

Our Ref: Report 1362 V2 30.11.22

5th September, 22nd September and 5th October 2022

Gas Sampling at Land of Upper Hagg Farm, Holmfirth, HD9 6NJ

Ben Crowther (GeoEnginSeer Ltd) has been commissioned by RB Geotechnical Ltd to complete 3 rounds of gas sampling at the above site. This report summarises the data collected and gives an opinion on that data.

Context: The site has been identified as suitable for a detached residential property and redevelopment. The site has previously been a yard or green space possibly occupied with a small animal housing structure. The space is currently open land and a former farm buildings. The surrounding properties in the area are residential farmhouse properties of a various ages in nature.

The first visit was conducted on the 5th September 2022, following a period of along barometric fall to 1006mbar, A second visit on the 22nd of September at 12:00PM following a similar slow fall to 995mbar and finally a third visit on the 5th of October at 10:00AM capturing a worst case rapid fall to 984mbar. The majority of the summer had been high pressure and poor sampling conditions occurred for a long period of time.

These visits consisted of extended bulk ground gas sampling during a period of dropping barometric pressure at each bore hole for over <20 minutes. Depth checking of water levels and total depth of the boreholes was also conducted post sampling.

Reference Guidance: CIRIA 665, BS 8485:2015+A1:2019, NHBC Documentation

The NHBC, British Standards Institute and CIRIA produced guidance for calculating a Gas Screening Value dependent on house build type, flow of gas and gas percentages measured in the ground. This limited study did not conduct the recommended minimum 6 samples over a 3month or longer period as per BS10175:2011+A2:2017, but exceeded this requirement

with targeted sampling exclusively during occasions of falling barometric pressure as per the CL:AIRE Technical Bulletin Documentation TB16, 17 and 18. The aim of the GeoEnginSeer Ltd study is to achieve sampling at the time of the worst-case barometric pressure drop.

These situations attempt to capture the worst case given a limited visit program and to avoid expensive continuous monitoring. Further sampling would not be required to further characterise this site completely. GeoEnginSeer Ltd believes this site has been adequately and appropriately tested given worst case barometric pressures situations and appropriate extended gas samples at the borehole.

The development model assumption for this site is a new build conversion of a farm barn/former house to create a semi-detached residential element. This will include small individual rooms sealed for thermal integrity and efficiency and for amenity use.

Calculation of the worst case detected: Gas Screening Value:

Quantitative Risk Assessment Based on the documentation presented in BS8485:2015+A:2019, which is the 'Code of practice for the characterisation and remediation from soil-gas in affected developments' the hazardous gas flow rate (Qhg) was calculated using Equation 1:

$$Q_{hg} = (C_{hg}/100) * q \quad \text{Equation 1}$$

Where: C_{hg} is the measured hazardous gas concentration (in percentage volume-by-volume).
q is the flow rate in litres per hour of combined gases found by direct measurement.

The Q_{hg} for carbon dioxide was calculated using Equation 2.

$$\begin{aligned} Q_{hg} \text{ (l/hr)} &= \text{gas concentration} * \text{borehole flow rate (l/hr)} \quad \text{Equation 2} \\ &= 14.4/100 * 1.4 = 0.2002 \text{ (Gas Screening Value - GSV)} \end{aligned}$$

The maximum carbon dioxide concentration was used for the gas concentration and the maximum gas flow for the one borehole and monitoring events was taken for the borehole flow rate, thus simulating a worst-case scenario, and increasing the degree of conservatism adopted.

No maximum concentration of methane was recorded and so no calculation of this GSV is possible.

The maximum concentration of carbon dioxide during the monitoring period was 14.4% v/v. Oxygen levels were detected at a depleted level of 16.0% and a maximum flow rate of 1.4l/h was recorded. The total VOC screening values for any of the site samples was 0.4ppm, which is fractionally above limit of detection for any contaminants of concern. This flow level should be indicative of revealing a worst-case scenario for gas emanating from the ground.

Based on a Site Characteristic hazardous gas flow rate (Qhg) of 1.4 l/hr, based on BS8485:2015+A1:2019 Table 2, the site shall be classified as 'Characteristic Gas Situation 2' (CS2) or 'Amber1' for which no special precautions are required as given in the "Guidance on methane and carbon dioxide, NHBC 2007" Tables 11.1 and 11.2.

The Tiger PID device used to detect gasses was calibrated for a wide range of volatile organic hydrocarbons and only Low levels of VOC were detected. The PS500 also is rated for Benzene as an indicator for VOC and no spikes were detected during the sampling events.

Opinion: This limited gas sampling regime did pick up several minor ground gas results. These results occurred at the three of the worst-case barometric pressure dropping events during late summer of 2022.

It is the opinion of geoenineer that a Characteristic Situation 2 standard applies to this site and as such gas protection is required as per BS8485:2015+A1:2019.

Recommendations: Installation of a retrospectively fitted carbon dioxide barrier to meet the standards of CS2 or Amber1 when any construction is conducted. This should include as a minimum passive pressure relief or sub floor void venting with the capacity to achieve 3.5 points on the British Standard (BS8485:2019+A1:2019) scale for gas protection. A design for this shall be submitted by a suitably qualified person and the installation of the system shall be verified in accordance with the above BS and CIRIA guidance 735.

This Risk Assessment Letter achieves an assessment of all the ground gas potential risk at the site because of the installation of the monitoring pipes with a response zone detecting gasses at the near surface zone of influence; this survey is therefore, in the opinion of GeoEnginSeer Ltd sufficient to capture any and all gas present that may affect the proposed development.

Upon submission to the Local Authority, it appears updated calibration certificates were not added to the document. These have been added except for the Tiger PID, fortunately the PS500 is also rated for indicative benzene, a catch all for fuel break down products and this result of no issue still applies, in the opinion of GeoEnginSeer Ltd.

If you have any further questions regarding the above, please do not hesitate to contact me.

Yours sincerely



Ben Crowther B.Sc, M.Sc, PGCE, FGS, CIEH, PCA-QT, DoWCoP, SGPV
For and on behalf of GeoEnginSeer Ltd.

Commorragh, 1 Harrison Street, Cornholme, Todmorden, OL14 8LF
www.GeoEnginSeerLtd.com

Appendix A: Gas Sampling Records – Summary


Upper Hagg Farm 5.9.22	WS1	WS2	WS3
Carbon Dioxide %v/v	Peak 2.3 Continuous 2.3	Peak 14.3 Continuous 14.1	Peak 5.6 Continuous 5.2
Methane %v/v	Peak 0.0 Continuous 0.0	Peak 0.0 Continuous 0.0	Peak 0.0 Continuous 0.0
Oxygen %v/v	Low 17.6 Continuous 17.6	Low 17.6 Continuous 17.6	Low 17.6 Continuous 17.6
PID indicative VOC Count ppm	0.4	0.3	0.1
Flow (max) l/hr	1.3	1.4	0.7
Depth of WS mbgl	NA	NA	NA
Depth to Water mbgl	NA	NA	NA
Pressure mb	1006	1006	1006
Comments	Long Steady Drop	Long Steady Drop	Long Steady Drop

Upper Hagg Farm 22.9.22	WS1	WS2	WS3
Carbon Dioxide %v/v	Peak 4.8 Continuous 4.8	Peak 12.7 Continuous 12.7	Peak 0.1 Continuous 0.1
Methane %v/v	Peak 0.0 Continuous 0.0	Peak 0.0 Continuous 0.0	Peak 0.0 Continuous 0.0
Oxygen %v/v	Low 16.0 Continuous 16.0	Low 10.4 Continuous 10.4	Low 19.5 Continuous 19.5
PID indicative VOC Count ppm	0.3	0.2	0.3
Flow (max) l/hr	0.4	0.2	0.8
Depth of WS mbgl	NA	NA	NA
Depth to Water mbgl	NA	NA	NA
Pressure mb	996	996	996
Comments	Long Steady Drop	Long Steady Drop	Long Steady Drop

Upper Hagg Farm 5.10.22	WS1	WS2	WS3
Carbon Dioxide %v/v	Peak 5.0 Continuous 5.0	Peak 11.4 Continuous 11.4	Peak 1.7 Continuous 1.7
Methane %v/v	Peak 0.0 Continuous 0.0	Peak 0.0 Continuous 0.0	Peak 0.0 Continuous 0.0
Oxygen %v/v	Low 12.9 Continuous 12.9	Low 0.7 Continuous 0.7	Low 18.2 Continuous 18.2
PID indicative VOC Count ppm	0.4	0.2	0.3
Flow (max) l/hr	1.4	1.2	0.9
Depth of WS mbgl	NA	NA	NA
Depth to Water mbgl	NA	NA	NA
Pressure mb	985	985	985
Comments	Rapid Drop	Rapid Drop	Rapid Drop

Appendix B Gas Analyser test certificates:


GFM 436

TEST DATE AND CONDITIONS		GAS DATA LTD				
Date	24/08/2022	Unit 4, Fairfield Court	 Seven Stars Estate Wheeler Rd Coventry CV3 4LJ Tel 02476303311 Fax 02476307711			
Atmospheric Pressure	996 mB					
Ambient Temperature	20.7 °C					
Enviroincs Serial No.	5089					
GFM436 Final Inspection & Calibration Check Certificate						
Customer	Shaw City	<table border="1"> <tr> <td>Recalibration DUE Date</td> <td>24/08/23</td> </tr> </table>		Recalibration DUE Date	24/08/23	
Recalibration DUE Date	24/08/23					
Certificate Number	123430					
Order Number	331832					
Serial Number	13255					
Software Version	G436-00.0027/0010					
Instrument Checks						
Keyboard	✓	Display Contrast	✓			
Pump Flow In	500 <small>Accept > 200 cc/min</small>	Pump Flow @ -200mB	300 <small>Accept > 200 cc/min</small>			
Clock Set / Running	✓	Labels Fitted	✓			
Gas Checks						
Sensor	CH ₄		CO ₂		O ₂	
	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %	Instrument Gas Readings %	True Gas Value %
	59.6 <small>Accept ±0.0</small>	60	39.6 <small>Accept ±0.0</small>	40	20.9 <small>Accept ±0.5</small>	20.9
	5.0 <small>Accept ±0.3</small>	5	4.9 <small>Accept ±0.3</small>	5	6.0 <small>Accept ±0.3</small>	6
Zero Reading (100% N ₂)	0.0 <small>Accept ±0.0</small>	0	0.0 <small>Accept ±0.0</small>	0	0.0 <small>Accept ±0.1</small>	0
Optional Gas Checks						
Applied Gas & Range	Concentration Tested (ppm)	Instrument Readings (ppm)				
Gas Type	Range (ppm)	Zero Reading	Instrument Gas Reading			
H2S	5000	1500	0	1500	0	
CO	2000	1000	0	997	0	
Hexane	2.0%	2.0%	0	1.99	0	

Cross Gas Effects						
Applied Gas (ppm)	Instrument Readings (ppm)					
Gas Type	Concentration	Toxic 1:	H2S	Toxic 2:	CO	Toxic 3:
H2S	1500	1500	0	0	0	0
CO	1000	110	997	0	0	0
Hexane	2.0%	0	0	0	1.99	0
Pressure Checks						
Atmospheric Pressure [AP] (mB)						
Current Atmospheric Pressure (mB)			Instrument Atmospheric Pressure Reading (mB)			
AP Open Ports			996 <small>Accept ±2.0</small>			
AP Port (Internal)			800 <small>Accept ±5.0</small>			
			1200 <small>Accept ±5.0</small>			
Flow Checks						
Borehole Flow			Differential Pressure			
Applied Reading (l/h)	Instrument Reading (l/h)	Applied Pressure (Pa)	Instrument Reading (Pa)			
-30	-29.8	-426	-424	-19	-19	0
-3	-3.0	0	0	0	0	0
3	3.0	16	17	17	17	17
30	30.0	340	340	340	340	340
60	59.7	1023	1017	1017	1017	1017
90	90.1	2007	2007	2007	2007	2007
Temperature Checks						
Calibration Temperature			Instrument Temperature Reading (°C)			
Applied Temperature (°C)			-10.0 <small>Accept ±2.0</small>			
0			0.0 <small>Accept ±1.0</small>			
30			30.0 <small>Accept ±1.0</small>			
60			60.0 <small>Accept ±1.0</small>			
100			100.0 <small>Accept ±1.0</small>			
Technician:		Date Tested:				
Jack Rutland		24/08/2022				

The instrument identified by the serial number stated above has been tested by Gas Data personnel for calibration accuracy on the date and under the ambient conditions stated. Gas Data Ltd internal BS EN ISO9001:2015, BS EN ISO14001:2015, BS EN ISO45001:2018 compliant workshop procedures were followed to apply known calibration test gases, gas flow rates, pressures and temperatures of the values stated. The results displayed on the instrument at each stage are recorded above.

Gas Data Ltd is certified to BS EN ISO9001:2015, BS EN ISO14001:2015, BS EN ISO45001:2018.

TEST DATE AND CONDITIONS		GAS DATA LTD	
Date	24.08.22	Unit 4, Fairfield Court	 Seven Stars Estate Coventry CV3 4LJ UK +44 (0)24 7630 3311
Atmospheric Pressure	996 mB		
Ambient Temperature	20.7 °C		
Enviroincs Serial No.	5089		
GFM436-1 OUTWARD INSPECTION & QUALITY CHECK SHEET			
INSTRUMENT DETAILS			
SO Number	Instrument Type	Instrument Serial Number + SW Version	Job Number(s)
331832	GFM436	13255 CV3 4LJ UK	123430
Calibration Technician	Date	24.08.22
Inspection Technician	Date	24.08.22

Function Tests	INSTRUMENT CHECKS	Pass (P), Fail (F) or not applicable (N/A)	INSTRUMENT PACKING LIST	Tick if included
Dust Caps Fitted		✓	Instrument	✓
Keyboard Test (All Keys)		✓	Leather Case	✓
Backlight		✓	Instrument Strap	✓
Clock Set / Running		✓	AC Battery Charger (UK)	✓
Comms Test		✓	AC Battery Charger (EURO)	✓
Pump Flow Test (In & Out)		✓	AC Battery Charger (US)	✓
Overall Leak Test (30mB)		✓	AC Battery Charger (AUS)	✓
Battery Charge Test		✓	Gas Sample Pipe - new issue	✓
Service Date set to?		24.8.22	Flow Sample Pipe - new issue	✓
Channel Tests			Hard Carry Case	✓
Data Logging Enabled?		✓	Spare Part	✓
Verify CH4,LEL,Hexane/PID		✓	Allen Key	✓
Verify CO2		✓	Temperature Probe	✓
Verify H2S		✓	Vane Anemometer	✓
Verify CO		✓	USB Cable	✓
Verify LEL		✓	USB Memory stick	✓
Verify 1st Option Gas		✓	SM VS Software	Ver 6.0 ✓
Verify Atmospheric pressure		✓	Internal Filter Pack	Qty ✓
Verify differential pressure		✓	External Filter Pack	Qty ✓
Verify flow		✓	Field Guide	✓
Verify temperature probe input		✓	Extra Items:	
Verify vane anemometer input		✓		
Database Checks				
Jobcard(s) completed and signed		✓		
Jobcard(s) backed off database		✓		
Calibration certificate completed		✓		
Complete & print QI record		✓		
Label Checks				
No. of Calibration label fitted		GDC 1, 1, 1, 1, 1		
MCEP'S label displayed		✓		
Warranty label fitted		✓		
H2S Range				
H2S Range from Sales Order		5000 ppm		
H2S Range from Cal Cert		5000 ppm		
Over-range value correct?		✓		

GMI PS500

GMI **TELEDYNE GAS MEASUREMENT INSTRUMENTS LTD**
Service Centre: 25 Cochran Close, Crownhill, Milton Keynes, MK8 0AJ
Telephone: 01908 568867
Email: gmi_service@teledyne.com

Calibration Certificate

Certificate # MK308221
Cust. Order # 36061
Serial # 254111
Asset Ref. N/A
Model PS500 DRY PUMP DATA LEL O2 CO2 BNZ (61168A)
Calibrated by Clive Wilden
Calibrated on 06 October 2022

The above instrument has been repaired in accordance with our ISO 9001 approved procedures and conforms to the quality and manufacturing standards laid down in our procedures.

The instrument has been calibrated for the gases shown using gas which is prepared in accordance with ISO 6145 and has the preparation and analysis traceable to national standards.

Calibration Results

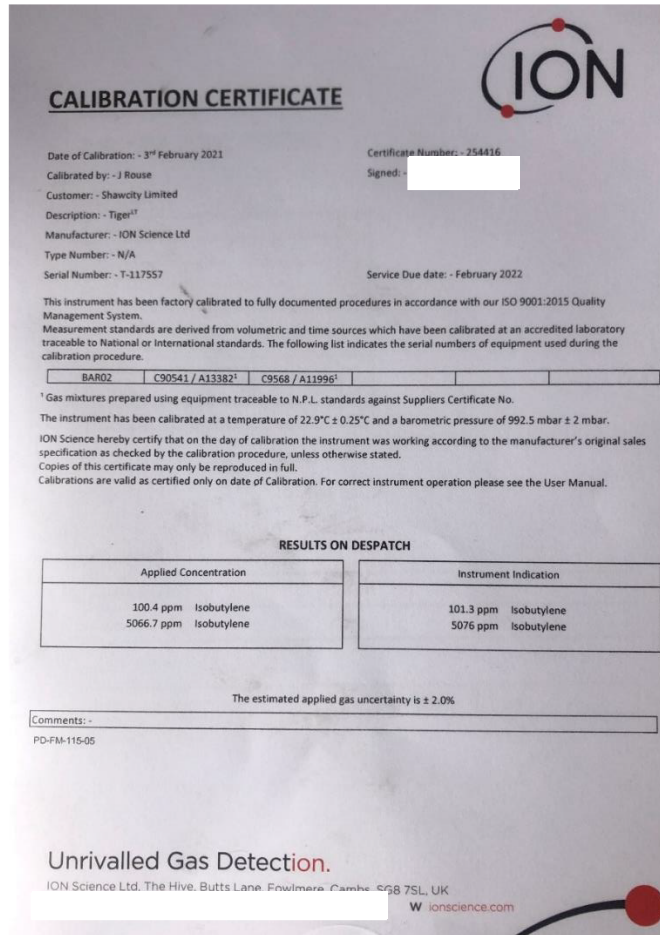
Range	Calibration Mixture	Cylinder #	Analysis #	Cal. Reading
Methane 0 - 100% LEL	2.45% Methane In Air	530365	390126	49%
Oxygen 0 - 25% Vol	20.9% Oxygen	530365	390126	20.9%
Carbon Dioxide 0 - 5% Vol	3% CO2 in Nitrogen	468855	PR 202890	3.00%
Benzene 0-30 ppm	25ppm Isobutene in air	261214	PR 299202	12.5ppm

Further information about this calibration
BENZENE RANGE WAS CALIBRATED WITH 25ppm ISOBUTENE AND A CONVERSION FACTOR OF 0.5

The above instrument has been calibrated with the above mixtures which are prepared and analysed to 2% of the major component value and the results are within the calibration tolerance with a confidence level of 95%

Signed _____ Date 6/10/22

Ion Science Tiger PID – Now being sent for calibration. Benzene calibration on above device is in date.



Location of bore holes on farm:



GFM recordings

