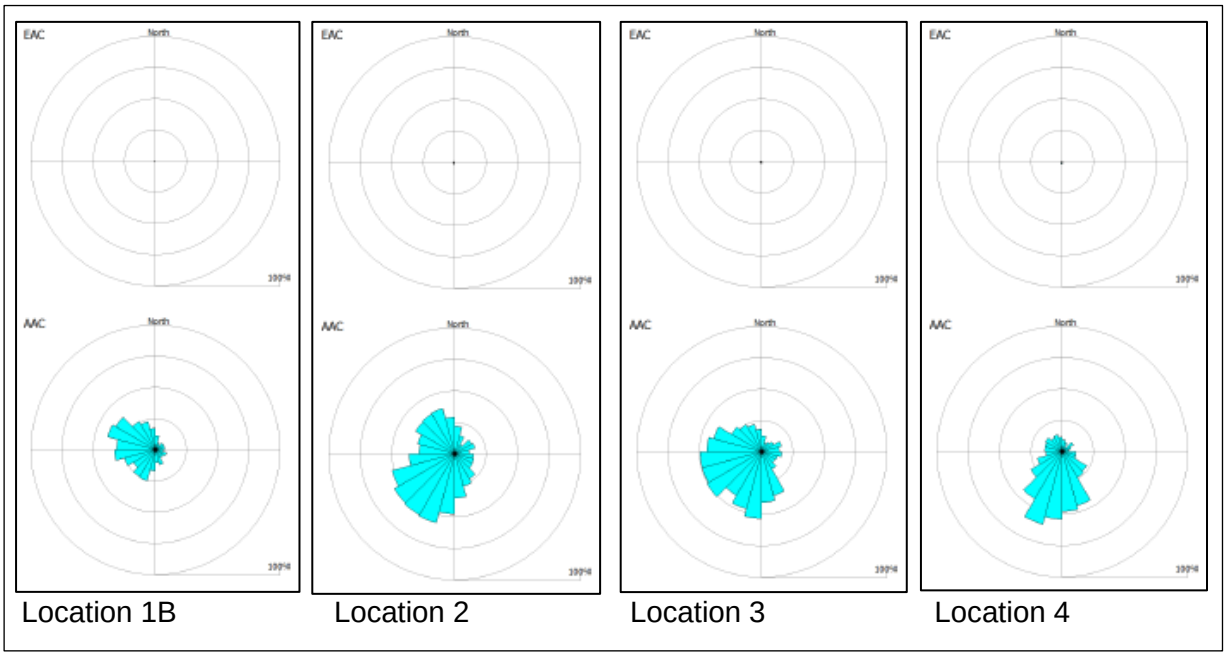

Figure 2 Directional Dust rose diagrams for period between 15th November 2017 and 23rd November 2017

The latest rounds of passive dust monitoring results are in line with baseline results observed at the site.

3.4 BTEX

BTEX refers to the chemicals benzene, toluene, ethylbenzene and xylene. These compounds occur naturally in petroleum deposits and are also present in vehicle exhaust fumes and cigarette smoke. BTEX monitoring at the site is required by the EA.

3.4.1 Methodology

The latest round of passive BTEX monitoring was undertaken between 7th November 2017 and 22nd November 2017. The sampling media was dispatched to the laboratories by GGS on 23rd November 2017.

GGS passively sampled for BTEX using Tenax sorbent tubes located at the four monitoring locations. The tubes were exposed for an approximate two-week period and dispatched to an appropriately accredited laboratory for BTEX analysis. A field blank was also deployed as a quality check in line with best practice guidelines to ensure that the samples were not contaminated in transit. This was left sealed in its container at Location 4 for the exposure period.

3.4.2 Results

The laboratory results can be provided to the EA upon request. A summary of the results is presented in the tables below.

Table 3.4.1 BTEX laboratory results – Location 1B

BTEX	Accreditation Status	ng on tube	ppb in air*	µgm^{-3*}
Benzene	U	9.3	0.4	1.2
Toluene	U	<5.0	<0.2	<0.6
Ethylbenzene	U	<5.0	<0.1	<0.6
m/p-Xylene	U	<5.0	<0.1	<0.6
o-Xylene	U	<5.0	<0.1	<0.6

Table 3.4.2 BTEX laboratory results – Location 2

BTEX	Accreditation Status	ng on tube	ppb in air*	µgm^{-3*}
Benzene	U	5.9	0.3	0.8
Toluene	U	6.7	0.3	0.9
Ethylbenzene	U	<5.0	<0.2	<0.7
m/p-Xylene	U	<5.0	<0.2	<0.7
o-Xylene	U	<5.0	<0.2	<0.7

Table 3.4.3 BTEX laboratory results – Location 3

BTEX	Accreditation Status	ng on tube	ppb in air*	µgm^{-3}*
Benzene	U	8.1	0.4	1.1
Toluene	U	5.7	0.2	0.8
Ethylbenzene	U	<5.0	<0.2	<0.7
m/p-Xylene	U	<5.0	<0.2	<0.7
o-Xylene	U	<5.0	<0.2	<0.7

Table 3.4.4 BTEX laboratory results – Location 4

BTEX	Accreditation Status	ng on tube	ppb in air*	µgm^{-3}*
Benzene	U	5.6	0.2	0.7
Toluene	U	<5.0	<0.2	<0.6
Ethylbenzene	U	<5.0	<0.1	<0.6
m/p-Xylene	U	<5.0	<0.1	<0.6
o-Xylene	U	<5.0	<0.1	<0.6

Table 3.4.5 BTEX laboratory results – Field Blank

BTEX	Accreditation Status	ng on tube
Benzene	U	<5.2
Toluene	U	<5.0
Ethylbenzene	U	<5.0
m/p-Xylene	U	<5.0
o-Xylene	U	<5.0

*Results with < (less than) indicate that concentrations are below the reporting limit.
U – Analysis is UKAS accredited
N – Analysis is not UKAS accredited

The latest round of passive BTEX monitoring results are in line with baseline results observed at the site.

3.5 Top 10 VOCs

Volatile organic compounds (VOCs) are substances with low boiling points that evaporate from solids or liquids. They occur both naturally and as products used in industrial processes. There are many different VOC's but one of the most common is formaldehyde which is found in building products and furniture. VOCs are also produced by diesel combustion. Monitoring of the top 10 VOC compounds is required by the EA.

3.5.1 Methodology

The latest round of passive VOC monitoring was undertaken between 7th October 2017 and 22nd November 2017. The sampling media was dispatched to the laboratories by GGS on 23rd November 2017.

GGS passively sampled VOCs using Tenax sorbent tubes located at the four monitoring locations in line with the Emissions Monitoring Plan. The tubes were exposed for an approximate two-week period and dispatched to an appropriately accredited laboratory for Top 10 VOC analysis. A field blank was also deployed as a quality check in line with best practice guidelines to ensure that the samples were not contaminated in transit. This was left sealed in its container at Location 4 for the exposure period.

The Top 10 VOCs were identified and their estimated concentrations were carried out in accordance with ISO16000-6.

3.5.2 Results

The Top 10 VOC laboratory results for the four locations are provided in the tables below.

Table 3.5.1 Top 10 VOC laboratory results – Location 1B

Top 10 VOC		Estimated ng on tube	ppb in air*	µgm^{-3}*
2,6-Diphenyl-p-benzoquinone***	N	276	5.9	61.1
Diethyl phthalate	U	40	0.8	7.5
Benzaldehyde**	U	29	0.6	2.6
1,3-Dichlorobenzene	U	12	0.2	1.4
Acetophenone**	U	9	0.2	0.9
1,3,5-Trifluorobenzene	N	8	0.2	0.9
Heptane, 2,2,4,6,6-pentamethyl-	N	5	0.1	0.8
Furan, 2,5-dihydro-	N	5	0.1	0.3
Benzene, 1,2,4-trimethyl-	U	<5	<0.1	<0.5
9 Compounds detected				

Table 3.5.2 Top 10 VOC laboratory results – Location 2

Top 10 VOC		Estimated ng on tube	ppb in air*	µgm^{-3}*
2,6-Diphenyl-p-benzoquinone***	N	152	3.5	36.5
Benzoic acid	N	38	0.9	4.3
Diethyl phthalate	U	27	0.6	5.6
Benzaldehyde**	U	23	0.5	2.3
Nonanal**	N	21	0.5	2.7
Furan, 2,5-dihydro-	N	17	0.4	1.1
Decanal**	N	12	0.3	1.7
Acetophenone**	U	11	0.3	1.3
Pentane, 3-methyl-	U	9	0.2	0.8
Ethanol, 2-phenoxy-	N	8	0.2	1.0

Table 3.5.3 Top 10 VOC laboratory results – Location 3

Top 10 VOC		Estimated ng on tube	ppb in air*	µgm^{-3}*
Benzaldehyde**	U	20	0.5	1.9
Diethyl phthalate	U	13	0.3	2.6
1,3,5-Trifluorobenzene	N	6	0.1	0.7
2-Ethyl-1-hexanol	U	5	0.1	0.6
4 Compounds detected				

Table 3.5.4 Top 10 VOC laboratory results – Location 4

Top 10 VOC		Estimated ng on tube	ppb in air*	µgm^{-3}*
Cyclohexadecane	N	29	0.6	5.5
Benzaldehyde**	U	21	0.5	1.9
Diethyl phthalate	U	19	0.4	3.6
Nonanal**	N	11	0.2	1.4
Benzoic acid	N	10	0.2	1.1
Acetophenone**	U	8	0.2	0.9
1,3,5-Trifluorobenzene	N	7	0.2	0.8
Decanal**	N	6	0.1	0.8
2-Ethyl-1-hexanol	U	<5	<0.1	<0.6
9 Compounds detected				

Table 3.5.5 Top 10 VOC laboratory results – Field Blank

Top 10 VOC		Estimated ng on tube
Diethyl phthalate	U	6
Pentane, 2-methyl-	U	6
Pentane, 3-methyl-	U	6
1,3,5-Trifluorobenzene	N	5
Benzaldehyde**	U	<5
Hexane	U	<5
Butane, 2-methyl-	U	<5
7 Compounds detected		

* Laboratory results obtained using exposure data.
** Compounds may be an artefact due to reaction of ozone with the Tenax sorbent.
*** 2,6-Diphenyl-p-benzoquinone may be an artefact due to degradation of Tenax by nitrogen dioxide.
U – Analysis is UKAS accredited
N – Analysis is not UKAS accredited

This latest round of passive VOC monitoring results are in line with baseline results observed at the site.

3.6 Nitrogen Dioxide (NO_2)

Trace concentrations of nitrogen dioxide occur naturally in the atmosphere from volcanic sources and lightening strikes. It is also a product of combustion and is present in vehicle exhaust fumes and cigarette smoke. Nitrogen dioxide monitoring is required by the EA.

3.6.1 Methodology

The latest round of passive Nitrogen Dioxide monitoring was undertaken between 7th November 2017 and 22nd November 2017. The sampling media was dispatched to the laboratories by GGS on 23rd November 2017.

GGS passively sampled nitrogen dioxide using diffusion tubes at all four locations. The tubes were exposed for an approximate two-week period and dispatched to an appropriately accredited laboratory for nitrogen dioxide analyses. Field blanks were also deployed in line with best practice guidelines.

Continuous monitoring of nitrogen dioxide at Location 1A began on 5th October 2017 (re-located to Location 1B on 12th October 2017) and readings are recorded at a frequency of 10 minutes.

3.6.2 Results

A summary of the latest monitoring results is presented in the tables and figure below. The laboratory certificates can be provided to the EA upon request.

Table 3.6.1 Nitrogen Dioxide Passive Sampling results

Location	Unit	Nitrogen Dioxide
1B	µg/m^3	31.11
	ppb	16.24
2	µg/m^3	19.27
	ppb	10.06
3	µg/m^3	13.03
	ppb	6.80
4	µg/m^3	19.11
	ppb	9.98

Figure 4 Continuous indicative nitrogen dioxide monitoring results at Location 1B.

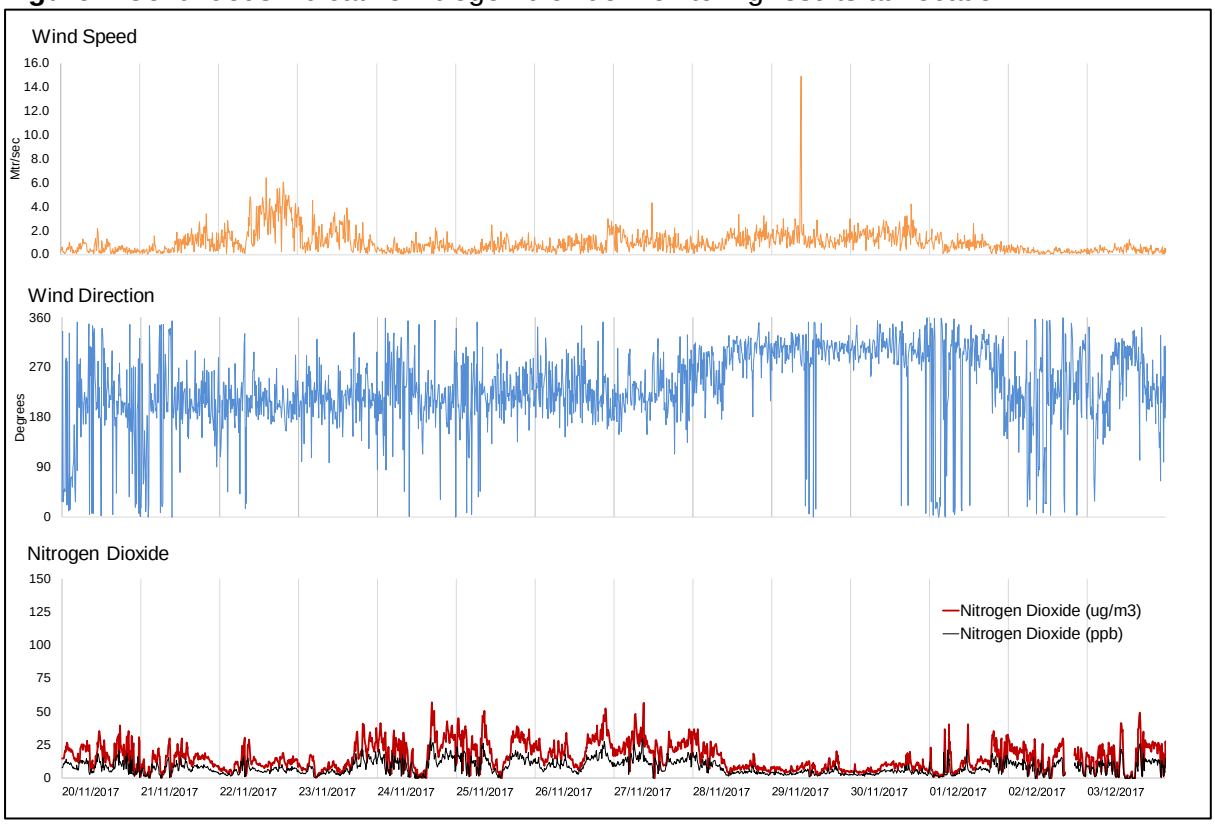

Table 3.6.2. Summary of nitrogen dioxide results from continuous monitoring.

Location	Unit	Minimum NO_2 Concentrations	Average NO_2 Concentrations	Maximum NO_2 Concentrations
1B	ppb	<0.01	7.91	29.61
	µg/m^3	<0.01	15.22	56.94

Continuous nitrogen dioxide results recorded between 20th November 2017 and 3rd December 2017 are in line with expected results for the activity undertaken at the site.

3.7 Nitric Oxide (NO)

Trace concentrations of nitric oxide occur naturally from lightening strikes. It is also a product of combustion and is present in vehicle exhaust fumes. Nitric oxide monitoring is required by the EA.

3.7.1 Methodology

Nitric oxide is sampled using molecular sieve tubes which are actively sampled using a low-flow sampling pump over a 30-minute period. The tubes are then dispatched to an appropriately accredited laboratory for nitric oxide analysis. Field blanks are also deployed in line with best practice guidelines.

The latest round of active Nitric Oxide monitoring was undertaken on 22nd November 2017. The sampling media was dispatched to the laboratories by GGS on 23rd November 2017.

Continuous monitoring of nitric oxide at Location 1A began on 5th October 2017 (re-located to Location 1B on 12th October 2017) and readings are recorded at a frequency of 10 minutes.

3.7.2 Results

The laboratory results can be provided to the EA upon request. A summary of the latest results is presented in the tables and figure below.

Table 3.7.1 Nitric Oxide Active Sampling results

Location	Unit	Nitric Oxide 7th November 2017
1B	mg/m^3	<0.08
	ppm	<0.068
2	mg/m^3	<0.08
	ppm	<0.068
3	mg/m^3	<0.08
	ppm	<0.068
4	mg/m^3	<0.08
	ppm	<0.068

**Results with < (less than) indicate that concentrations are below the reporting limit.*

Figure 5 Continuous indicative nitric oxide monitoring results at Location 1B.

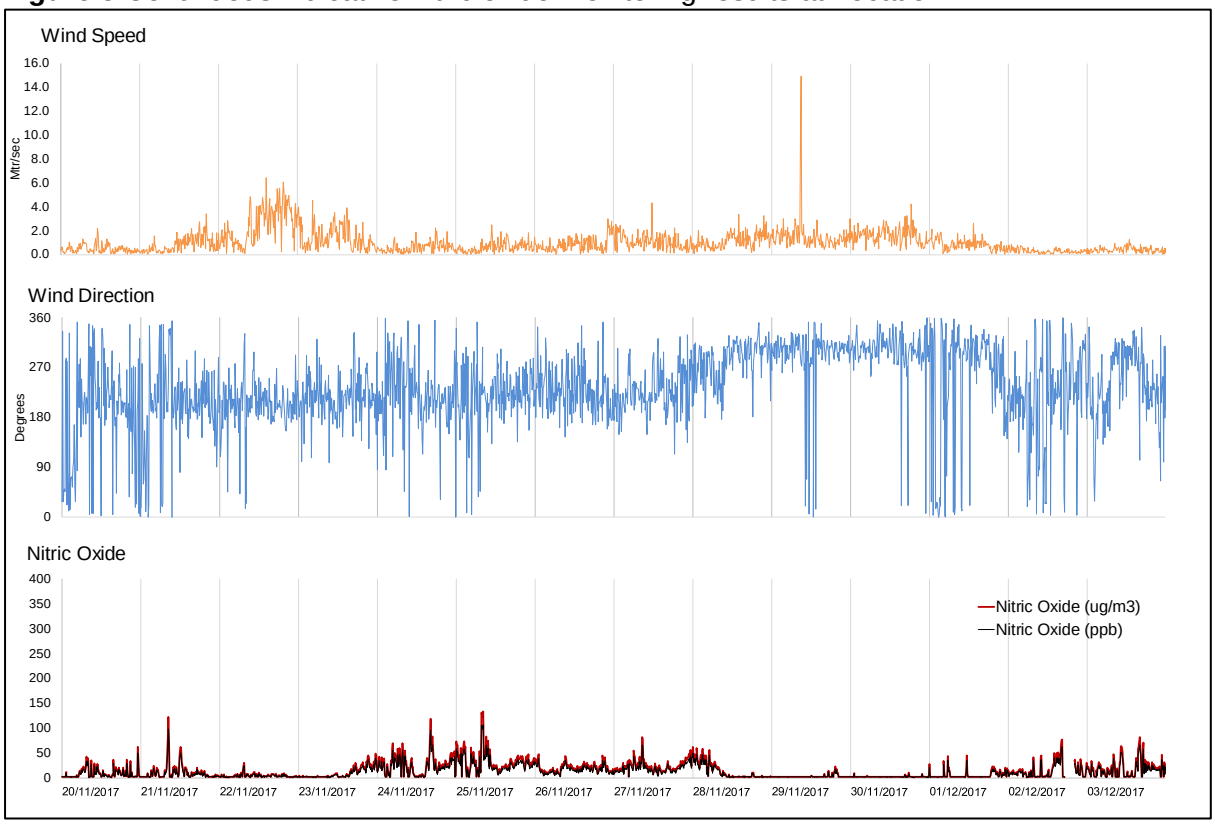

Table 3.7.2 Summary of nitric oxide results from continuous monitoring.

Location	Unit	Minimum NO Concentrations	Average NO Concentrations	Maximum NO Concentrations
1B	ppb	0.68	11.33	106.27
	µg/m^3	0.84	14.16	132.83

Continuous Nitric Oxide results recorded between 20th November 2017 and 3rd December 2017 are in line with expected results for the activity undertaken at the site.

3.8 Hydrogen Sulphide (H_2S)

Hydrogen sulphide is a naturally occurring compound found in peaty deposits, volcanic areas and petroleum deposits. As such, North Yorkshire County Council requires it to be monitored under Planning Condition 25.

3.8.1 Methodology

The latest round of passive hydrogen sulphide monitoring was undertaken between 7th November 2017 and 22nd November 2017. The sampling media was dispatched to the laboratories by GGS on 23rd November 2017.

GGS passively sampled hydrogen sulphide using diffusion tubes at all four locations. The tubes were exposed for a two-week period and dispatched to an accredited laboratory for hydrogen sulphide analyses. Field blanks were also deployed in line with best practice guidelines.

3.8.2 Results

The laboratory results can be provided to NYCC upon request. A summary of the results is presented in Table 3.8.1 below.

Table 3.8.1 Hydrogen Sulphide Passive Sampling results

Location	Unit	Hydrogen Sulphide
1B	µg/m^3	<0.02
	ppb	<0.01
2	µg/m^3	0.07
	ppb	0.05
3	µg/m^3	0.22
	ppb	0.15
4	µg/m^3	0.14
	ppb	0.10

Hydrogen sulphide results recorded between 7th November 2017 and 22nd November 2017 are in line with baseline results observed at the site.

3.9 Carbon Monoxide (CO)

Carbon Monoxide is a constituent of the exhaust gases from diesel engines and North Yorkshire County Council require it to be monitored under Planning Condition 25.

3.9.1 Methodology

Periodic monitoring of carbon monoxide was undertaken over a 10-minute duration at the four monitoring locations at the site.

Continuous monitoring of carbon monoxide at Location 1A began on 5th October 2017 (re-located to Location 1B on 12th October 2017) and readings are recorded at a frequency of 10 minutes.

3.9.2 Results

Table 3.9.1 Carbon monoxide results from periodic monitoring.

Location	Unit	Range of Carbon Monoxide Concentrations 22nd November 2017
1B	ppm	<1*
2	ppm	<1*
3	ppm	<1*
4	ppm	<1*

*Indicates that concentrations remained below the limit of detection of the instrument

Figure 6 Continuous indicative carbon monoxide monitoring results at Location 1B.

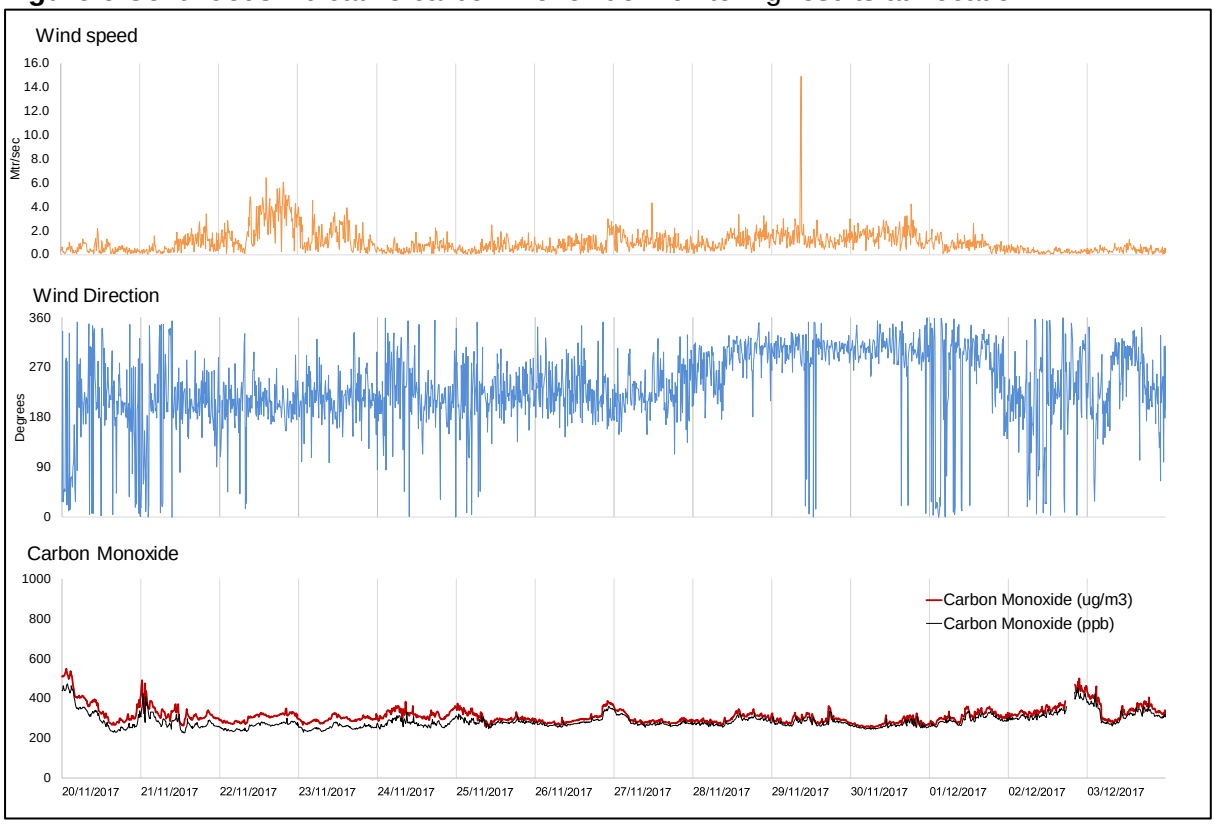

Table 3.9.2. Summary of carbon monoxide results from continuous monitoring.

Location	Unit	Minimum CO Concentrations	Average CO Concentrations	Maximum CO Concentrations
1B	ppb	225.34	284.65	472.66
	µg/m^3	252.86	311.97	549.60

Carbon monoxide results recorded between 20th November 2017 and 3rd December 2017 are in line with expected results for the activity undertaken at the site.

3.10 Oxygen (O_2)

Oxygen, at a concentration of 21% in ambient air (at sea level), is the second most common gas in the atmosphere and is essential for respiration in animals. It is also used in the combustion of diesel fuels and is required by North Yorkshire County Council to be monitored at the site under Planning Condition 25.

3.10.1 Methodology

Periodic monitoring of oxygen was undertaken over a 10-minute duration at the four monitoring locations at the site.

Continuous oxygen monitoring at Location 1B began on 25th October 2017 and readings are recorded at a frequency of 10 minutes.

3.10.2 Results

A summary of the results is presented in the tables and figure below.

Table 3.10.1 Oxygen results from periodic monitoring.

Location	Unit	Range of Oxygen Concentrations 22nd November 2017
1B	%	20.4 – 20.9
2	%	20.2 – 20.9
3	%	20.2 – 20.9
4	%	20.4 – 20.9

Figure 7 Continuous indicative oxygen monitoring results at Location 1B.

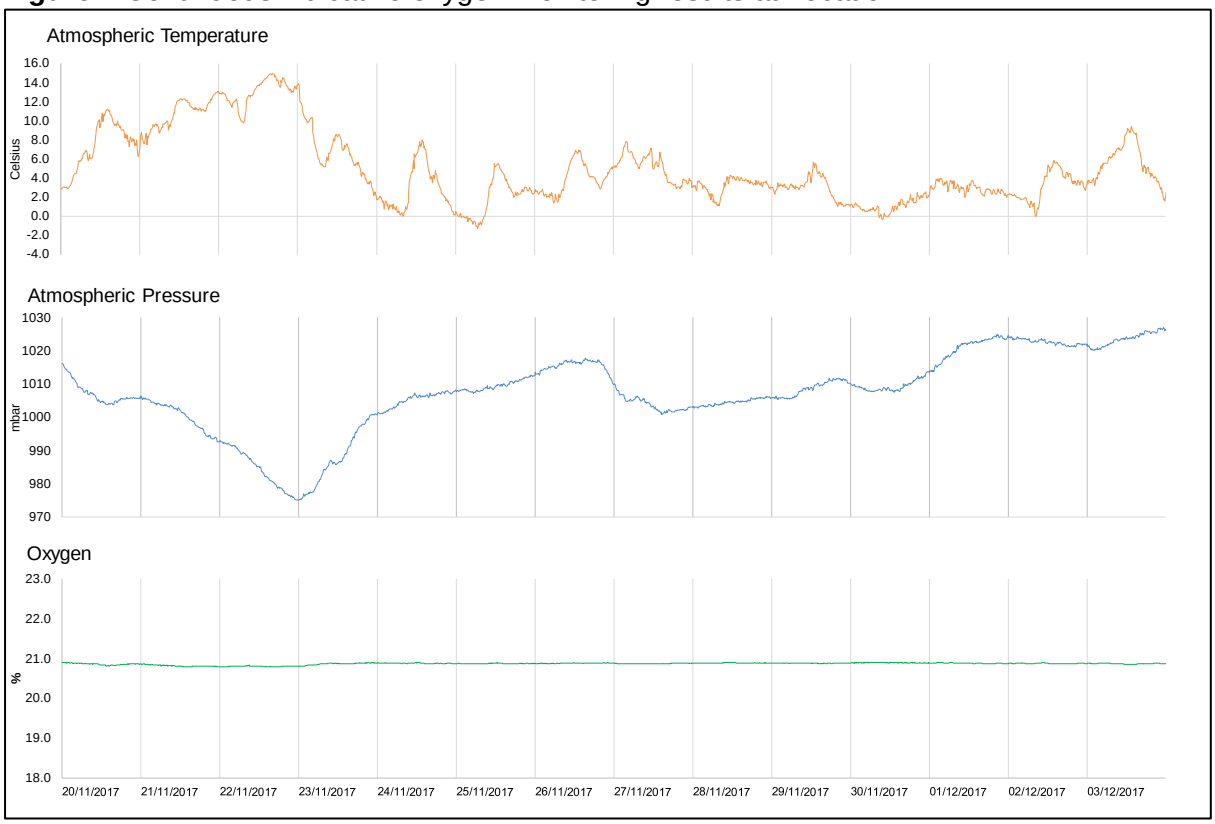

Table 3.10.2. Summary of oxygen results from continuous monitoring.

Location	Unit	Minimum O_2 Concentrations	Average O_2 Concentrations	Maximum O_2 Concentrations
1B	%	20.78	20.86	20.89

Oxygen results recorded between 20th November 2017 and 3rd December 2017 are in line with baseline results observed at the site.

3.11 Ozone (O_3)

Ozone occurs naturally in the upper atmosphere and is formed by the action of ultraviolet light and lightening discharges on oxygen. Near ground level it is formed by chemical reactions between the oxides of nitrogen and VOCs in the presence of sunlight. Ozone is a powerful oxidising agent and is an indicator of poor air quality. Monitoring of Ozone is not a requirement by either the EA or NYCC, but GGS has advised that this parameter be included in the monitoring regime at the site.

3.11.1 Methodology

The latest round of passive Ozone monitoring was undertaken between 7th November 2017 and 22nd November 2017. The sampling media was dispatched to the laboratories by GGS on 23rd November 2017.

GGS passively sampled Ozone using diffusion tubes at all four locations. The tubes were exposed for a two-week period and dispatched to an appropriately accredited laboratory for Ozone analyses. Field blanks were also deployed in line with best practice guidelines.

Continuous monitoring of Ozone at Location 1A began on 5th October 2017 (re-located to Location 1B on 12th October 2017) and readings are recorded at a frequency of 10 minutes.

3.11.2 Results

The laboratory results can be provided upon request. A summary of the results is presented in the tables and figure below.

Table 3.11.1 Ozone Passive Sampling results

Location	Unit	Ozone
1B	µg/m^3	28.06
	ppb	14.03
2	µg/m^3	48.04
	ppb	24.02
3	µg/m^3	45.70
	ppb	22.85
4	µg/m^3	28.62
	ppb	14.31

Figure 8 Continuous indicative Ozone monitoring results at Location 1B.

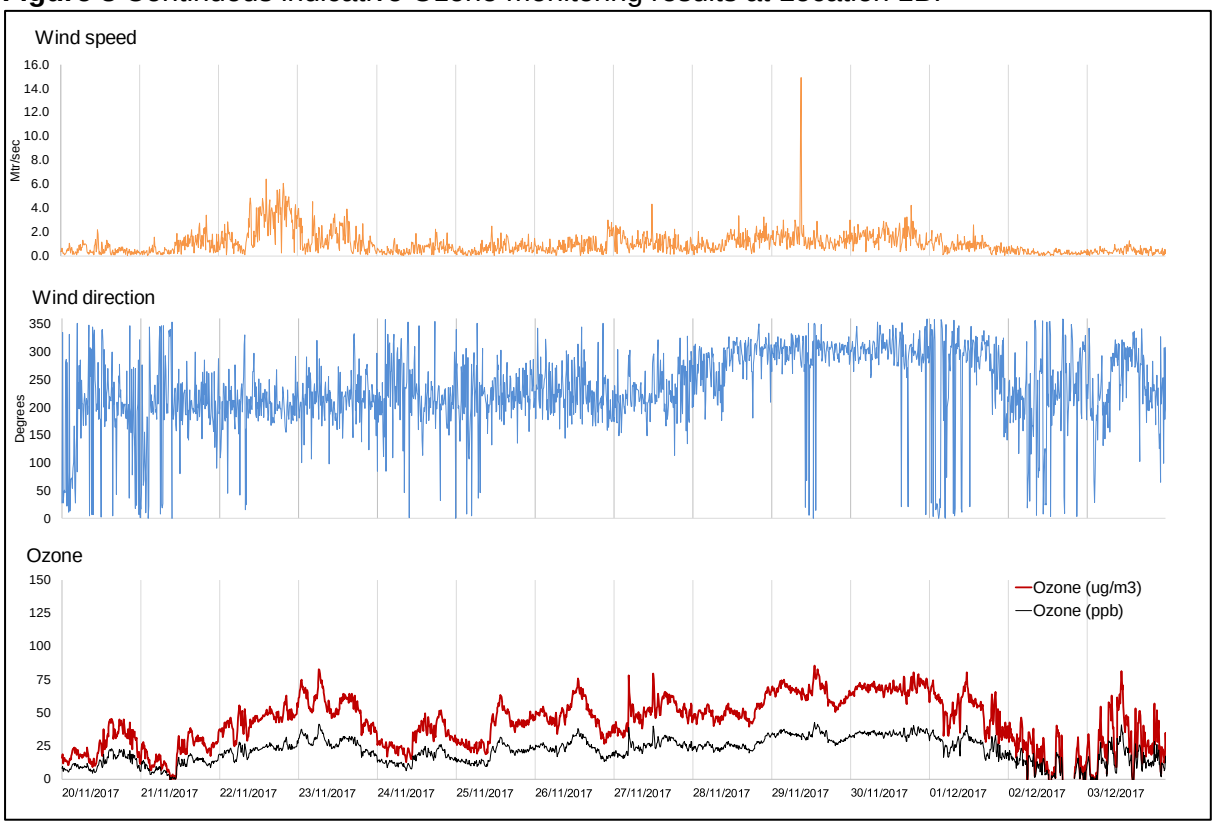

Table 3.11.2. Summary of Ozone results from continuous monitoring.

Location	Unit	Minimum O_3 Concentrations	Average O_3 Concentrations	Maximum O_3 Concentrations
1B	ppb	<0.01	21.39	42.83
	µg/m^3	<0.01	42.79	85.66

Continuous Ozone results recorded between 20th November 2017 and 3rd December 2017 are in line with expected results for the activity undertaken at the site.

3.12 Particulate Matter

Airborne particulate matter is made up of a collection of materials of various sizes that range from a few nanometres in diameter to around 100 microns (100 µm). It consists of a wide range of material from both natural and anthropogenic sources and includes sea salt, soil dust and the products of combustion. Particulate Matter monitoring is required by the EA.

3.12.1 Methodology

Continuous monitoring of Particulate Matter (Total Suspended Particles, PM_{10}, $PM_{2.5}$ and PM_1) at Location 1A began on 5th October 2017 (re-located to Location 1B on 12th October 2017) and readings are recorded at a frequency of 10 minutes.

3.12.2 Results

Figure 9 Continuous Particulate Matter monitoring results at Location 1B.

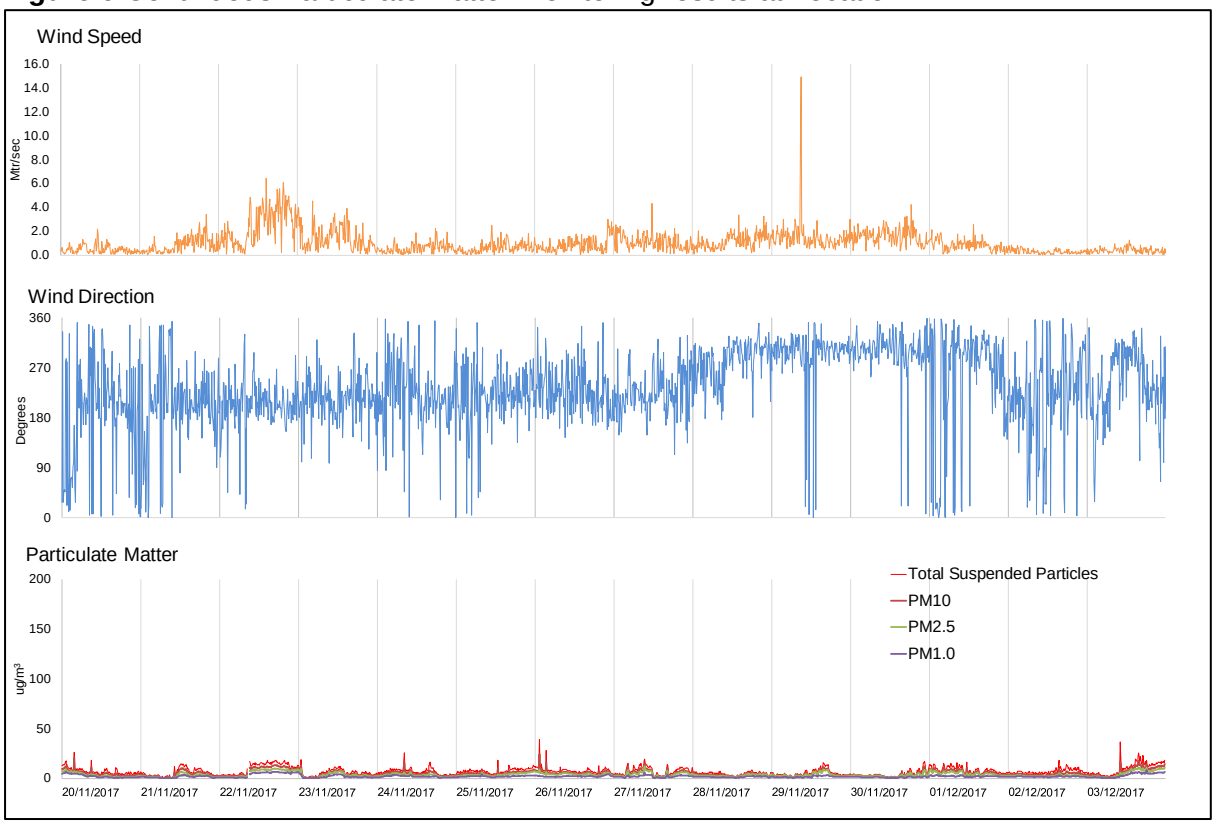

Table 3.12.1. Summary of Particulate Matter results from continuous monitoring at Location 1B.

Particulate Matter	Unit	Minimum Concentrations	Average Concentrations	Maximum Concentrations
Total Suspended Particles	µg/m^3	0.30	6.94	39.20
PM_{10}	µg/m^3	0.20	4.93	24.30
$PM_{2.5}$	µg/m^3	0.23	3.70	12.18
PM_1	µg/m^3	0.11	2.02	8.07

Particulate Matter results recorded between 20th November 2017 and 3rd December 2017 are in line with expected results for the activity undertaken at the site.

4 Quality Control & Assurance

All monitoring equipment operated by GGS is maintained in accordance with the manufacturer's guidelines. Annual services and calibrations are undertaken when required and routine visual inspections of the equipment are undertaken prior to and during site visits by GGS staff.

GGS operates an Integrated Management System (IMS) that is accredited by QMS International plc as complying with the following international standards:

- BS EN ISO 9001:2008 (Quality Management System);
- ISO 14001:2004 (Environmental Management System), and;
- OHSAS 18001:2007 (Occupational Health and Safety Management System).

All of GGS' monitoring and sampling are carried out to procedures that are subject to independent annual audit.

5 Ongoing Monitoring Regime

Ambient air monitoring will continue to be undertaken throughout the duration of site operations with particular attention given to monitoring during key site operations including cementing and hydraulic fracturing of the five designated intervals.

Ambient air monitoring will also continue for four weeks after the site operations have ceased and the hydraulic fracturing plant and machinery has been removed from the site.

GGS will attend the site at approximately two-weekly intervals for the duration of the ambient air monitoring to collect samples for laboratory analysis, undertake periodic monitoring and to maintain the continuous monitoring equipment. GGS will also undertake additional periodic sampling during a number of key operational phases.

During the on-site operations, regular reports, containing the results of the continuous monitoring, periodic monitoring and available laboratory analyses will be submitted to the Environment Agency and North Yorkshire County Planning Authority.

In addition, with specific reference to methane concentrations, if significant concentrations[1], as determined from baseline monitoring carried out prior to well stimulation operations and as agreed with the Environment Agency, are observed then the source of the exceedance will be identified and the Environment Agency will be informed within 24 hours of the occurrence.

[1] In the context of the ambient air quality monitoring, a significant concentration is taken to be two consecutive readings of methane recorded at twice the previous highest baseline concentration of 5.34ppm recorded at BGS Monitoring Station on site on 4th March 2017 i.e. two consecutive readings of greater than 10.68 ppm