

Air Quality Monitoring Plan Third Energy UK Gas Ltd

Kirby Misperton A Wellsite

Prepared for:

**Third Energy UK Gas Ltd
Knapton Generating Station
East Knapton
Malton
North Yorkshire
YO17 8JF**

Prepared by: N J Fenwick

Reviewed by: P Shead

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1.0 Introduction

Environmental Scientifics Group Limited has been requested to undertake environmental ambient air monitoring at Third Energy UK Gas Limited's Kirby Misperton 'A' wellsite to establish a baseline and undertake this monitoring programme for the duration of the KMA wellsite operation. Although no permit has been issued as yet, Third Energy has taken a proactive approach by considering ambient air quality within both its planning and permitting application.

Any additional parameters to be monitored may be requested by the Environment Agency upon issue of the permit as a Pre-Operational condition.

The purpose of this document is to set out the ambient air monitoring programme, including parameters, sampling and frequency.

The monitoring regime will cover the pollutants requested by Third Energy including those expected to be requested by the Environment Agency as a Pre-Operational condition of the environmental permit.

- Methane (CH₄)
- Carbon Dioxide (CO₂)
- Non-Methane Volatile Organic Compounds (BTEX Compounds, Top 10 prevalent VOC compounds and estimate of total VOC's)
- Nitrogen Dioxide (NO₂)
- Nitric Oxide (NO)
- Oxides of Nitrogen (NO_x)
- Hydrogen Sulphide (H₂S)
- Sulphur Hexafluoride (SF₆)
- Fugitive Dust (Dust deposition and direction)

Samples and spot readings/measurements will be taken on a two weekly basis on dates to be agreed, using the methodologies described below.

Methods of recording data for evaluation are also described, together with proposed further actions in response to any dust exceedances reported.

Four monitoring locations were selected in order to give a wide coverage of the main site. A 'clean' sample point was chosen and a monitoring stand positioned outside the South West corner of the KMA wellsite, 20m south along the access track. The position was chosen to give a baseline for all of the required parameters. Three (3) further monitoring locations identified around KMA wellsite. The first location, in the North East corner of the wellsite, was chosen, taking into account prevailing wind direct, site elevation and future positioning of equipment. The second location, in the North West corner of the wellsite, was chosen following the considerations as the first. The third monitoring location, in the South East corner of the wellsite, was chosen to provide a full perimeter monitoring suite and the prevailing wind direction. The exact monitoring locations are indicated in Appendix II of this Air Quality Monitoring Plan. The 'clean sample' placed outside the South West corner of the wellsite would give the make of any particles coming onto the wellsite. This would then be deducted from other samples to give a true sample of particulates generated from the works being carried out within the wellsite. For clarity, any parameters that will be monitored by grab sampling techniques will be done so at the four (4) monitoring locations to ensure consistency amongst all of the monitoring rounds. It is important to state that the locations proposed are the same locations that have been used to establish the baseline condition.

An additional grab sample will also be taken by the ESG engineers for methane whilst attending site. The additional monitoring location shall be variable and will be determined on the day by the wind speed and direction. A minimum distance from the methane emission sources will be 5m on a still/calm day, with a maximum of 20 meters on a windy day. The location will also be dependent on any ATEX zones that are established at the KMA wellsite.

2.0 Nitrogen Dioxide

This two-tube pack is designed for passively monitoring gaseous airborne Nitric oxide, Nitrogen dioxide and total NO_x.

Description: The NO_x diffusion tube system consists of a two-tube pack:

1. A conventional Nitrogen dioxide tube containing the absorbent in a closed grey cap.
2. A Nitrogen oxide tube where the absorbent grid is fitted into a grey open cap. Placed onto this open cap is a black plastic cap containing a secondary absorbent.

Both tubes are exposed in parallel by removing the white plastic cap. During exposure, Nitrogen oxides (NO /NO₂) are taken up into the tube, the NO passes through into the black cap and the NO₂ is absorbed in the grey cap. The NO is oxidised to NO₂ and is back diffused into to the grey cap. The conventional tube just absorbs NO₂.

The concentrations of Nitrite ions and hence NO₂ chemically adsorbed are quantitatively determined by UV / Visible Spectrophotometry with reference to a calibration curve derived from the analysis of standard Nitrite solutions (UKAS Accredited Methods). When analysed, both tubes are measured for weight (ug) of nitrate collected on each tube, using the standard formula the concentration NO₂ is calculated. The difference between the two concentrations is reported as Nitric oxide.

NOTE: When the values of NO₂ and NO_x are very close, a negative NO result may be achieved.



3.0 Hydrogen Sulphide

This tube is designed for passively monitoring gaseous airborne Hydrogen sulphide.

Description: Black acrylic tube fitted with black thermoplastic rubber caps. One cap is fitted with a one-micron porosity filter to prevent particulate ingress, the other cap contains the absorbent.

Hydrogen sulphide is chemically adsorbed and transformed into a stable compound, which is then quantitatively determined by UV/ Visible Spectrophotometry with reference to a calibration curve derived from the analysis of standard sulphide solutions (UKAS Accredited Methods).

Suitable for carrying out spatial or localized assessments for H₂S in ambient air or workplace monitoring.

Clips and straps are not included and must be ordered separately.

Tube Dimensions: 71.0mm length x 11.0mm internal diameter.

Recommended Exposure Periods: 2 –4 weeks.

Air Velocity: No influence when filter fitted.

Storage: Store in a dark, cool environment preferably between 5-10 degrees centigrade.

Shelf Life: 6-weeks from preparation date.

Limit of detection: Less than 0.1 ug_m⁻³ over a 4-week exposure period. Specific values available upon request.

Analytical Expanded Measurement Uncertainty: available upon request.

Relevant Standards: BS EN 13528 Parts 1-3 : 2002/3

Special Factors: Ozone may reduce the recovery of H₂S. Some reducing agents such as SO₂ may inhibit colour development.



4.0 Methane & Carbon Dioxide

Spot measurements to be taken using 'grab/spot' samples with a CRE pump and Gresham sampling tube.

Carbon Dioxide concentration from grab sample to be determined by infra-red absorption, with a reporting limit of 0.01%.V/V.

Methane concentration from grab sample to be determined by GC-FID, with a reporting limit of 0.0005% V/V.

UKAS accredited analysis carried out at ESG Gas Analysis Laboratory, Bretby.



MSA Altair Instrument



Gresham Sampling Pump & Tube



'Lung box' and Tedlar Bag



Diffusion Tube Shelter

For clarity, the MSA Altair 4X detailed above is the chosen method of personal protection monitor (occupational Safety) and not for use in air quality monitoring. It provides for the monitoring of a range of gases that are common to wellsites, is portable and can be worn with very little discomfort. Any other type of monitoring is bulky, heavy and does not have the number of gas sensors provided.

5.0 BTEX & Volatile Organic Compounds (VOC's)

These tubes are designed for passive (time weighted average concentrations) and active monitoring of volatile and semi-volatile organic compounds in the range C₂ – C₂₈. The tubes can be used passively for time weighted average concentrations or pumped (active) for workplace monitoring and comparison to health and safety workplace exposure limits.

Description: Stainless steel tube filled with a solid polymer absorbent, two brass swagelock caps. An appropriate sorbent is selected to suit the application required – several tubes may be required to measure all compounds required.

For passive sampling an aluminium air diffuser is supplied which is fitted to the sampling end of the tube (groove end) during exposure.

Concentrations absorbed by the tube are measured by thermal desorption and analysis by GC/MS (UKAS Accredited Methods).

Suitable for carrying out spatial or localised assessments of volatile and semi-volatile organics in ambient air, soil, workplace, or industrial monitoring.

Tube Dimensions: 6.3mm OD x 5.0mm ID x 90mm length.

Recommended Exposure Periods:

Passive Sampling: 1 – 4 weeks.

Air Velocity: Tube fitted with filter therefore negligible influence.

Storage: Store in a dark, cool environment free from residual airborne VOC. After sampling, tubes can be wrapped in tin foil if required – do not use any other form of wrapping.

Shelf Life: 12 weeks from conditioning date (dependant on type of solid sorbent used).

Limit of Detection: Specific values available upon request.

Toluene is used as the non-specific standard for most identification & estimation analysis – general limits of detection are given as a guide below:

For passive samples results are reported in ppb.

Relevant Standards: ISO16017 : EN14662 : EN13528: MDHS 72 : MDHS 80: EPA T0-1

Packaging of Sorbents: Each type of sorbent is packed into the thermal desorption tube under strict quality control and under laboratory environment conditions. The weight of the sorbent packed is controlled to within ±5%.



Calculation of results:

ppb of analyte in air =

$$\frac{\text{mass (ng) on tub}}{(2^* \times \text{sampling time in minutes})}$$

2 = average uptake rate; specific values to be used for BTEX Compounds

µg.m⁻³ of analyte in air =

$$\frac{(\text{ppb} \times \text{Molecular Weight} \times 40)}{1000}$$

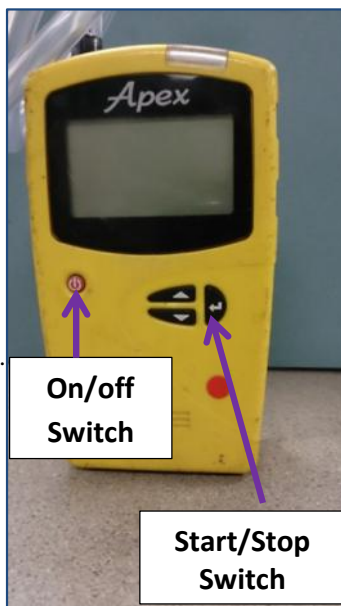
6.0 Sulphur Hexafluoride

Samples will be taken on equipment installation visits to site or planned periodic sample collection dates as appropriate.

The collection of samples to determine airborne concentrations of Sulphur Hexafluoride will be made using Casella APEX personal sampling pumps calibrated at a flow rate of approximately $100 \text{ ml}\cdot\text{min}^{-1}$, connected to Sulficarb packed Automated Thermal Desorption (ATD) tubes.

Pump flow measurements will be made pre and post sampling and the average flow rate calculated will be used to determine the sample volume used in subsequent calculations to determine the airborne concentration of SF_6 .

Sampling will be carried out on site over a four – six hour period. The samples will be returned to the laboratory and analysed (by an approved sub-contract laboratory) using the technique of Gas Chromatography – Mass Spectrometry (GC-MS).



7.0 Fugitive (Environmental) Dust

Background Levels of fugitive dust will be measured using passive Frisbee dust deposition gauges and adhesive strip directional gauges.

Samples will be taken on equipment installation visits to site or planned periodic sample collection dates as appropriate.

The samples will be analysed at the laboratory in accordance with ESG’s in house UKAS accredited procedures.

The results will be calculated as follows:

For Frisbee Gauges the result is reported as a deposition rate calculated in terms of milligrams of deposit per square metre per day ($\text{mg.m}^{-2}\text{d}^{-1}$), the calculation being:

$$\frac{\text{mass of deposit (mg)} \times \text{Gauge Factor}^*}{\text{Number of days sampled}}$$

* 25.15 for a Frisbee deposit gauge

For adhesive strip gauges, the results are expressed either as percentage effective area covered per day ($\% \text{ eac.day}^{-1}$), the calculation being:

$$\frac{100 - \text{reflectance value obtained}}{\text{number of days sample exposed}}$$

The result being reported to one decimal place if the result is ≤ 0.9 ; or rounded to the nearest whole number if the result is 1 or above.

The Frisbee gauge analysis results obtained will be charted to establish trends and compared against the limits tabulated below:

FUGITIVE DUST NUISANCE LIMITS		
REFERENCE HARRY VALLACK SEI (YORK UNIVERSITY)		
DRY FRISBEE (FOAM) GAUGE EQUIVALENT ($\text{mg.m}^{-2}\text{day}^{-1}$)		
	COMPLAINTS POSSIBLE	COMPLAINTS LIKELY
OPEN COUNTRY	100	140
RESIDENTIAL AREAS AND OUTSKIRTS OF TOWN	150	200
COMMERCIAL CENTRES OF TOWNS	200	260

Should any deposition results exceed a level of $100 \text{ mg.m}^{-2}\text{.day}^{-1}$ then the sample will be further examined using the technique of Scanning Electron Microscopy combined with Energy Dispersive X-Ray Analysis (SEM-EDS) to determine the composition of the collected deposits.

Should the results indicate exceedance for three consecutive periods from any individual monitoring station then the possible causes will be investigated and a short-term programme of PM_{10} monitoring will be taken to assist in confirming that background environmental dust levels on site conform to the documented national air quality standards and targets. Details of the sampling equipment to be used are detailed in Appendix I.

The results from the adhesive strip samples will be entered on to a spreadsheet to establish trends against the criteria listed below, and plotted as wind rose charts on a site plan to provide graphical detail of dust flux on site.

**ADHESIVE STRIPS - FROM BEAMAN & KINGSBURY
CLEAN AIR VOLUME 14 2**

%eac.day⁻¹	Typical Situation	Public Reponse
0.01	Rural	
0.02	Suburban/small towns	
0.2 0.3-0.4	Urban	Noticeable
0.5 0.7	Rural summer time	Possible complaint Objectionable
0.8-1	Industrial	
2		Probable complaints
5		Serious complaints

8.0 Duration and Frequency

Monitoring has been undertaken at the KMA wellsite to establish a baseline summary to allow Third Energy to benchmark and compare results taken during phases of operational activity. The baseline sampling rounds have been concluded and the results are available upon request from Third Energy.

During phases of operational activity as described within the environmental permit application monitoring will be undertaken to assess the impact Third Energy's operations will have on the environment. Four (4) monitoring stands shall be installed prior to the vehicle movements to site and the commencement of operations. Samples from each sampling round will be collected after two (2) weeks and replaced/refurbished for the commencement of the following sampling round.

The number of sampling rounds will be indefinite, until the completion of the well testing phase. Upon completion of the well testing phase a further two (2) final sampling rounds will be undertaken at the KMA wellsite, as vehicles will have been removed from the site and the site will revert back to a production site.

The frequency of sampling has been determined by ESG, based on its experience gathering the specified parameters, as being a minimum frequency of 2 weeks. Any lesser frequency is likely to lead to unreliable results, due to the nature of the monitoring equipment requiring sufficient time to collect each sample, through absorption. Sampling over a longer frequency, for example in excess of four (4) weeks, will result in it being difficult to determinations or pinpoint the actual events that have occurred and the conditions under which the event occurred. With this in mind, an ESG engineer will attend the KMA wellsite every two (2) weeks in order to collect the optimum number of samples over the period of operation.

Having already established a baseline in advance of the KM8 hydraulic fracturing operation, air quality monitoring will commence immediately prior to the commencement of pre-stimulation workover operation. Thereafter, air quality monitoring will continue through the KM8 hydraulic fracture stimulation/well test and subsequent production test and/or initial production. During the production test and/or initial production, should the air quality monitoring from a minimum of two (2) sampling rounds indicate that the emissions from the wellsite are consistent with the pre-operational air quality baseline condition, no further air quality monitoring will be undertaken. In the event that the sampling rounds taken during the first four (4) weeks of production are not representative of the baseline air quality samples, the period of air quality monitoring will be extended until such time as the monitoring samples are indicative of the baseline, or otherwise agreed with the Environment Agency.

APPENDIX I

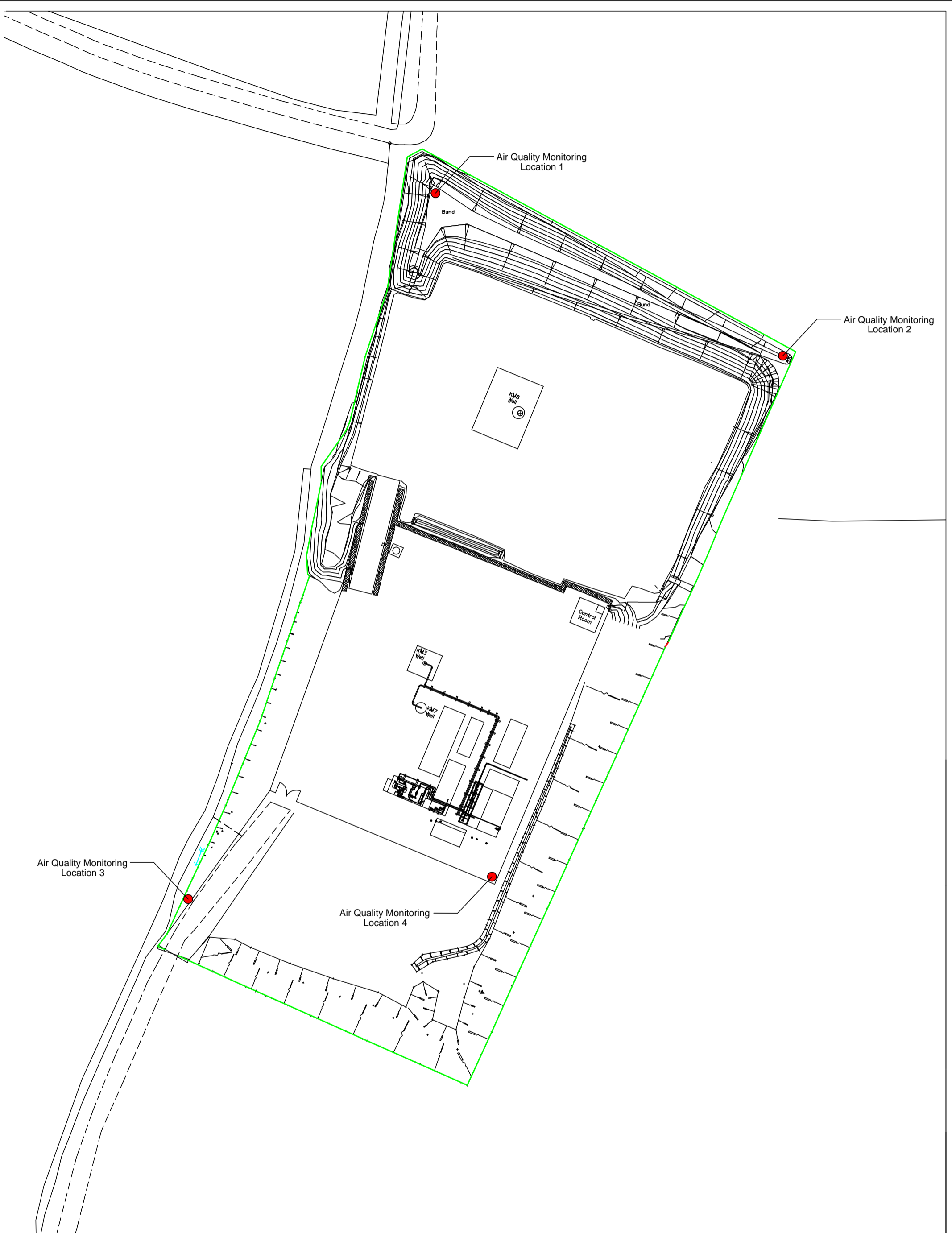
PM₁₀ Monitoring

- ESG Field Technician to attend site and install up to 4 SKC Leland Legacy sampling pumps (illustrated below) with PM₁₀ Impactor sampling heads containing pre-weighed 47mm Ø membrane filters operating at a flow rate of 10 l.min⁻¹.
- ESG Field Technician to return to site next day and collect samplers and 24 hour duration PM₁₀ samples
- Return pumps and samples to laboratory
- Gravimetric determinations to be carried out on collected samples and calculation of PM₁₀ concentrations
- Report results as factual tabulated data on an ESG UKAS Test Report (method reference ENV/MORD2), expressed in µg.m⁻³.



APPENDIX II

Air Quality Monitoring Location Plan



Key: Site Boundary Air Quality Monitoring Locations		 PSSL Petroleum Safety Services Limited	Client: Third Energy UK Gas Ltd	Drawn By: Jonathan Foster
			Project: KM8 Hydraulic Fracturing Operation	Date Drawn: 20/04/2015
		Petroleum Safety Services Limited 23a Milton Street Saltburn by the Sea TS12 1DJ	Drawing Title: Air Quality Monitoring Plan	Approved By: Jonathan Foster
			Scale: 1:750 (Print A3)	Date Approved: 20/04/2015
				Drawing No: PSSL/TE/KM8/HFS/AQMP/01
				Rev: 0