Our Ref.: 17-179.02L

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21ST June 2017

Dear [redacted]

Re: Former West Boldon Primary School – Hazardous Ground Gas Risk Assessment Addendum Report

This letter report is an addendum to the Ground Investigation Report (GIR) (Project No.: 17-179, May 2017) undertaken for the proposed development at the above location.

Please find enclosed:

- ARC Environmental Ground Gas Monitoring Certificate

Monitoring was undertaken using a Gas Data GFM 435 infra-red gas analyser with integral flow meter, and an electronic dipmeter.

In accordance with CIRIA Report C665, November 2007, BS8485:2007: Code of practice for the characterization and remediation from ground gas affected developments, and BS8576:2013: Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds, it is felt that an adequate risk assessment can be undertaken based on the following limiting factors:

- The Residential development has been considered as **high sensitivity** (Table 5.5 – Typical/Idealised frequency and period of monitoring, after Wilson et al, 2005).
- The risk associated with the generation potential of a source is considered as **very low**, assessment based on the environmental setting as well as observations noted during the fieldworks.
- Monitoring over a **minimum** of **three months** with **six recorded** readings (Table 5.5 – Typical /idealised frequency and period of monitoring after Wilson et al, 2005).
- **Negligible** flow rates have been recorded (Table 8.5 – Modified Wilson & Card classification).
- A targeted and phased programme of gas monitoring should be completed which obtains gas monitoring readings during varying atmospheric conditions, which covers the 'worst case' scenario for ground gas emissions to occur, particularly during rapid falls in atmospheric pressure (i.e. from c.1020mb and c.1010mb).

Within CIRIA C665 it is suggested that a 'worst case' scenario for ground gas emissions is more likely to occur during rapid falls in atmospheric pressure, in particular from c.1020mb and c.1010mb. In addition, it has also been suggested that low atmospheric pressures (i.e. c.1000mb and below) can give rise to greater emission potential for lighter gases, in particular methane.

As such for this monitoring, a targeted and phased programme of gas monitoring has been completed which has obtained gas monitoring readings during varying atmospheric conditions. Monitoring of the weather conditions and predicated atmospheric pressures (Met Office Surface Pressure Charts) are carried out up to 72 hours in advance of proposed monitoring visits, in order that a reasonable period of data is obtained to determine atmospheric trends, and also to target the 'worst case' scenario.

A summary of the results for all 6 no. visits undertaken are presented in Table 1 below, with a copy of the monitoring results attached with this report. During the completion of the monitoring visits, the high water levels recorded (BH's 4 & 6) were purged of water to open up the response zone so that potential soil gases can be monitored in the well.

Table 1

Position	Date	Atmospheric Pressure (mbar)	Water (m bgl)	CH_4 (%v/v)	LEL (%v/v)	CO_2 (%v/v)	O_2 (%v/v)	Flow Rate (l/hr)
BH1	31/03/2017	996 (Rising trend 1001-1024)	2.30	0.0	0.0	0.6	19.7	<0.1
BH4			0.55	0.0	0.0	0.0	20.4	<0.1
BH6			0.95	0.0	0.0	0.0	20.4	<0.1
BH1	12/04/2017	1012 (Steady trend 1009-1015)	2.22	0.0	0.0	0.4	19.7	<0.1
BH4			0.50	0.0	0.0	0.0	20.2	<0.1
BH6			0.62	0.0	0.0	0.1	20.2	<0.1
BH1	27/04/2017	1006-1007 (Rising trend 1011-1022)	2.18	0.0	0.0	0.4	19.9	<0.1
BH4			0.50	0.0	0.0	0.0	20.4	<0.1
BH6			0.63	0.0	0.0	0.0	20.4	<0.1
BH1	05/05/2017	1022 (Falling trend 1032-1018)	2.19	0.0	0.0	0.3	20.1	<0.1
BH4			0.68	0.0	0.0	0.0	20.4	<0.1
BH6			0.94	0.0	0.0	0.0	20.5	<0.1
BH1	19/05/2017	995-996 Steady Trend 1016-1009)	2.17	0.0	0.0	0.1	20.3	<0.1
BH4			0.61	0.0	0.0	0.0	20.5	<0.1
BH6			0.92	0.0	0.0	0.0	20.3	<0.1
BH1	05/06/2017	994-995 Falling Trend 1012-985)	2.12	0.0	0.0	0.0	20.3	<0.1
BH4			0.68	0.0	0.0	0.0	20.1	<0.1
BH6			Borehole destroyed during demolition works					

Note – Atmospheric pressure trend taken from www.wunderground.com for Newcastle Airport

As can be seen from the results undertaken to date, no concentrations of Methane (CH_4) were recorded within any of the boreholes. However, detectable levels of Carbon Dioxide (CO_2) were recorded within the boreholes, up to a maximum level of 0.6% *v/v*, with associated slightly depleted oxygen (O_2) concentrations (minimum 19.7% *v/v*). In addition, negligible flow rates of <0.1l/hr have been recorded during the monitoring visits completed to date during periods of low and falling atmospheric pressures. It should be noted that BH6 was unable to be monitored during the visit completed on the 5th June, due to this location being destroyed during the demolition works.

Based upon the results recorded, in accordance with CIRIA Report C665, the risk to the site from ground gases has been assessed by converting the CH_4 & CO_2 results in Table 6.3 to gas screening values (GSV's), calculated by multiplying the typical maximum gas concentrations with the recorded maximum positive flow rates (after Wilson & Card).

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Re: Former West Boldon Primary School – Hazardous Ground Gas Risk Assessment Addendum Report (Cont'd)

As no levels of Methane have been recorded to date, the gas screening value (GSV) for CO_2 only has been calculated, using the maximum recorded value of 0.4% v/v, with a maximum flow rate of <0.1l/hr. The GSV can be calculated as follows:

Carbon Dioxide GSV = 0.006 (0.6%) x 0.1 = 0.0006 l/hr

When considering these results, in accordance with CIRIA C665, and considering the NHBC Traffic light system (low rise housing with ventilated underfloor void), it can be seen that the GSV value for CO_2 is below the assessment GSV of 0.78 l/hr (Green classification), indicating that no gas protection measures will be required. Alternatively, if the proposed development were to comprise a ground bearing floor slab within the structure, in accordance with CIRIA C665, the GSV for CO_2 would also fall below the lower target concentration of 0.07l/hr and would also equate to a Characteristic Situation 1 site classification, indicating no gas protective measures being required for the proposed development.

We trust the information we have provided to you is to your satisfaction. However if you require any further information or clarification, please do not hesitate to contact us.

Yours sincerely
For and on behalf of Arc Environmental Ltd

[redacted]

Associate Director

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Arc Environmental Ground Gas & Groundwater Monitoring Certificate

Site:	West Boldon School
Ref:	17-179

Visit	Date	Time	Equipment	Weather	Initials	Comments	Borehole	Gas Flow (l/hr)	Atmospheric Pressure (mb)	Trend	Methane (% v/v)		Methane (% LEL)		Carbon Dioxide (% v/v)		Oxygen (% v/v)		Hydrocarbons (GFM 435 only)		Other Gases (PPM)			Depth to Water (m bgl)
											Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	Hex %	PID Cf	PID (Isobutylene)	H_2S	CO	
1	31/03/2017	12:30pm	GFM435	Sunny spells and windy	IH	Atmospheric trend taken from www.wunderground.com for Newcastle Airport over three consecutive days.Bailed out BH's 4 & 6 prior to monitoring	1	<0.1	996	Rising (1001-1024)		0.0		0.0		0.6		19.7						2.30
							4	<0.1	996	Rising (1001-1024)		0.0		0.0		0.0		20.4						0.55
							6	<0.1	996	Rising (1001-1024)		0.0		0.0		0.0		20.4						0.95
2	12/04/2017	9.15am	GFM435	Sunny	IH	Atmospheric trend taken from www.wunderground.com for Newcastle Airport over three consecutive days.Bailed out BH's 4 & 6 prior to monitoring	1	<0.1	1012	Steady (1009-1015)		0.0		0.0		0.4		19.8						2.22
							4	<0.1	1012	Steady (1009-1015)		0.0		0.0		0.0		20.2						0.50
							6	<0.1	1012	Steady (1009-1015)		0.0		0.0		0.1		20.2						0.62
3	27/04/2017	2.45pm	GFM435	Overcast/showers	IH	Atmospheric trend taken from www.wunderground.com for Newcastle Airport over three consecutive days.Bailed out BH's 4 & 6 prior to monitoring	1	<0.1	1006	Rising (1011-1022)		0.0		0.0		0.4		19.9						2.18
							4	<0.1	1007	Rising (1011-1022)		0.0		0.0		0.0		20.4						0.50
							6	<0.1	1006	Rising (1011-1022)		0.0		0.0		0.0		20.4						0.63
4	05/05/2017	11:35am	GFM435	Sunny	IH	Atmospheric trend taken from www.wunderground.com for Newcastle Airport over three consecutive days.Bailed out BH's 4 & 6 prior to monitoring	1	<0.1	1022	Falling (1032-1018)		0.0		0.0		0.3		20.1						2.19
							4	<0.1	1022	Falling (1032-1018)		0.0		0.0		0.0		20.4						0.68
							6	<0.1	1022	Falling (1032-1018)		0.0		0.0		0.0		20.5						0.94
5	19/05/2017	11:30am	GFM435	Raining	IH	Atmospheric trend taken from www.wunderground.com for Newcastle Airport over three consecutive days.Bailed out BH's 4 & 6 prior to monitoring	1	<0.1	995	Steady (1009-1016)		0.0		0.0		0.1		20.3						2.17
							4	<0.1	996	Steady (1009-1016)		0.0		0.0		0.0		20.5						0.61
							6	<0.1	995	Steady (1009-1016)		0.0		0.0		0.0		20.3						0.92
6	05/06/2017	11.30am	GFM435	Overcast/showers	KC	Atmospheric trend taken from www.wunderground.com for Newcastle Airport over three consecutive days.Bailed out BH4 prior to monitoring	1	<0.1	995	Falling (1012-985)		0.0		0.0		0.0		20.3						2.12
							4	<0.1	994	Falling (1012-985)		0.0		0.0		0.0		20.1						0.68
							6	Borehole destroyed during demolition works																

Notes:

Detection limits - Methane = 0.0%, Carbon Dioxide = 0.0%, LEL = 0.0%, Oxygen = 0.0%, Flow = 0.1l/hr

Monitoring order is from **Left to Right** across table

Monitoring should be for **Not Less** than 3 minutes However, if high concentrations of gasses initially recorded, monitoring should be for up to 10 minutes

N/A = Not applicable = Off the scale

Cf = PID compensation Factor (1-10) - Must be used to multiply the PID reading to give an accuate measure of the total hydrocarbons in the borehole when methane is present

Hex = Hexane (Valid and in range up to 2.000%) - Recorded when abnormally high methane is present.

PID = Photo Ionisation Detector (Calibrated to Isobutylene)