

009/3162/REG/LH

10th January 2019

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Dear Andrew

High Shann, Keighley – Gas Risk Assessment

Further to issue of our Geoenvironmental Appraisal Report (No. 3162/1, dated September 2018), 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 3162/1, 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 1.5km from Keighley town centre at NGR 050 421. The site comprises 3 grassed fields with a combined area of approximately 4.7 hectares (11.6 acres).

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

- Several backfilled quarries located approximately 130m to the east and southeast
- A historic landfill located approximately 250m to the east, believed to have been tipped with inert and commercial wastes between 1990 to 1998.

Based on the above, it was considered that the site might be at risk from hazardous gas and therefore monitoring wells were installed in 9 boreholes. Details of the individual installations are provided in Report No 3162/1.

The proposed residential development comprises 130 No. 2 and 3 storey domestic dwellings, associated gardens, POS and adoptable roads and sewers, as shown on Drawing 3162/2 in Report No 3162/1. The houses will likely be founded on traditional strip footings at a minimum depth of 0.9m.

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 September and December 2018.

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)
RH01	2.8 to 4.8m (Mudstone)	0.0	0.1 to 4.2	0.0 – 0.1
RH02	2.9 to 4.9m (Mudstone)	0.0	1.9 to 8.7	0.0 – 0.1
RH03	1.0 to 2.0m (Mudstone)	0.0	0.6 to 2.1	0.0
RH04	2.0 to 5.0m (Sandstone)	0.0	0.6 to 4.2	0.0 – 0.1
RH05	1.0 to 2.3m (Clay)	0.0	0.4 to 2.9	0.0
RH06	1.0 to 1.5m (Clay)	0.0	0.5 to 0.8	0.0
RH07	2.0 to 5.0m (Mudstone)	0.0	0.0 to 0.8	0.0
RH08	3.0 to 5.0m (Siltstone)	0.0	0.2 to 4.6	0.0 – 0.1
RH09	2.0 to 3.0m (Sandstone)	0.0	1.1 to 4.9	0.0

Value in **red** is above carbon dioxide threshold of 5%

Note: Atmospheric pressures varied between 977.5mb and 1023.8mb.

In accordance with the DETR approach, a default value of 0.1 litres/hour has been used in the gas risk assessment.

During 2 of the 6 monitoring visits, atmospheric pressure was falling, including on one occasion where the pressure was falling and below 1000mb. 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 Values (GSVs) for carbon dioxide is 0.01 (no methane was detected). This GSVs equate to a Green gas regime (traffic light) for this site.

Steady concentrations of carbon dioxide have been recorded in excess of the Amber 1 lower threshold (5%) in RH02 on four occasions, with a maximum value of 8.7% recorded during visit 4. Whilst this is considered typical for this monitoring location, it is not typically for the site, and should not be considered as a "Typical Maximum Concentration".

High initial flows were observed in RHs 01, 02, 04 and 08 (between 8.5 and 53.1 litres/hour) during 4 of the 6 visits. Gas flows fell rapidly during monitoring to <0.11/hr in all cases within 2minutes. These peak flows are almost certainly associated with a rise in the water table. All monitoring locations where high peak flow was recorded had groundwater levels above the response zone. Where groundwater rises into the plain casing, above the slotted pipe (response zone), a positive pressure is created within the casing.

This “trapped” air is released as\when the well valve is opened resulting in short-lived, but high flow, and consequently represents release of a positive pressure rather than significant generation of gas. Such short-lived flows are not considered representative of gas production or gas risk at the site.

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 0.01 classes as Characteristic Situation 1.

Scope of protection measures

Based on the site characterisation (Green & CS1) discussed above, no special gas protective measures are required.

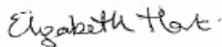
Traffic light classification and “score” req’d by BS8485#	Floor slab (BS8485 “score”)	Protective measures	
		Sub-floor ventilation (BS8485 “score”)	Membrane
			Type (BS8485 “score”)
Green & CS1 (Wilson & Card) 0	Well constructed ground-bearing or suspended	Not required for ground bearing slab, otherwise to comply with Building Regulations (Part C).	Waterproof DPM

Footnotes:

Scores are broadly based on those outlined in BS8485:2015 (for Characteristic Situations 2 & 3, and Building Type A).

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

Yours sincerely



Liz Hart
Associate Director
for and on behalf of
LITHOS CONSULTING LIMITED

Enclosures:

- Drawing 3262/6 – 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				
Amber 2				
Red	20	1.56	30	3.13

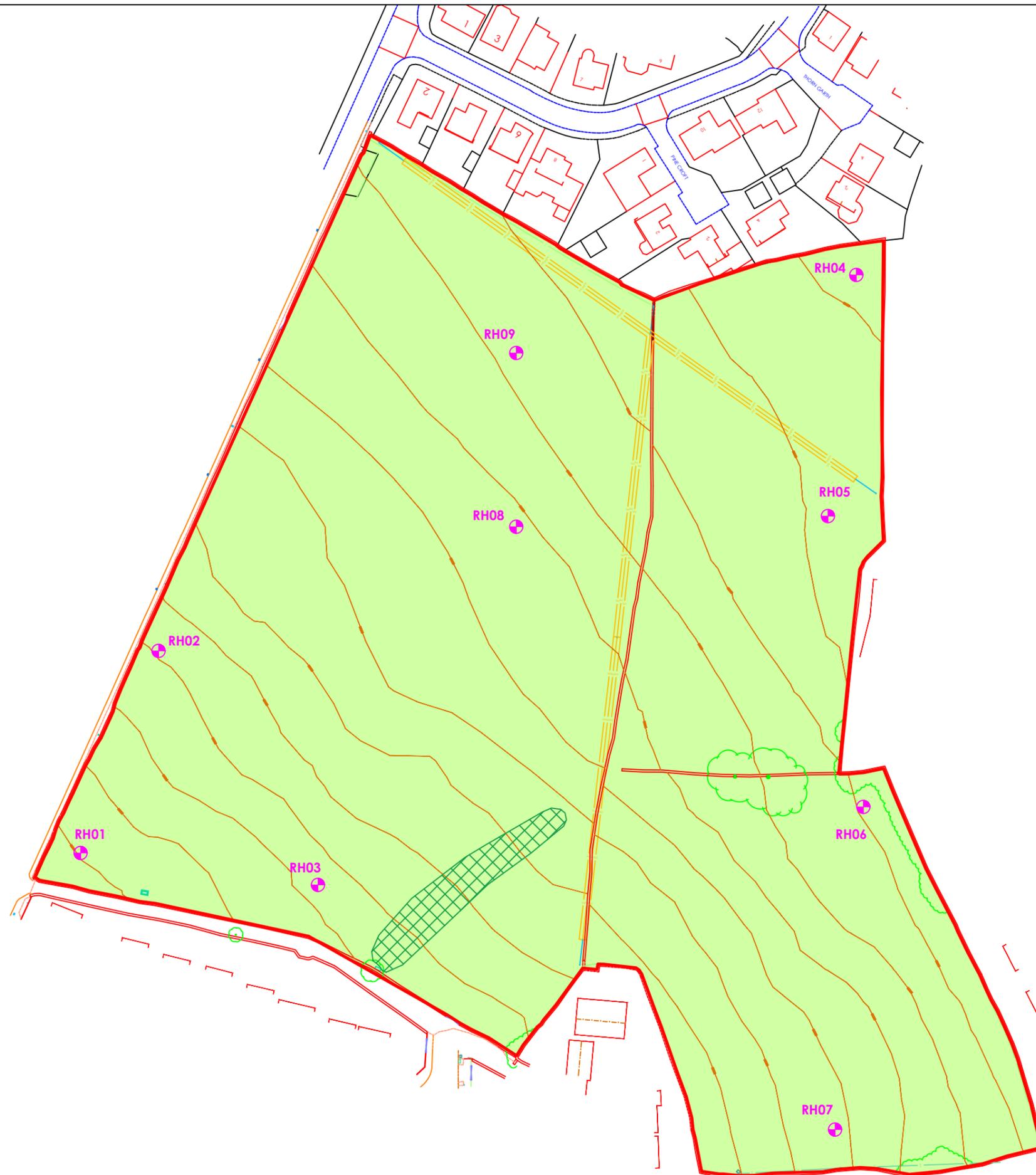
Generic notes – gas risk assessments

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 (TP01 to 21)
 - ROTARY OPEN BOREHOLE LOCATION (RH01 to 09)
 - APPROXIMATE SITE BOUNDARY

REV.	DESCRIPTION	DATE



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THE
DEVONSHIRE
GROUP

HIGH SHANN,
KEIGHLEY

EXPLORATORY HOLE LOCATIONS

DRAWN	JBR	DATE	07/09/2018	STATUS	FOR COMMENT <input type="checkbox"/>
CHECKED	MJT	DATE	07/09/2018	FOR APPROVAL	<input type="checkbox"/>
				DRAFT	<input type="checkbox"/>
				FINAL	<input checked="" type="checkbox"/>
SCALE	1:1250	SHEET	A3	DRAWING NO.	3162/6
				REVISION	

APPENDIX C
Gas monitoring results

Job Title:				Job No:	
High Shann, Keighley				3162	
Client:				Sheet:	
The Devonshire Group				1 of 1	
Date:	Arrival Time:	Depart Time:	Operator:		
05/09/2018	15:15	17:00	M Naylor & A Taylor		



Gas Monitoring Results:							
Ambient Concentration (% Volume):		CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :	21.0

Monitoring Point	Groundwater level (m) bgl	Concentrations					Gas Flow Rates			Bottom of well m	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄ % v/v	CO ₂ (%)	CH ₄ % v/v	CO ₂ (%)	O ₂ (%)	litre/hr	litre/hr	secs		
RH01	1.22	ND	0.1	ND	0.1	20.9	ND	ND	N/A	4.72	Bailed to 3.90m at 15:35.
RH02	4.00	ND	1.9	ND	1.9	17.8	ND	ND	N/A	4.81	
RH03	ND	ND	1.8	ND	1.8	19.5	ND	ND	N/A	2.02	
RH04	2.13	ND	0.8	ND	0.8	20.2	ND	ND	N/A	4.95	Bailed to 4.00m at 16:20.
RH05	ND	ND	0.4	ND	0.4	20.3	ND	ND	N/A	2.30	
RH06	ND	ND	0.5	ND	0.5	20.5	ND	ND	N/A	1.64	
RH07	2.65	ND	ND	ND	ND	21.2	ND	ND	N/A	5.01	
RH08	1.94	ND	0.5	ND	0.5	20.8	ND	ND	N/A	4.62	Bailed to 2.05m at 16:40 - well recharging very quickly (c. 20litres of water bailed out).
RH09	ND	ND	2.1	ND	2.1	18.8	ND	ND	N/A	2.99	

Notes

Equipment Used:	Next Calibration Date	Key
Gas Data GFM436 Infrared Gas Analyser	16/01/2019	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 (Keighley N Station)						CH ₄	CO ₂	O ₂	
	Temp (°C):	17 to 18		Barometric Pressure Trend:			Falling						
Time:	15:15	16:00	17:00	00:00	05:00	10:00	15:15	16:00	17:00	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	994	995	994	1023.8	1023.4	1023.7	1021.7	1021.2	1020.7	Trigger level 2	5.0	10.0	10.0
Weather Conditions:	Sunny and cloudy.												
Surface Ground Conditions:	Damp.												

Remarks:

Job Title:				Job No:	
High Shann, Keighley				3162	
Client:				Sheet:	
The Devonshire Group				1 of 1	
Date:	Arrival Time:	Depart Time:	Operator:		
05/09/2018	15:15	17:00	M Naylor & A Taylor		



Gas Monitoring Results:							
Ambient Concentration (% Volume):		CH ₄ :	0.0	CO ₂ :	0.0	O ₂ :	21.0

Monitoring Point	Groundwater level (m) bgl	Concentrations					Gas Flow Rates			Bottom of well m	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄ % v/v	CO ₂ (%)	CH ₄ % v/v	CO ₂ (%)	O ₂ (%)	litre/hr	litre/hr	secs		
RH01	1.55	ND	2.2	ND	1.9	20.1	15.2	0.0	20.0	4.72	Re-monitored at 16:15.
RH02	4.00	ND	1.9	ND	1.9	17.8	ND	ND	N/A	4.81	
RH03	ND	ND	1.8	ND	1.8	19.5	ND	ND	N/A	2.02	
RH04	3.04	ND	0.6	ND	0.6	20.8	ND	ND	ND	4.95	Re-monitored at 16:50. Bung loose on arrival (possibly due to pressure).
RH05	ND	ND	0.4	ND	0.4	20.3	ND	ND	N/A	2.30	
RH06	ND	ND	0.5	ND	0.5	20.5	ND	ND	N/A	1.64	
RH07	2.65	ND	ND	ND	ND	21.2	ND	ND	N/A	5.01	
RH08	2.00	ND	0.2	ND	0.2	21.1	24.0	0.0	30.0	4.62	Re-monitored at 16:40.
RH09	ND	ND	2.1	ND	2.1	18.8	ND	ND	N/A	2.99	

Notes

Equipment Used:	Next Calibration Date	Key
Gas Data GFM436 Infrared Gas Analyser	16/01/2019	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 (Keighley N Station)						Trigger level 1	CH ₄	CO ₂	O ₂
	Temp (°C):	17 to 18		Barometric Pressure Trend:			Falling						
Time:	15:15	16:00	17:00	00:00	05:00	10:00	15:15	16:00	17:00	1.0	5.0	16.0	
Pressure (mb):	994	995	994	1023.8	1023.4	1023.7	1021.7	1021.2	1020.7	5.0	10.0	10.0	
Weather Conditions:	Sunny and cloudy.												
Surface Ground Conditions:	Damp.												

Remarks:

Visit 2

Job Title: High Shann, Keighley							Job No: 3162							
Client: The Devonshire Group							Sheet: 1 of 1							
Date: 20/09/2018		Arrival Time: 15:20		Depart Time: 17:10		Operator: A Taylor								
Gas Monitoring Results:														
Ambient Concentration (% Volume):			CH₄:	0.0	CO₂:	0.0	O₂:	20.7						
Monitoring Point	Groundwater level (m) bgl	Concentrations					Gas Flow Rates			Bottom of well m	Remarks			
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady					
		CH ₄ % v/v	CO ₂ (%)	CH ₄ % v/v	CO ₂ (%)	O ₂ (%)	litre/hr	litre/hr	secs					
RH01	1.24	ND	0.6	ND	0.6	20.5	ND	ND	ND	4.69				
RH02	4.03	ND	6.6	ND	6.6	13.7	1.0	0.0	120.0	4.82				
RH03	ND	ND	1.3	ND	1.3	19.7	ND	ND	ND	2.03				
RH04	2.11	ND	0.5	ND	0.5	20.4	ND	ND	ND	4.84	15:59 - Bailed to 3.25m.			
RH05	ND	ND	1.0	ND	1.0	17.6	ND	ND	ND	2.32				
RH06	ND	ND	0.8	ND	0.8	19.9	ND	ND	ND	1.64				
RH07	2.58	ND	0.4	ND	0.4	20.4	ND	ND	ND	5.01				
RH08	1.92	ND	0.9	ND	0.9	20.1	44.9	0.0	80.0	4.42				
RH09	ND	ND	1.9	ND	1.9	18.1	ND	ND	ND	2.97				
Notes														
Equipment Used: Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter						Next Calibration Date 16/01/2019			Key					
									ND None Detected					
									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 (Black Hill Weather Station)										
		Temp (°C):		Barometric Pressure Trend:			Falling							
		10												
Time:		15:20 16:25 17:10		06:04 12:04 15:19		16:24 17:09 20:04					Trigger level 1	1.0	5.0	16.0
Pressure (mb):		976 976 973		985 983.6 979.6		977.5 976.9 971.8					Trigger level 2	5.0	10.0	10.0
		Weather Conditions:		Very heavy rain.										
		Surface Ground Conditions:		Very wet ground.										
Remarks:														

Visit 2 Bailed

Job Title: High Shann, Keighley				Job No: 3162	
Client: The Devonshire Group				Sheet : 1 of 1	
Date: 20/09/2018	Arrival Time: 15:20	Depart Time: 17:10	Operator: A Taylor		

Gas Monitoring Results:						
Ambient Concentration (% Volume):	CH₄:	0.0	CO₂:	0.0	O₂:	20.7

Monitoring Point	Groundwater level (m) bgl	Concentrations					Gas Flow Rates			Bottom of well m	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄ % v/v	CO ₂ (%)	CH ₄ % v/v	CO ₂ (%)	O ₂ (%)	litre/hr	litre/hr	secs		
RH01	1.24	ND	0.6	ND	0.6	20.5	ND	ND	ND	4.69	
RH02	4.03	ND	6.6	ND	6.6	13.7	1.0	0.0	120.0	4.82	
RH03	ND	ND	1.3	ND	1.3	19.7	ND	ND	ND	2.03	
RH04	1.53	ND	1.8	ND	1.8	19.6	34.1	0.0	28.0	4.84	Remonitored at 17:04.
RH05	ND	ND	1.0	ND	1.0	17.6	ND	ND	ND	2.32	
RH06	ND	ND	0.8	ND	0.8	19.9	ND	ND	ND	1.64	
RH07	2.58	ND	0.4	ND	0.4	20.4	ND	ND	ND	5.01	
RH08	1.92	ND	0.9	ND	0.9	20.1	44.9	0.0	80.0	4.42	
RH09	ND	ND	1.9	ND	1.9	18.1	ND	ND	ND	2.97	

Notes

Equipment Used: Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter		Next Calibration Date 16/01/2019		Key	
				ND	None Detected
				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 (Black Hill Weather Station)			
Temp (°C): 10		Barometric Pressure Trend: Falling			
Time:	15:20 16:25 17:10	06:04	12:04	15:19	16:24 17:09 20:04
Pressure (mb):	976 976 973	985	983.6	979.6	977.5 976.9 971.8
Weather Conditions:		Very heavy rain.			
Surface Ground Conditions:		Very wet ground.			

Remarks:					
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Visit 3

Job Title: High Shann, Keighley				Job No: 3162	
Client: The Devonshire Group				Sheet: 1 of 1	
Date: 09/10/2018	Arrival Time: 15:30	Depart Time: 16:15	Operator: A Taylor		



Gas Monitoring Results:							
Ambient Concentration (% Volume):		CH₄:	0.0	CO₂:	0.0	O₂:	20.9

Monitoring Point	Groundwater level (m) bgl	Concentrations					Gas Flow Rates			Bottom of well m	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄ % v/v	CO ₂ (%)	CH ₄ % v/v	CO ₂ (%)	O ₂ (%)	litre/hr	litre/hr	secs		
RH01	1.36	ND	1.1	ND	1.1	20.3	ND	ND	ND	4.69	On arrival bung valve open. Closed 15:25. Remonitored 16:05.
RH02	3.99	ND	6.8	ND	6.8	13.4	ND	ND	ND	4.85	
RH03	1.90	ND	1.3	ND	1.3	19.8	ND	ND	ND	2.03	
RH04	2.07	ND	0.7	ND	0.7	20.5	ND	ND	ND	4.78	
RH05	ND	ND	0.9	ND	0.9	18.4	ND	ND	ND	2.28	
RH06	1.60	ND	0.4	ND	0.4	20.5	ND	ND	ND	1.67	
RH07	2.43	ND	0.3	ND	0.3	20.7	ND	ND	ND	4.94	
RH08	1.95	ND	0.9	ND	0.9	20.4	ND	ND	ND	4.40	
RH09	ND	ND	2.1	ND	2.1	18.8	ND	ND	ND	2.95	

Notes

Equipment Used: Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	Next Calibration Date: 16/01/2019	Key
		ND None Detected
		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 (Black Hill Weather Station)						CH ₄	CO ₂	O ₂	
	Temp (°C):	17		Barometric Pressure Trend:			Steady						
Time:	15:30	15:50	16:15	00:04	09:04	15:29	15:49	16:14	20:04	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	987	989	986	991.4	989.7	991.1	990.7	990.7	991.4	Trigger level 2	5.0	10.0	10.0
	Weather Conditions: Sunny.												
	Surface Ground Conditions: Dry.												

Remarks:

Visit 4

Job Title: High Shann, Keighley				Job No: 3162	
Client: The Devonshire Group				Sheet: 1 of 1	
Date: 01/11/2018	Arrival Time: 09:15	Depart Time: 10:15	Operator: A Taylor		



Gas Monitoring Results:							
Ambient Concentration (% Volume):		CH₄:	0.0	CO₂:	0.0	O₂:	20.5

Monitoring Point	Groundwater level (m) bgl	Concentrations					Gas Flow Rates			Bottom of well m	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄ % v/v	CO ₂ (%)	CH ₄ % v/v	CO ₂ (%)	O ₂ (%)	litre/hr	litre/hr	secs		
RH01	1.33	ND	2.1	ND	2.1	19.4	ND	ND	ND	4.61	
RH02	3.89	ND	8.7	ND	8.7	10.4	ND	ND	ND	4.82	
RH03	1.02	ND	0.6	ND	0.6	20.2	ND	ND	ND	2.02	
RH04	2.06	ND	0.8	ND	0.8	20.2	ND	ND	ND	4.75	
RH05	ND	ND	1.7	ND	1.7	16.2	ND	ND	ND	2.28	
RH06	1.40	ND	0.8	ND	0.8	20.0	ND	ND	ND	1.67	
RH07	2.30	ND	0.8	ND	0.8	20.1	ND	ND	ND	4.94	
RH08	1.92	ND	1.0	ND	1.0	20.0	5.1	0.0	3.0	4.39	
RH09	ND	ND	4.9	ND	4.9	15.1	ND	ND	ND	2.98	

Notes

Equipment Used: Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	Next Calibration Date: 16/01/2019
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Key	ND	None Detected
	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 (Black Hill Weather Station)					
	Temp (°C): 5 to 7			Barometric Pressure Trend: Steady					
Time:	09:15	09:45	10:15	00:04	05:04	09:14	09:44	10:14	15:24
Pressure (mb):	977	976	975	978.9	977.5	979.2	979.2	979.6	982.3
	Weather Conditions: Overcast.								
	Surface Ground Conditions: Wet.								

	CH₄	CO₂	O₂
Trigger level 1	1.0	5.0	16.0
Trigger level 2	5.0	10.0	10.0

Remarks:

Visit 5

Job Title: High Shann, Keighley				Job No: 3162
Client: The Devonshire Group				Sheet: 1 of 1
Date: 27/11/2018	Arrival Time: 15:15	Depart Time: 16:20	Operator: A Taylor	



Gas Monitoring Results:				
Ambient Concentration (% Volume):	CH₄:	0.0	CO₂:	0.0
			O₂:	20.6

Monitoring Point	Groundwater level (m) bgl	Concentrations					Gas Flow Rates			Bottom of well m	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄ % v/v	CO ₂ (%)	CH ₄ % v/v	CO ₂ (%)	O ₂ (%)	litre/hr	litre/hr	secs		
RH01	0.84	ND	4.2	ND	4.2	18.3	8.5	0.0	12.0	4.61	
RH02	3.43	ND	5.5	ND	5.5	19.6	ND	ND	ND	4.83	
RH03	0.32	ND	0.9	ND	0.9	20.0	ND	ND	ND	2.03	
RH04	1.64	ND	4.2	ND	4.2	18.9	ND	ND	ND	4.75	
RH05	2.09	ND	2.9	ND	2.9	14.3	ND	ND	ND	2.31	
RH06	0.89	ND	0.9	ND	0.9	19.9	ND	ND	ND	1.64	
RH07	1.04	ND	0.5	ND	0.5	20.2	ND	ND	ND	4.92	
RH08	1.65	ND	2.8	ND	2.8	19.1	33.0	0.0	60.0	4.40	
RH09	1.80	ND	3.6	ND	3.6	18.0	ND	ND	ND	2.96	

Notes

Equipment Used: Gas Data GFM436 Infrared Gas Analyser Geotechnical Instruments Dipmeter	Next Calibration Date: 16/01/2019	Key ND None Detected 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
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	Site Data:			Weather Station Data (Black Hill Weather Station)						Trigger level 1	CH ₄	CO ₂	O ₂
	Temp (°C):	6 to 7.		Barometric Pressure Trend:			Falling						
Time:	15:15	15:50	16:20	05:59	11:59	15:14	15:49	16:19	19:59	1.0	5.0	16.0	
Pressure (mb):	981	981	980	990.7	986.3	983	982.6	982.3	981.3	5.0	10.0	10.0	
	Weather Conditions: Heavy rain.												
	Surface Ground Conditions: Wet Ground.												

Remarks:

Visit 6

Job Title:				Job No:	
High Shann, Keighley				3162	
Client:				Sheet:	
The Devonshire Group				1 of 1	
Date:	Arrival Time:	Depart Time:	Operator:		
17/12/2018	09:01	10:36	A Taylor		



Gas Monitoring Results:					
Ambient Concentration (% Volume):		CH₄:	0.0	CO₂:	0.0
		O₂:	20.1		

Monitoring Point	Groundwater level (m) bgl	Concentrations					Gas Flow Rates			Bottom of well m	Remarks
		Initial / Highest		Steady concentrations		Lowest concn	Initial / Maximum	Steady	Time to fall from highest to steady		
		CH ₄ % v/v	CO ₂ (%)	CH ₄ % v/v	CO ₂ (%)	O ₂ (%)	litre/hr	litre/hr	secs		
RH01	ND	1.9	ND	1.9	19.0	ND	ND	ND	4.65		
RH02	ND	6.0	ND	6.0	12.0	47.5	0.0	20.0	4.81		
RH03	ND	2.1	ND	2.1	18.9	ND	ND	ND	2.03		
RH04	ND	3.6	ND	3.6	19.1	ND	ND	ND	4.76		
RH05	ND	0.9	ND	0.9	19.5	ND	ND	ND	2.30		
RH06	ND	0.8	ND	0.8	20.0	ND	ND	ND	1.62		
RH07	ND	0.8	ND	0.8	19.8	ND	ND	ND	4.98		
RH08	ND	4.6	ND	4.6	18.1	53.1	0.0	0.0	4.52		
RH09	ND	1.1	ND	1.1	19.9	ND	ND	ND	2.96		

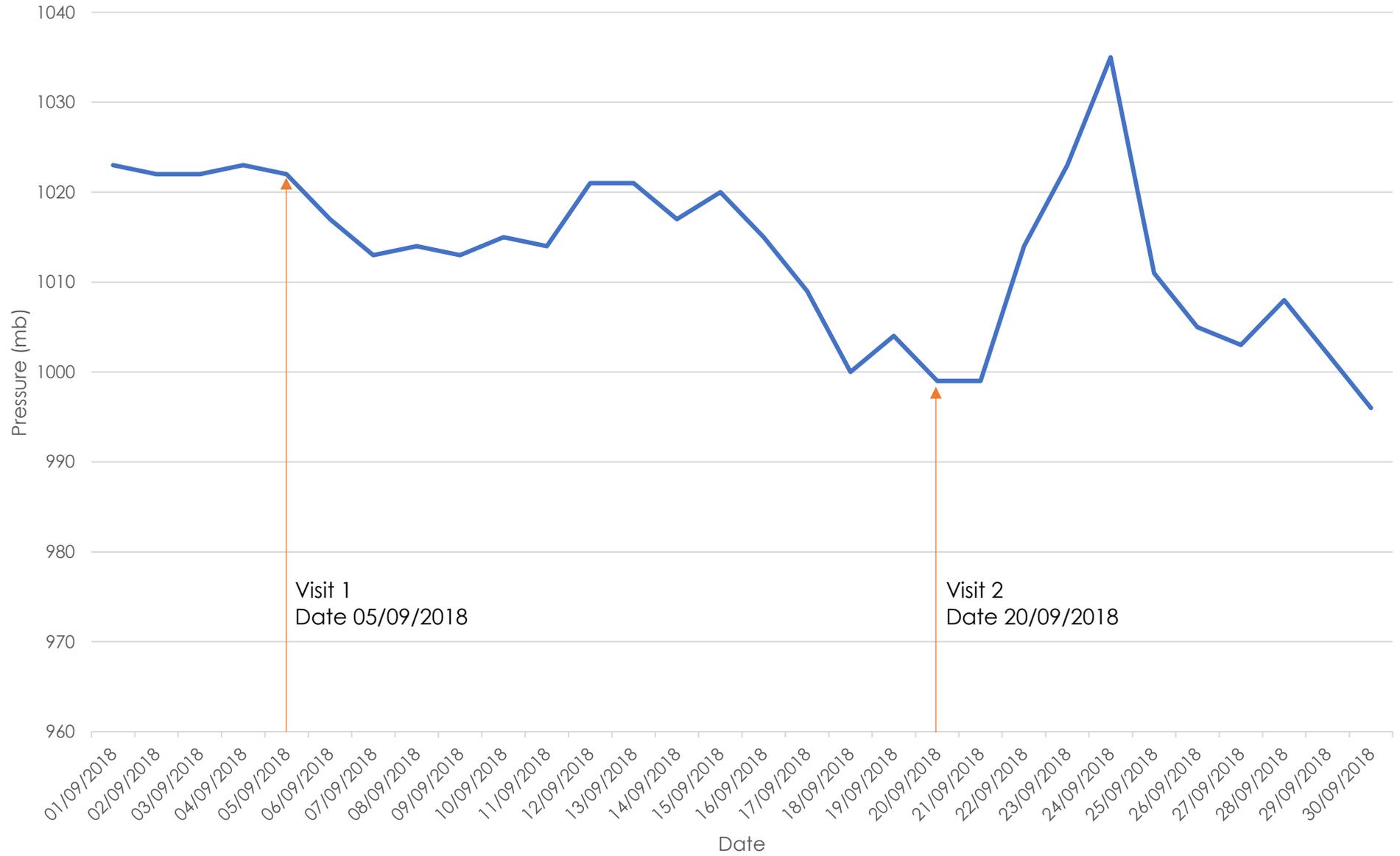
Notes

Equipment Used:	Next Calibration Date	Key
Gas Data GFM436 Infrared Gas Analyser	16/01/2019	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

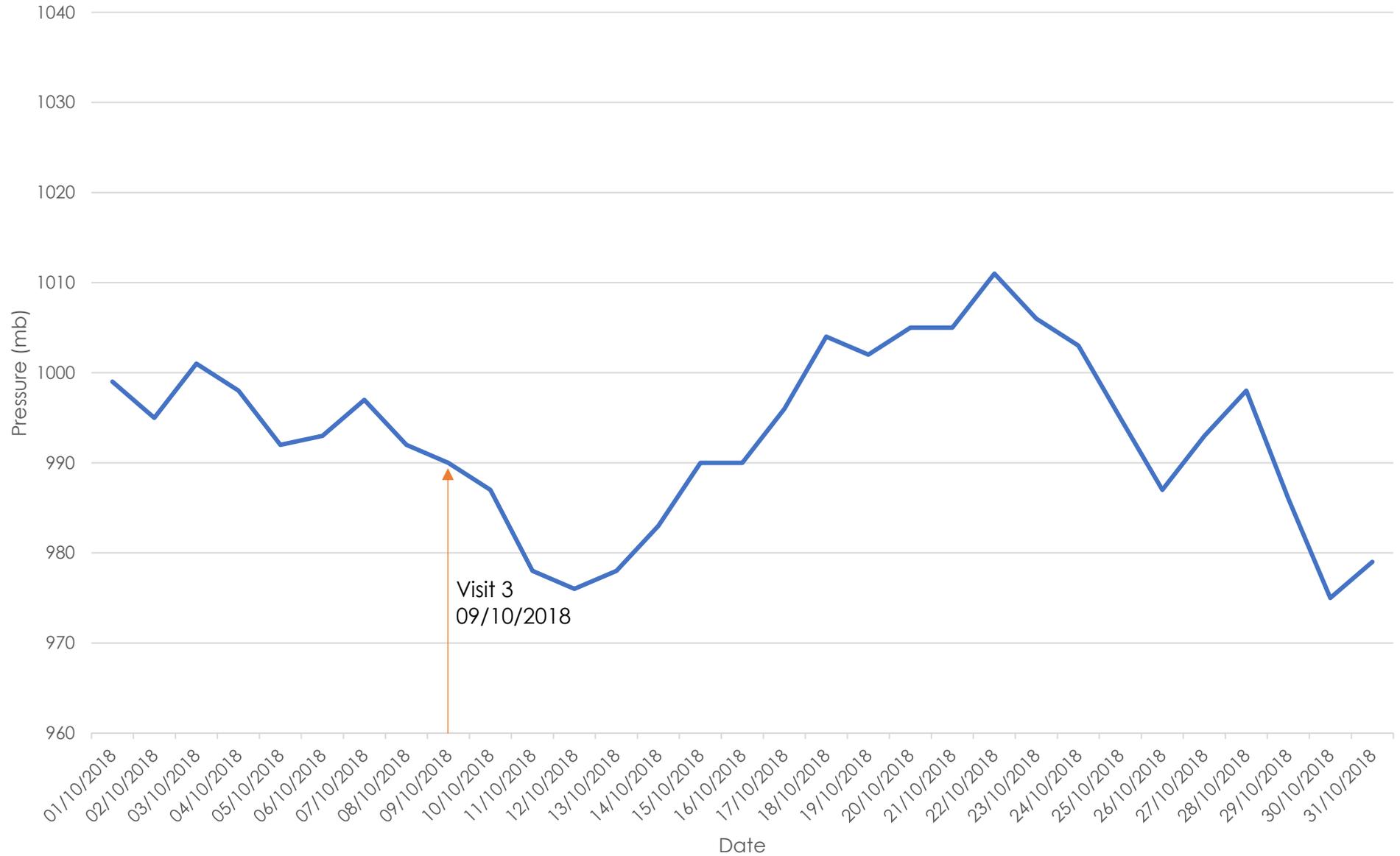
	Site Data:			Weather Station Data (Black Hill Weather Station)						CH ₄	CO ₂	O ₂	
	Temp (°C):	7 to 8.		Barometric Pressure Trend:			Rising.						
Time:	09:01	10:05	10:36	00:04	05:04	08:59	10:04	10:34	17:04	Trigger level 1	1.0	5.0	16.0
Pressure (mb):	987	989	985	981.9	986	989.4	990.4	990.7	990.7	Trigger level 2	5.0	10.0	10.0
	Weather Conditions:			Intermittant cloud.									
	Surface Ground Conditions:			Wet.									

Remarks:

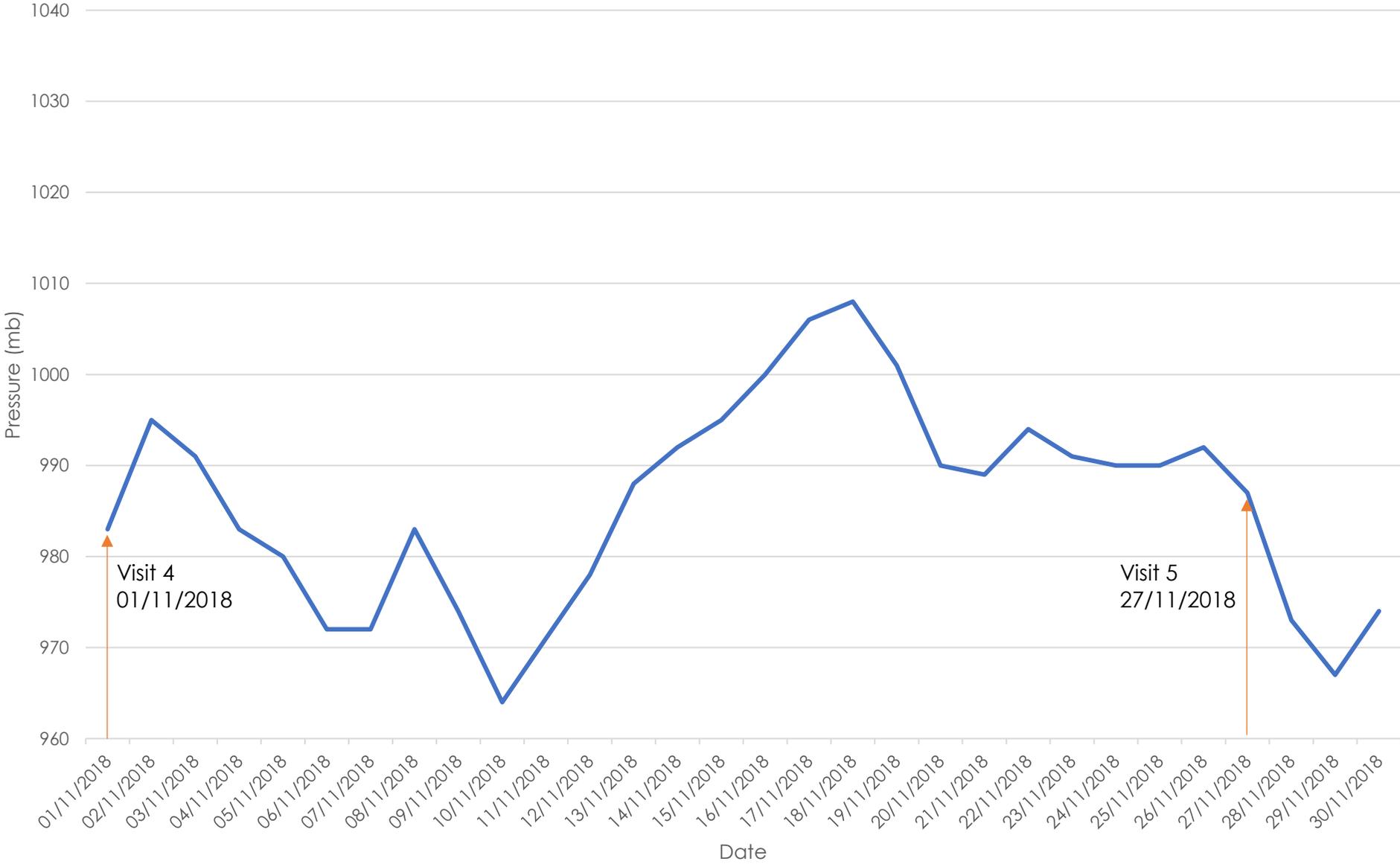
September 2018 Atmospheric Pressure Graph



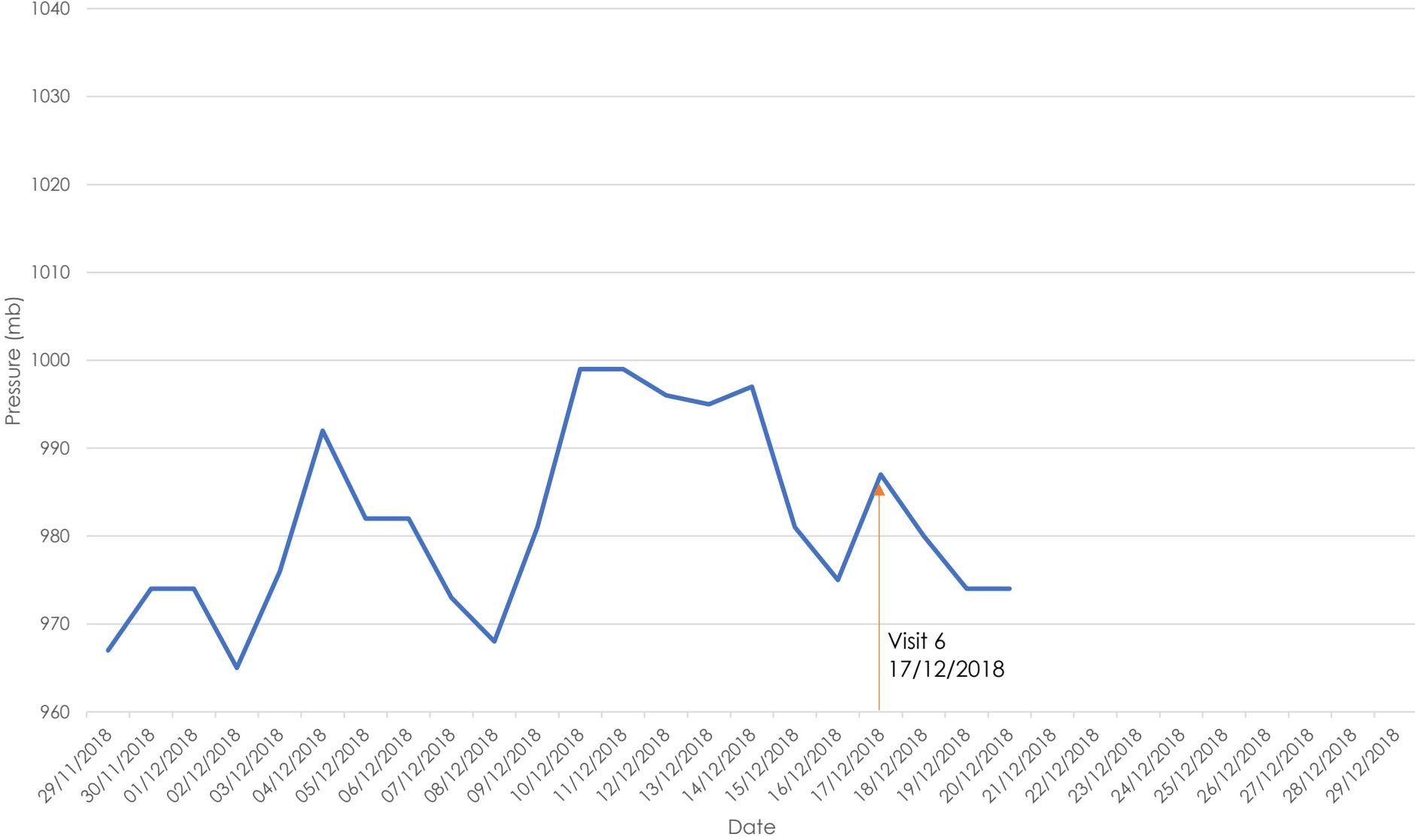
October 2018 Atmospheric Pressure Graph



November 2018 Atmospheric Pressure Graph



December 2018 Atmospheric Pressure Graph



Borehole Log

Borehole No.

RH01

Sheet 1 of 1

Project Name: High Shann

Project No.
3162

Co-ords: 404873.00 - 442049.00

Hole Type
PH

Location: Keighley

Level:

Scale
1:25

Client: The Devonshire Group

Dates: 30/08/2018 - 30/08/2018

Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
							TOPSOIL. (TOPSOIL)	
				0.30			SANDSTONE BOULDER. (GRANULAR RESIDUAL SOIL)	
				0.60			Very weak MUDSTONE. (MILLSTONE GRIT GROUP)	
				5.00			End of borehole at 5.00 m	

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.



Borehole Log

Borehole No.

RH02

Sheet 1 of 1

Project Name: High Shann

Project No.
3162

Co-ords: 404895.00 - 442106.00

Hole Type
PH

Location: Keighley

Level:

Scale
1:25

Client: The Devonshire Group

Dates: 30/08/2018 - 30/08/2018

Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
							TOPSOIL. (TOPSOIL)	
				0.30			Brown CLAY. (COHESIVE RESIDUAL SOIL)	
				2.00			Very weak MUDSTONE. (MILLSTONE GRIT GROUP)	
				5.00			End of borehole at 5.00 m	

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

Borehole Log

Borehole No.

RH03

Sheet 1 of 1

Project Name: High Shann	Project No. 3162	Co-ords: 404940.00 - 442040.00	Hole Type PH
Location: Keighley		Level:	Scale 1:25
Client: The Devonshire Group		Dates: 30/08/2018 - 30/08/2018	Logged By JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
Well					0.30			TOPSOIL. (TOPSOIL)	
					1.00			Brown CLAY. (COHESIVE RESIDUAL SOIL)	
					3.00			Very weak MUDSTONE. (MILLSTONE GRIT GROUP)	1 2 3 4 5
							----- End of borehole at 3.00 m		

Remarks
 1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.



Borehole Log

Borehole No.

RH04

Sheet 1 of 1

Project Name: High Shann

Project No.
3162

Co-ords: 405092.00 - 442212.00

Hole Type
PH

Location: Keighley

Level:

Scale
1:25

Client: The Devonshire Group

Dates: 30/08/2018 - 30/08/2018

Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30			TOPSOIL. (TOPSOIL)
					1.70			Brown CLAY. (COHESIVE RESIDUAL SOIL)
					5.00			Weak brown SANDSTONE. (MILLSTONE GRIT GROUP)
End of borehole at 5.00 m								5

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.



Borehole Log

Borehole No.

RH05

Sheet 1 of 1

Project Name: High Shann

Project No.
3162

Co-ords: 405084.00 - 442144.00

Hole Type
PH

Location: Keighley

Level:

Scale
1:25

Client: The Devonshire Group

Dates: 30/08/2018 - 30/08/2018

Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30		TOPSOIL. (TOPSOIL)	
							Brown CLAY. (COHESIVE RESIDUAL SOIL)	
					2.50		Weak brown SANDSTONE. (MILLSTONE GRIT GROUP)	
				5.00			End of borehole at 5.00 m	

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

Borehole Log

Borehole No.

RH06

Sheet 1 of 1

Project Name: High Shann

Project No.
3162

Co-ords: 405094.00 - 442062.00

Hole Type
PH

Location: Keighley

Level:

Scale
1:25

Client: The Devonshire Group

Dates: 30/08/2018 - 30/08/2018

Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30		TOPSOIL. (TOPSOIL)	
							Brown CLAY. (COHESIVE RESIDUAL SOIL)	
					1.80		Brown SANDSTONE. (MILLSTONE GRIT GROUP)	
					2.60		Very weak dark grey MUDSTONE. (MILLSTONE GRIT GROUP)	
				3.00			End of borehole at 3.00 m	

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

Borehole Log

Borehole No.

RH07

Sheet 1 of 1

Project Name: High Shann

Project No.
3162

Co-ords: 405086.00 - 441971.00

Hole Type
PH

Location: Keighley

Level:

Scale
1:25

Client: The Devonshire Group

Dates: 30/08/2018 - 30/08/2018

Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30		TOPSOIL. (TOPSOIL)	
							Brown CLAY. (COHESIVE RESIDUAL SOIL)	
					2.00		Very weak dark grey MUDSTONE. (MILLSTONE GRIT GROUP)	
					5.00		----- End of borehole at 5.00 m	

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

Borehole Log

Borehole No.

RH08

Sheet 1 of 1

Project Name: High Shann

 Project No.
3162

Co-ords: 404996.00 - 442141.00

 Hole Type
PH

Location: Keighley

Level:

 Scale
1:25

Client: The Devonshire Group

Dates: 30/08/2018 - 30/08/2018

 Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.30		TOPSOIL. (TOPSOIL)	
					1.30		Brown CLAY. (COHESIVE RESIDUAL SOIL)	
					3.00		Weak brown SANDSTONE. (MILLSTONE GRIT GROUP)	
					5.00		Weak grey SILTSTONE. (MILLSTONE GRIT GROUP)	
End of borehole at 5.00 m								

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.

Borehole Log

Borehole No.

RH09

Sheet 1 of 1

Project Name: High Shann

Project No.
3162

Co-ords: 404979.00 - 442190.00

Hole Type
PH

Location: Keighley

Level:

Scale
1:25

Client: The Devonshire Group

Dates: 30/08/2018 - 30/08/2018

Logged By
JBR

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.40		 TOPSOIL. (TOPSOIL)	
					1.40		 Brown CLAY. (COHESIVE RESIDUAL SOIL)	
					1.60		 Very weak dark grey MUDSTONE. (MILLSTONE GRIT GROUP)	
					3.00		 Weak brown SANDSTONE. (MILLSTONE GRIT GROUP)	
							End of borehole at 3.00 m	

Remarks

1. Prior to drilling a Cable Avoidance Tool (CAT) survey was carried out. 2. Groundwater was not apparent during drilling.