

016/3253/LIZ/at

31st July 2019

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Dear Lucy

Green Acres Close, Emley – Gas risk assessment

Further to issue of our Geoenvironmental Appraisal Report (No. 3253/2, dated April 2019), gas monitoring at the above site has now been completed and we are able to issue this supplementary letter report, together with copies of the monitoring results. This letter, which should be read in conjunction with Report No 3253/2, reviews soil-gas conditions, assesses risks and details any mitigation measures required to render the site suitable for the proposed development.

Background

The site is located approximately 8.5 km south of Dewsbury town centre at NGR SE 243 128. The site comprises a single parcel of land of approximately 1.2 hectares (3.0 acres).

In relation to hazardous gas, the above-mentioned report found:

- The site is located in an area considered susceptible to radon emissions
- Former underground coal workings may underlie the site
- Backfilled sandstone quarries are located within 250m of the site. Nature of backfill material is unknown.

Based on the above, it was considered that the site might be at risk from hazardous gas and therefore monitoring wells were installed in 6 boreholes. Details of the individual installations are provided in Report No 3253/1.

The proposed residential development comprises 44 detached, semi-detached and terrace homes, with associated gardens, POS and adoptable roads and sewers as shown on Drawing 3253/2 in Report No 3253/1. The houses will likely be founded on traditional strip / trench fill.

Scope of works

The generation potential of the gas source was initially considered to be Very Low and this has been confirmed by the monitoring results obtained. Consequently, in accordance with CIRIA Report C665, given the proposed residential end use, 6 visits have been completed over a 3 month period, between April and July 2019.



A standard procedure was followed in accordance with CIRIA guidance; this procedure involved measurement, in the following order of:

- Atmospheric temperature, pressure and ambient oxygen concentration on site immediately prior to and on completion of monitoring
- Methane, oxygen and carbon dioxide concentrations and flow rates using a Gas Data GFM430 infra-red gas analyser
- Standing water level using a dipmeter

Gas monitoring results

The monitoring results are enclosed and summarised below:

Monitoring well	Response zone	Range of methane concentrations (% v/v)	Range of carbon dioxide concentrations (% v/v)	Range of steady flow rates (litre/hour)
PH01	2.5 – 6.0m (Coal Measures)	N.D	1.5 – 2.2	N.D – 8.0
PH02	2.5 – 6.0m (Coal Measures)		0.5 – 1.3	N.D
PH03	1.0 – 4.0m (Coal Measures)		0.0 – 0.9	N.D
PH04	2.5 – 6.0m (Coal Measures)		0.7 – 1.7	N.D
PH05	1.0 – 4.0m (Coal Measures)		0.7 – 1.8	N.D
PH06	1.0 – 4.0m (Coal Measures)		0.4 – 1.2	N.D

Note: Atmospheric pressures varied between 1006mb and 1017mb.

In accordance with the DETR approach, a value of 8.0 litres/hour has been used to calculate gas screening values; i.e. the maximum sustained flow detected during monitoring.

During 1 of the 6 monitoring visits, atmospheric pressure was falling. Plots of atmospheric pressure versus time, with the monitoring visits indicated, are appended to this letter report.

Current guidance

Generic Notes (01 Site Characterisation) outlining how monitoring results are interpreted are enclosed.

Current gas regime

The proposed residential development comprises low rise residential housing. Consequently, the gas regime has been characterised in accordance with the Situation B (traffic light) methodology outlined in CIRIA Report C665.

Based on worst-case (peak) gas concentrations and steady flows, Gas Screening Value (GSV) for carbon dioxide is 0.18 (no methane was detected). This GSV equates to a Green gas regime (traffic light) for this site.

No concentrations of carbon dioxide have been recorded in excess of the Amber 1 lower threshold (5%).

Where Green, Lithos also consider the site in accordance with Situation A methodology (which does not assume a ventilated sub-floor) to check whether or not it lies within Characteristic Situation 1 (in

which case no measures would be appropriate), or Characteristic Situation 2 (in which case a ventilated sub-floor void and membrane should be required). The carbon dioxide GSV of 0.18 classes as Characteristic Situation 2.

Characteristic situation 2 is a consequence of the sustained gas flows recorded in PH01 during monitoring visit 5 & 6. Elevated flow, where there is no clear gas source, is typically associated with changes in atmospheric pressure. As atmospheric pressure drops ground pressures rises, leading to a positive flow rate. Review of the atmospheric graphs indicates this is almost certainly the case during visit 6, although pressure was increasing during visit 5.

During both visit 5 & 6 depleted oxygen concentrations (less than 10%) were also recorded. There is little research on the implications of depleted oxygen in soils. However, it is most commonly associated with bacterial activity.

The Public Health England UK radon map indicate that the site is in an area where more than 3% of homes are estimated to be above the action level, and basic radon protection measures are required in new dwellings. Basic radon broadly equates to Green/CS2 measures.

Scope of protection measures

Based on the site characterisation (Traffic Light) discussed above, the proposed foundation solution, and with reference to the gas protection "scoring" system outlined in BS8485:2015+A1:2019, Lithos consider that the following protective measures should be incorporated in all new dwellings:

Traffic light classification and "score" req'd by BS8485#	Floor slab (BS8485 "score")	Protective measures	
		Sub-floor ventilation (BS8485 "score")	Membrane
			Type (BS8485 "score")
Green & CS2 (Wilson & Card) 2.5*	Select one from: i. Block & Beam – (0). ii. Reinforced ground bearing slab – (0.5). iii. Reinforced cast in-situ suspended slab (with minimal and suitably sealed service penetrations & joints) – (1.5). iv. Reinforced ground bearing raft (with limited service penetrations cast into slab). Note: the venting area through any downstand beam should be 3 times greater than that provided by the side ventilation (air bricks) – (1.5).	Select one from: Passive sub-floor ventilation venting layer could be: i. A min. 150mm clear void (2.5) or ii. A proprietary void former providing an equivalent clear void depth of 60mm see Section B7 in BS8485 (2.5) or iii. Min. 300mm thick blanket of min. 20mm single size gravel (1.0). Min. ventilation = 1 500 mm²/m run of external wall (via air bricks on each of 2 opposite sides) with 100mm pipes at 1.75m centres or honeycombing of any sub-floor sleeper walls.	Waterproof DPM (2000 gauge polyethylene). Lapped & sealed in accordance with BR 414. (0)

Footnotes:

- # Scores are broadly based on those outlined in BS8485:2015+A1:2019 (for Characteristic Situations 2 & 3 and Building Type A).
 - * Modified from BS8485:2015+A1:2019 by Lithos. Monitoring data has also been reviewed using Wilson & Card methodology and found to be Characteristic Situation 2 consequently a lapped/sealed membrane & ventilation are recommended.
- A combination of two or more of the three types of protection measures (slab ventilation & membrane) should be used to achieve the BS8485 score.
 - The membrane should always be lapped and sealed in accordance with BRE/Environment Agency Report BR 414 (2001) – "Protective Measures for housing on gas-contaminated land". The membrane should be **continuous** across internal walls & the cavity and there should be a **cavity tray** in external walls.
 - In all cases there should be minimum penetration of floor slab by **services** any penetrations should be suitably sealed.
 - Integral **garages** with occupied rooms above or direct access through a doorway from the garage to the house should be provided with the same protective measures as the rest of the dwelling. Buildings with basement car parks (with ventilation in accordance with Building Regulations) may not require gas resistant membranes.

BRE\Environment Agency Report BR 414 (2001) – "*Protective Measures for housing on gas-contaminated land*" provides a practical guide to good practice for the detailing and construction of passive soil gas protection measures for new residential development. Of particular relevance are a list of 'Watchpoints', which offer practical information for installation and buildability.

BRE211:2015 highlights the importance of good practice and workmanship to ensure radon membranes are installed to a high standard and suggests regular supervision and inspection. Whilst there are no specific statutory requirements to inspect radon barriers, BRE and Lithos strongly recommend a programme of inspections.

It is not deemed necessary to inspect each barrier before it is covered but Lithos would suggest the first plot is inspected and 1 in 20 plots thereafter.

We trust the above is sufficient for your present needs, but should you have any queries please contact the undersigned.

Associate Director
for and on behalf of
LITHOS CONSULTING LIMITED

Enclosures:

Drawing 3253/6 – Borehole Location Plan
Gas Monitoring Results
Plot of Atmospheric vs Time
Borehole Logs

APPENDIX A

General notes

Current guidance

CIRIA Report 151 (1995)ⁱ identified that there was inadequate guidance on trigger concentrations for ground gases. CIRIA concluded that the most important aspect of a gas regime below or adjacent to a site was the surface emission rate, i.e. how quickly the gas is coming out of the ground. The lower the surface emission rate the lower the risk. CIRIA Report C665 (2006)ⁱⁱ advocates two methodologies (both refer to Gas Screening Values - GSV) for characterising sites:

A – All developments except low rise housing. The advocated methodology is that proposed by Wilson & Card, 1999ⁱⁱⁱ.

B – Low rise housing. An alternative (traffic light) methodology, derived by Boyle and Witherington, 2006^{iv} for NHBC

A – All developments except low rise housing. (Wilson & Card, 1999)^v revised Table 28 of CIRIA 149^v in terms of borehole gas volume flow rate (now GSV) in order to achieve a more consistent design of protection measures. This was done to reflect the importance of recognising the gas surface emission rate. Wilson & Card then developed a method for classifying gassing sites (Table 1 below), which took into account the combined gas concentration and GSV.

Table 1 – Site classification (Wilson & Card)

Characteristic Situation (W&C, 1999)	Gas Screening Value, CH ₄ or CO ₂ (l/hr)	Additional limiting factors	Typical source of generation
1	<0.07	Methane not to exceed 1% v/v and carbon dioxide not to exceed 5% v/v	Natural soils with low organic content
2	<0.7	Borehole air flow rate not to exceed 70 litre/hr otherwise increase to Characteristic Situation 3	Natural soil high peat/organic content
3	<3.5		Old landfill inert waste mineworking flooded.
4	<15	Quantitative Risk Assessment required to evaluate scope of protection measures.	Mineworking – susceptible to flooding completed landfill inert waste (WMP 26B criteria)
5	<70		Mineworking unflooded inactive
6	>70		Recent landfill site

Notes:

Borehole flow rate = volume of gas (regardless of composition) which is escaping from well (l/hr).

Gas Screening Value (litre/hour) = gas concentration (%) / 100 x borehole flow rate (l/hr).

To facilitate design implementation the limiting values for both methane and carbon dioxide are identical.

B – Low rise housing. NHBC have developed a characterisation system similar to that of Wilson & Card above, but specific to low-rise housing development (Boyle and Witherington) (Table 8.7). This approach compares measured gas emission rates with generic “Traffic Lights”. The Traffic Lights include “Typical Maximum Concentrations” for initial screening, and risk-based Gas Screening Values (GSVs) for consideration of situations where the Typical Maximum Concentrations are exceeded. Calculations are carried out for both methane and carbon dioxide and the worst case adopted in order to establish the appropriate protection measures.

Table 8.7 NHBC Traffic light system for 150 mm void

Traffic light	Methane ¹		Carbon dioxide ¹	
	Typical maximum concentration ⁵ (% v/v)	Gas screening value (GSV) ^{2,4,6} (litres per hour)	Typical maximum concentration ⁵ (% v/v)	Gas screening value (GSV) ^{2,3,4,5} (litres per hour)
Green	1	0.16	5	0.78
Amber 1			10	1.56
Amber 2			30	3.13
Red	20	1.56		

Generic notes – gas risk assessments

Notes:

1. The **worst gas-regime** identified at the site, either methane or carbon dioxide, recorded from monitoring in the worst temporal conditions, will be the decider for which Traffic Light and GSV is allocated.
2. Generic GSVs are based on guidance contained within "The Building Regulations: Approved Document C" (2004) and assume a sub-floor void of 150 mm thickness.
3. The small room is considered to be a downstairs toilet, with dimensions of 1.50 × 1.50 × 2.50 m, with a soil pipe passing into the sub-floor void.
4. The GSV, in litres per hour, is as defined in Wilson and Card (1999) as the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered.
5. The Typical Maximum Concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgment will be required, based on a thorough understanding of the gas regime identified at the site where monitoring in the worst temporal conditions has occurred.
6. The GSV thresholds should not generally be exceeded without completion of a detailed gas risk assessment taking into account site-specific conditions.

i Harries CR, Witherington PJ and McEntee JM (1995). *Interpreting measurements of gas in the ground*. CIRIA Report 151
ii CIRIA (2006) – *Assessing risks posed by hazardous ground gases to buildings*.
iii Wilson SA and Card GB (February 1999). *Reliability and Risk in Gas Protection Design*. Ground Engineering.
iv Boyle & Witherington (2006) – *Guidance on evaluation on development proposals on sites where methane and carbon dioxide are present, incorporating "traffic lights"*. Report Ref. 10627-R01-(02), for NHBC
v Wilson SA and Card GB (February 1999). *Reliability and Risk in Gas Protection Design*. Ground Engineering.

APPENDIX B

Drawings



NOTES

- TRIAL PIT LOCATION
- SOAKAWAY PIT LOCATION
- PROBEHOLE LOCATION
- APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE
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CLIENT

HIGHSTONE HOUSING ASSOCIATION LTD

JOB TITLE

GREEN ACRES CLOSE, EMLEY

DRAWING TITLE

EXPLORATORY HOLE LOCATIONS

DRAWN	JBR	DATE	03/04/2019	STATUS	FOR COMMENT	☐
CHECKED	MJT	DATE	03/04/2019	FOR APPROVAL	DRAFT	☐
				FINAL		☒

SCALE	1:750	SHEET	A3	DRAWING NO.	3253/6	REVISION	
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APPENDIX C

Gas monitoring results

Job Title:							Job No:								
Green Acres Close, Emley							3253								
Client:							Sheet :								
Highstone Housing Association Ltd							1 of 1								
Date:		Arrival Time:		Depart Time:		Operator:									
30/04/2019		13:30		14:50		A Taylor									
Gas Monitoring Results:															
Ambient Concentration (% Volume):				CH ₄ :		0.0		CO ₂ :		0.0		O ₂ :		19.9	
Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks				
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady						
		CH ₄	CO ₂	CH ₄	CO ₂	O ₂									
		(m) bgl	% v/v	(%)	% v/v	(%)						(%)	litre/hr	litre/hr	secs
PH01	5.45	ND	2.2	ND	2.2	10.2	ND	ND	ND	5.75	Bailed to 5.62m at 14:39 - heavily silted water				
PH02	3.90	ND	0.5	ND	0.5	19.5	ND	ND	ND	5.72	Bailed to 5.59m at 14:22 - heavily silted water				
PH03	3.31	ND	0.1	ND	0.1	20.0	ND	ND	ND	4.07	Bailed to 4.01m at 14:33 - heavily silted water.				
PH04	5.07	ND	0.7	ND	0.7	19.3	ND	ND	ND	5.77	Bailed to 5.62m at 14:14 - heavily silted water.				
PH05	3.23	ND	0.7	ND	0.7	19.6	ND	ND	ND	3.97	Bailed to 3.78m at 14:27 - heavily silted water.				
PH06	3.83	ND	0.4	ND	0.4	19.9	ND	ND	ND	3.95	Bailing ineffective,				
Notes															
Equipment Used:						Next Calibration Date			Key						
Gas Data GFM436 Infrared Gas Analyser						12/02/2020			ND None Detected						
Geotechnical Instruments Dipmeter									NR Not Recorded						
									1.0 Recorded value does not breach trigger levels						
									5.0 Recorded value breaches trigger level 1						
									10.0 Recorded value breaches trigger level 2						
		Site Data:		Weather Station Data (Emley Village Weather Station)											
		Temp (°C):	6	Barometric Pressure Trend:			Steady								
Time:	13:30	14:10	14:50	00:45	05:30	13:30	14:15	14:45	19:00	Trigger level 1	1.0	5.0	16.0		
Pressure (mb):	1000	1000	1000	1014	1014	1013	1014	1014	1014	Trigger level 2	5.0	10.0	10.0		
		Weather Conditions:		Sunny (hazy).											
		Surface Ground Conditions:		Dry.											
Remarks:	All wells were bailed to try reduce the water level. All arising water was heavily silted and believed to be remnant drilling water. Groundwater levels on the second visit will show any recharge if true groundwater.														

Visit 2

Job Title:							Job No:							
Green Acres Close, Emley							3253							
Client:							Sheet :							
Highstone Housing Association Ltd							1 of 1							
Date:		Arrival Time:		Depart Time:		Operator:								
16/05/2019		15:20		15:58		A Taylor								
Gas Monitoring Results:														
Ambient Concentration (% Volume):			CH ₄ :		0.0		CO ₂ :		0.0		O ₂ :		20.4	
Monitoring Point	Groundwater level	Concentrations						Gas Flow Rates			Bottom of well	Remarks		
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady					
		CH ₄	CO ₂	CH ₄	CO ₂	O ₂								
		(m) bgl	% v/v	(%)	% v/v	(%)				(%)			litre/hr	litre/hr
PH01	ND	ND	1.5	ND	1.5	17.5	ND	ND	ND	5.81				
PH02	3.78	ND	0.8	ND	0.8	18.7	ND	ND	ND	5.78				
PH03	3.39	ND	ND	ND	ND	20.3	ND	ND	ND	4.07				
PH04	4.88	ND	1.2	ND	1.2	17.9	ND	ND	ND	5.77				
PH05	3.32	ND	1.1	ND	1.1	18.7	ND	ND	ND	4.02				
PH06	3.74	ND	0.7	ND	0.7	19.7	ND	ND	ND	3.92				
Notes														
Equipment Used:						Next Calibration Date			Key					
Gas Data GFM436 Infrared Gas Analyser						12/02/2020			ND None Detected					
Geotechnical Instruments Dipmeter									NR Not Recorded					
									1.0 Recorded value does not breach trigger levels					
									5.0 Recorded value breaches trigger level 1					
									10.0 Recorded value breaches trigger level 2					
		Site Data:		Weather Station Data (Emley Village Weather Station)										
		Temp (°C):		14 to 16.		Barometric Pressure Trend:				Falling.				
Time:	15:20	15:45	15:58	00:00	08:00	15:15	15:45	16:00	20:00	Trigger level 1	1.0	5.0	16.0	
Pressure (mb):	995	994	995	1023	1022	1018	1018	00:00	1017	Trigger level 2	5.0	10.0	10.0	
		Weather Conditions:		Sunny with intermittent cloud.										
		Surface Ground Conditions:		Dry.										
Remarks:														

Visit 3

Job Title:							Job No:						
Green Acres Close, Emley							3253						
Client:							Sheet :						
Highstone Housing Association Ltd							1 of 1						
Date:		Arrival Time:		Depart Time:		Operator:							
31/05/2019		A15:10		15:45		A Taylor							
Gas Monitoring Results:													
Ambient Concentration (% Volume):				CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :	20.3				
Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks		
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady				
		CH ₄	CO ₂	CH ₄	CO ₂	O ₂	litre/hr	litre/hr	secs				
		(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr			secs	
PH01	5.66	ND	1.8	ND	1.8	16.3	ND	ND	ND	5.77			
PH02	4.16	ND	1.0	ND	1.0	18.7	ND	ND	ND	5.82			
PH03	3.44	ND	0.9	ND	0.9	19.9	ND	ND	ND	4.07			
PH04	5.11	ND	0.7	ND	0.7	19.7	ND	ND	ND	5.79			
PH05	3.39	ND	0.7	ND	0.7	19.9	ND	ND	ND	4.02			
PH06	3.77	ND	0.5	ND	0.5	20.0	ND	ND	ND	3.99			
Notes													
Equipment Used:						Next Calibration Date			Key				
Gas Data GFM436 Infrared Gas Analyser						12/02/2020			ND None Detected				
Geotechnical Instruments Dipmeter									NR Not Recorded				
									1.0 Recorded value does not breach trigger levels				
									5.0 Recorded value breaches trigger level 1				
									10.0 Recorded value breaches trigger level 2				
		Site Data:		Weather Station Data (Emley Village Weather Station)									
		Temp (°C):		Barometric Pressure Trend:									
		17 to 18.		Steady									
Time:	15:10	15:36	15:45	00:00	06:00	15:15	15:30	15:45	18:00	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	997	996	995	1018.3	1018.3	1018.3	1018.3	1018.3	1016.3	Trigger level 2	5.0	10.0	10.0
		Weather Conditions:		Overcast.									
		Surface Ground Conditions:		Dry.									
Remarks:													

Visit 4

Job Title:							Job No:																				
Green Acres Close, Emley							3253																				
Client:							Sheet :																				
Highstone Housing Association Ltd							1 of 1																				
Date:		Arrival Time:		Depart Time:		Operator:																					
10/06/2019		15:25		15:50		A Taylor																					
Gas Monitoring Results:																											
Ambient Concentration (% Volume):			CH ₄ :		0.0		CO ₂ :		0.0		O ₂ :		20.1														
Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks																
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady																		
		CH ₄	CO ₂	CH ₄	CO ₂	O ₂																					
		(m) bgl	% v/v	(%)	% v/v	(%)						(%)	litre/hr	litre/hr	secs	m											
PH01	5.70	ND	1.8	ND	1.8	16.1	ND	ND	ND	5.74																	
PH02	3.83	ND	1.2	ND	1.2	18.3	ND	ND	ND	5.78																	
PH03	3.45	ND	0.3	ND	0.3	19.9	ND	ND	ND	4.10																	
PH04	4.55	ND	1.4	ND	1.4	17.3	ND	ND	ND	5.78																	
PH05	3.37	ND	1.1	ND	1.1	18.9	ND	ND	ND	3.98																	
PH06	3.77	ND	0.9	ND	0.9	19.1	ND	ND	ND	3.98																	
Notes																											
Equipment Used:						Next Calibration Date			Key																		
Gas Data GFM436 Infrared Gas Analyser						12/02/2020			ND None Detected																		
Geotechnical Instruments Dipmeter									NR Not Recorded																		
									1.0 Recorded value does not breach trigger levels																		
									5.0 Recorded value breaches trigger level 1																		
									10.0 Recorded value breaches trigger level 2																		
		Site Data:		Weather Station Data (Emley Village Weather Station)																							
		Temp (°C):		10 to 11.		Barometric Pressure Trend: Steady.																					
Time:		15:25		15:40		15:50		00:00		06:00		15:00		15:30		15:45		20:00		Trigger level 1		1.0		5.0		16.0	
Pressure (mb):		994		994		994		1017.6		1016		1016		1016		1016		1016		Trigger level 2		5.0		10.0		10.0	
		Weather Conditions:		Raining.																							
		Surface Ground Conditions:		Wet.																							
Remarks:																											

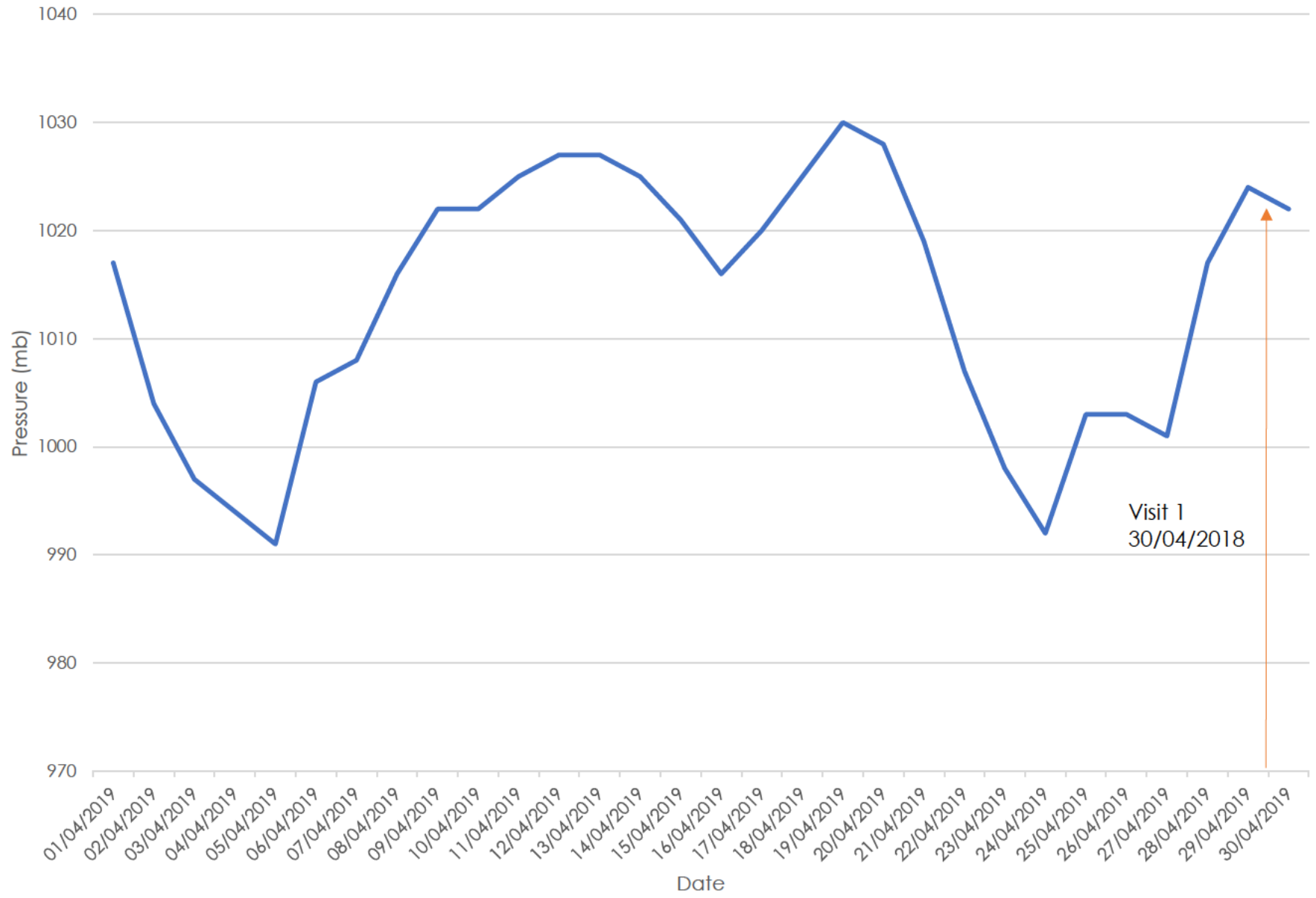
Visit 5

Job Title:						Job No:					
Green Acres Close, Emley						3253					
Client:						Sheet :					
Highstone Housing Association Ltd						1 of 1					
Date:		Arrival Time:		Depart Time:		Operator:					
26/06/2019		13:30		14:30		Mawgan Naylor					
Gas Monitoring Results:											
Ambient Concentration (% Volume):				CH ₄ :	ND	CO ₂ :	ND	O ₂ :	20.2		
Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄	CO ₂	CH ₄	CO ₂	O ₂					
		(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr		
PH01	5.27	ND	1.5	ND	1.5	6.1	46.3	5.4	180.0	5.75	
PH02	3.58	ND	1.2	ND	1.2	17.9	ND	ND	ND	5.81	
PH03	3.28	ND	0.2	ND	0.2	20.0	ND	ND	ND	4.10	
PH04	4.37	ND	1.7	ND	1.7	17.7	ND	ND	ND	5.80	
PH05	3.03	ND	1.8	ND	1.8	18.1	ND	ND	ND	4.03	
PH06	2.82	ND	1.2	ND	1.2	18.7	ND	ND	ND	4.00	
Notes											
Equipment Used:						Next Calibration Date			Key		
Gas Data GFM436 Infrared Gas Analyser						12/02/2020			ND None Detected		
Geotechnical Instruments Dipmeter									NR Not Recorded		
									1.0 Recorded value does not breach trigger levels		
									5.0 Recorded value breaches trigger level 1		
									10.0 Recorded value breaches trigger level 2		
		Site Data:		Weather Station Data (Emley Village Weather Station)							
		Temp (°C):	12	Barometric Pressure Trend: Rising							
Time:	13:30	14:00	14:30	00:00	08:00	13:30	14:00	14:30	20:00	Trigger level 1	
Pressure (mb):	1008	1006	1006	1025	1029	1030	1030	1030	1031	Trigger level 2	
		Weather Conditions:		Overcast, humid							
		Surface Ground Conditions:									
Remarks:											

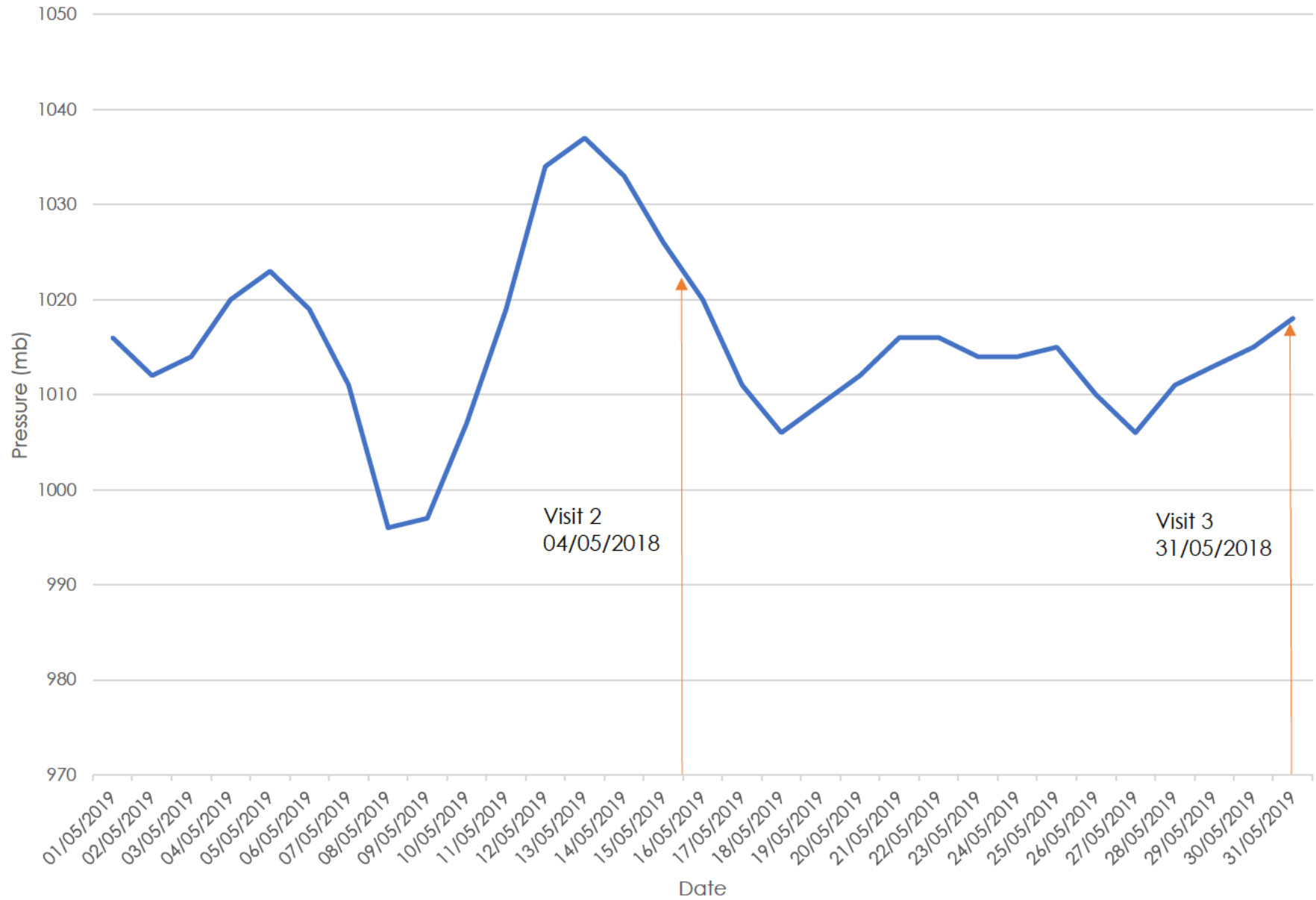
Visit 6

Job Title:						Job No:							
Green Acres Close, Emley						3253							
Client:						Sheet :							
Highstone Housing Association Ltd						1 of 1							
Date:		Arrival Time:		Depart Time:		Operator:							
26/07/2019		09:15		10:20		M Naylor							
Gas Monitoring Results:													
Ambient Concentration (% Volume):				CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :	20.5				
Monitoring Point	Groundwater level	Concentrations					Gas Flow Rates			Bottom of well	Remarks		
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady				
		CH ₄	CO ₂	CH ₄	CO ₂	O ₂							
		(m) bgl	% v/v	(%)	% v/v	(%)	(%)	litre/hr	litre/hr			secs	m
PH01	5.24	ND	1.9	ND	1.9	4.2	66.6	8.0	360.0	5.75			
PH02	3.74	ND	1.3	ND	1.3	18.0	ND	ND	ND	5.82			
PH03	3.28	ND	0.9	ND	0.9	19.6	ND	ND	ND	4.11			
PH04	4.86	ND	1.4	ND	1.4	18.5	ND	ND	ND	5.80			
PH05	3.24	ND	0.7	ND	0.7	19.9	ND	ND	ND	4.03			
PH06	3.15	ND	0.8	ND	0.8	19.7	ND	ND	ND	3.97			
Notes													
Equipment Used:						Next Calibration Date			Key				
Gas Data GFM436 Infrared Gas Analyser						12/02/2020			ND None Detected				
Geotechnical Instruments Dipmeter									NR Not Recorded				
									1.0 Recorded value does not breach trigger levels				
									5.0 Recorded value breaches trigger level 1				
									10.0 Recorded value breaches trigger level 2				
		Site Data:		Weather Station Data (Emley Village Weather Station)									
		Temp (°C):		20 to 21.		Barometric Pressure Trend: Steady.							
Time:	09:15	09:50	10:20	00:00	06:30	09:15	09:45	10:15	18:00	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	985	984	984	1006	1006	1008	1007	1007	1008	Trigger level 2	5.0	10.0	10.0
		Weather Conditions:		Warm and cloudy.									
		Surface Ground Conditions:		Damp.									
Remarks:													

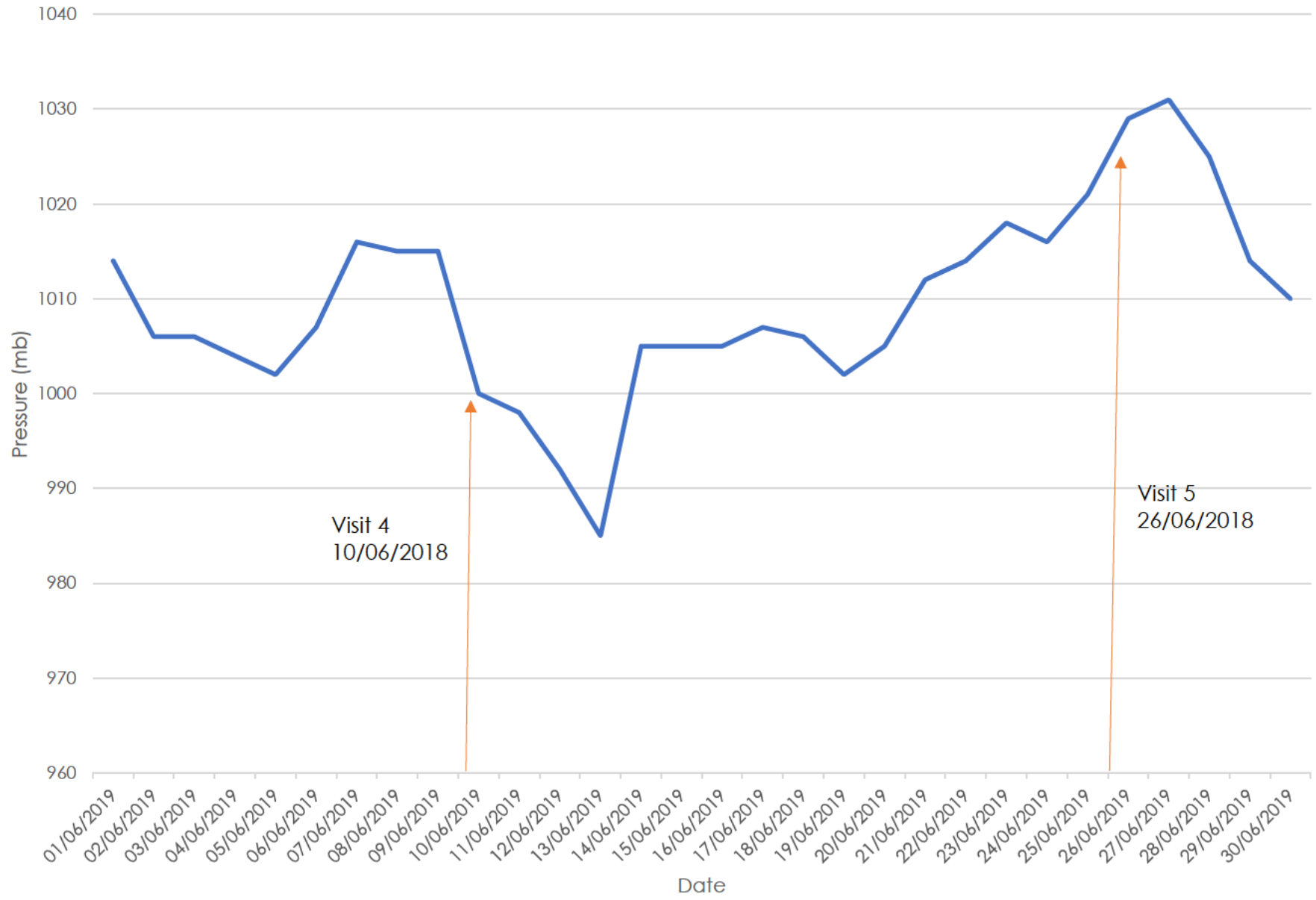
April 2019 Atmospheric Pressure Graph



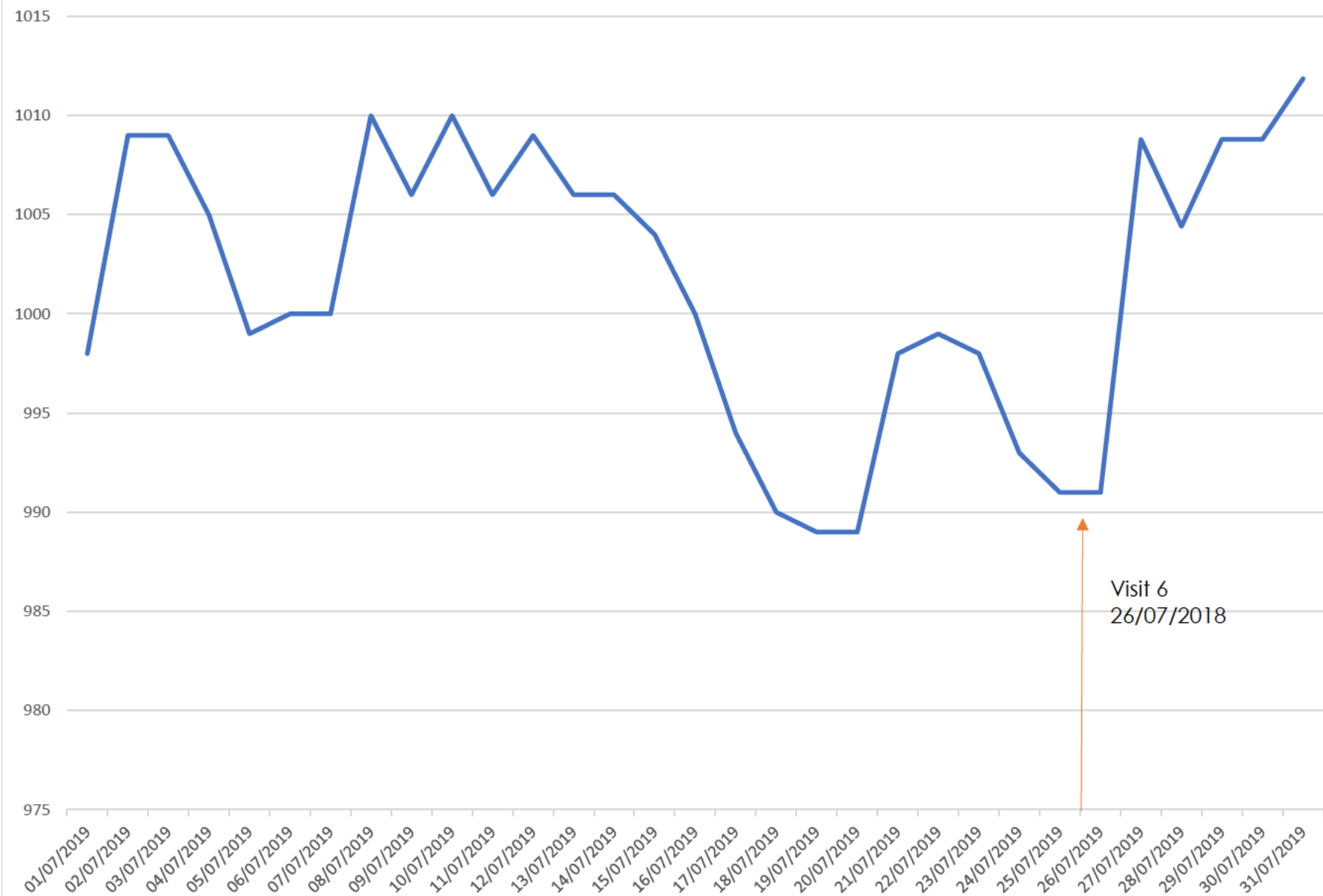
May 2019 Atmospheric Pressure Graph



June 2019 Atmospheric Pressure Graph



July 2019 Atmospheric Pressure Graph



Borehole Log

Borehole No.

PH01

Sheet 1 of 2

Project Name: Green Acres Close

Project No.
3253

Co-ords: 424308.00 - 412824.00

Hole Type
PH

Location: Emley

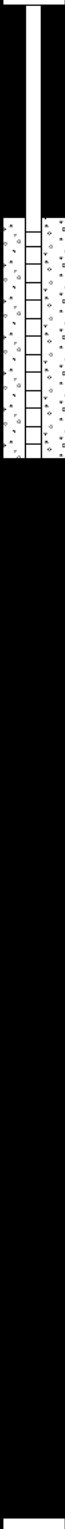
Level:

Scale
1:100

Client: Highstone Housing Association Limited

Dates: 16/04/2019 - 16/04/2019

Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.70			Light brown OVERBURDEN. (GRANULAR RESIDUAL SOIL)	1
								Light yellowish brown SANDSTONE. (EMLEY ROCK)	2
									3
					4.00			Grey SILTSTONE. (COAL MEASURES)	4
									5
									6
									7
									8
									9
									10
									11
					12.10			Black COAL. (FLOCKTON THIN COAL)	12
					12.50			Grey SILTSTONE. (COAL MEASURES)	13
								12.50m to 12.80m: <i>Flashes of black coal.</i>	14
									15
									16
									17
									18
									19
								19.10m to 20.10m: <i>4 flashes of black coal.</i>	20
								Continued on next sheet	

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS, not surveyed in.

Borehole Log

Borehole No.

PH02

Sheet 1 of 2

Project Name: Green Acres Close

Project No.
3253

Co-ords: 424409.00 - 412833.00

Hole Type
PH

Location: Emley

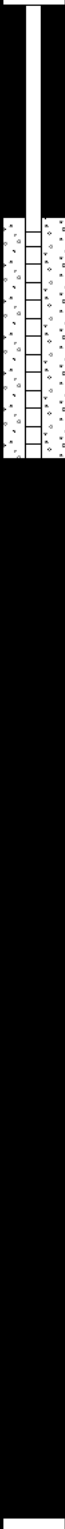
Level:

Scale
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Client: Highstone Housing Association Limited

Dates: 16/04/2019 - 16/04/2019

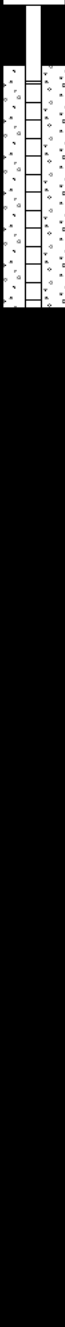
Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.00			Light brown OVERBURDEN. (GRANULAR RESIDUAL SOIL)	1
								Brown SANDSTONE. (EMLEY ROCK)	2
									3
									4
					4.70			Grey MUDSTONE. (COAL MEASURES)	5
									6
									7
									8
									9
									10
									11
								11.00m: Groundwater encountered.	12
					12.30			Black COAL. (FLOCKTON THIN COAL)	13
					12.80			Grey MUDSTONE. (COAL MEASURES)	14
									15
									16
									17
									18
								18.60m to 19.10m: Flashes of black coal.	19
									20

Continued on next sheet

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 11.00m. 3. Coordinates from handheld GPS, not surveyed in.

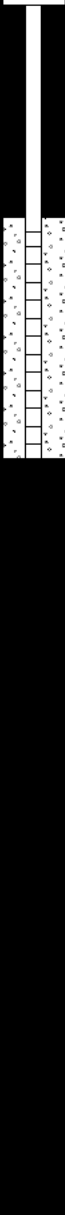
				Borehole Log			Borehole No. PH03 Sheet 1 of 1			
Project Name: Green Acres Close				Project No. 3253		Co-ords: 424347.00 - 412811.00		Hole Type PH		
Location: Emley				Level:		Scale 1:100				
Client: Highstone Housing Association Limited				Dates: 16/04/2019 - 16/04/2019		Logged By JBR				
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
					1.00			Light brown OVERBURDEN. (GRANULAR RESIDUAL SOIL)	1	
									Orangish brown SANDSTONE. (EMLEY ROCK)	2
						4.00			Grey MUDSTONE. (COAL MEASURES)	3
										4
										5
										6
										7
										8
										9
										10
									11	
								11.50m: Groundwater encountered.	12	
					12.90			Black COAL. (FLOCKTON THIN COAL)	13	
					13.50			Grey MUDSTONE. (COAL MEASURES)	14	
									15	
									16	
									17	
					17.50			End of borehole at 17.50 m	18	
									19	
									20	

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was encountered at 11.00m. 3. Coordinates from handheld GPS, not surveyed in.

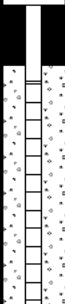


				Borehole Log			Borehole No. PH04 Sheet 1 of 1	
Project Name: Green Acres Close				Project No. 3253		Co-ords: 424420.00 - 412803.00		Hole Type PH
Location: Emley				Level:		Scale 1:100		
Client: Highstone Housing Association Limited				Dates: 18/04/2019 - 18/04/2019		Logged By JBR		

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.80		 Light brown OVERBURDEN. (GRANULAR RESIDUAL SOIL)		
							 Orangish brown SANDSTONE. (EMLEY ROCK)	1	
									2
									3
									4
						5.00		 Grey MUDSTONE. (COAL MEASURES)	5
									6
									7
									8
									9
								10	
								11	
								12	
					13.00		 Black COAL. (FLOCKTON THIN COAL)	13	
					13.50		 Grey MUDSTONE. (COAL MEASURES)	14	
								15	
					16.00		End of borehole at 16.00 m	16	
								17	
								18	
								19	
								20	

Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS, not surveyed in.		
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				Borehole Log			Borehole No. PH05 Sheet 1 of 1		
Project Name: Green Acres Close				Project No. 3253		Co-ords: 424380.00 - 412831.00		Hole Type PH	
Location: Emley				Level:		Scale 1:100			
Client: Highstone Housing Association Limited				Dates: 18/04/2019 - 18/04/2019		Logged By JBR			

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.90		 Light brown OVERBURDEN. (GRANULAR RESIDUAL SOIL)	1	
							 Light brown SANDSTONE. (EMLEY ROCK)	2	
									3
									4
									5
					5.00		 Grey MUDSTONE. (COAL MEASURES)	6	
								7	
								8	
								9	
								10	
					12.50		 Black COAL. (FLOCKTON THIN COAL)	11	
					13.10		 Grey MUDSTONE. (COAL MEASURES)	12	
								13	
								14	
								15	
					16.00		End of borehole at 16.00 m	16	
								17	
								18	
								19	
								20	

Remarks 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS, not surveyed in.		
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Borehole Log

Borehole No.

PH06

Sheet 1 of 1

Project Name: Green Acres Close

Project No.
3253

Co-ords: 424331.00 - 412860.00

Hole Type
PH

Location: Emley

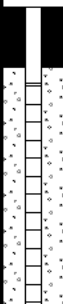
Level:

Scale
1:100

Client: Highstone Housing Association Limited

Dates: 18/04/2019 - 18/04/2019

Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description					
		Depth (m)	Type	Results									
					0.80			Light brown OVERBURDEN. (GRANULAR RESIDUAL SOIL)					
								Yellowish brown SANDSTONE. (EMLEY ROCK)	1				
													2
													3
													4
													5
					5.70							Grey MUDSTONE. (COAL MEASURES)	6
													7
													8
													9
													10
													11
													12
													12.30
													12.90
							Grey MUDSTONE. (COAL MEASURES)	14					
								15					
								16					
16.00							End of borehole at 16.00 m	16					
								17					
								18					
								19					
								20					

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling. 3. Coordinates from handheld GPS, not surveyed in.