By Email

Our ref: 16-136.04L

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20th October 2017

Dear Bill,

Re: Proposed Retirement Apartments - Roundel Kitchens, Harton Centre, 52 Harton Lane, South Shields, Tyne & Wear – Hazardous Ground Gas Risk Assessment Addendum Report

This letter report supplements the Phase 2: Ground Investigation Report (GIR) (Project No.: 16-136, July 2016) undertaken for the proposed development at the above location.

Please find enclosed:

- ARC Environmental Ground Gas Monitoring Certificates

Monitoring was undertaken using GFM 430/435 series soil gas analysers, with an integral flow meter, and a Geotechnical Instruments electronic dip-meter. Based on the findings of the Phase 1: DTS report and the intrusive works, and in accordance with CIRIA Report C665, November 2007, BS8485:2015: Code of practice for the design of protective measures for Methane & Carbon Dioxide ground gases for new buildings, 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 proposed development has been considered as *moderate* sensitivity (Tables 5.5a & 5.5b – 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 *low* (assessment based on the findings of the intrusive works)
- Monitoring over a minimum of *three* months with a minimum of *six* recorded readings including during periods of low or falling atmospheric pressure (Tables 5.5a & 5.5b – Typical /idealised frequency and period of monitoring after Wilson et al, 2005). In this instance, the number of monitoring visits was extended due to shallow groundwater levels.
- Negligible flow rates have been recorded throughout the monitoring period (Table 8.5 – Modified Wilson & Card classification)

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 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, i.e. methane. As such for this monitoring, a targeted and phased programme of gas monitoring was completed which obtained gas monitoring readings during varying atmospheric conditions and which also covers the 'worst case' scenarios. The monitoring visits were targeted to correlate with the worst-case conditions, comprising a falling atmospheric pressure trend. As a comparison to the falling atmospheric pressure trends, monitoring was also undertaken during a period of rising pressure, to determine background and static levels. A summary of the results for the visits undertaken are presented in Table 1 below and continued on the following page, with a copy of the monitoring results attached with this report.

Table 1

Borehole	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)
1	19/04/16	1022 (Rising trend*)	Dry	0.0	0.0	0.0	20.1	<0.1
4			3.61	0.0	0.0	0.1	19.4	<0.1
5			1.48	0.0	0.0	0.2	20.0	<0.1
8			1.24	0.0	0.0	0.2	20.0	<0.1
11			1.10	0.0	0.0	0.4	19.7	<0.1
1	03/05/16	1013 (Rising trend*)	Dry	0.0	0.0	0.0	20.1	<0.1
4			2.90	0.0	0.0	0.3	19.4	<0.1
5			1.49	0.0	0.0	0.5	19.8	<0.1
8			1.24	0.0	0.0	0.6	19.4	<0.1
11			1.58	0.0	0.0	0.8	19.3	<0.1
1	13/05/16	1005 (Steady trend*)	Dry	0.0	0.0	0.0	20.0	<0.1
4			2.91	0.0	0.0	0.5	19.5	<0.1
5			1.52	0.0	0.0	0.7	19.2	<0.1
8			1.27	0.0	0.0	0.6	19.7	<0.1
11			1.60	0.0	0.0	1.1	19.0	<0.1
1	17/06/16	1000 (Rising trend*)	Dry	0.0	0.0	0.0	19.6	<0.1
4			1.87	0.0	0.0	0.4	19.4	<0.1
5			1.50	0.0	0.0	0.0	20.1	<0.1
8			1.24	0.0	0.0	0.6	19.6	<0.1
11			1.68	0.0	0.0	1.8	18.1	<0.1
1	22/07/16	1005-1006 (Rising trend*)	Dry	0.0	0.0	0.0	19.9	<0.1
4			2.93	0.0	0.0	0.7	19.3	<0.1
5			1.57	0.0	0.0	1.0	18.8	<0.1
8			1.34	0.0	0.0	0.9	19.6	<0.1
11			1.63	0.0	0.0	1.6	18.3	<0.1
1	04/08/16	994-995 (Falling trend*)	Dry	0.0	0.0	0.0	20.3	<0.1
4			1.15	0.0	0.0	0.2	19.5	<0.1
5			1.44	0.0	0.0	0.6	20.2	<0.1
8			1.24	0.0	0.0	1.2	19.2	<0.1
11			Dry	0.0	0.0	0.9	19.6	<0.1

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

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Table 1 (Cont'd)

Borehole	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)
1	26/08/16	1005 (Falling trend*)	Dry	0.0	0.0	0.0	20.2	<0.1
4			1.26	0.0	0.0	0.4	19.2	<0.1
5			1.51	0.0	0.0	0.8	19.9	<0.1
8			1.30	0.0	0.0	1.6	18.7	<0.1
11			Dry	0.0	0.0	0.8	19.9	<0.1
1	07/10/16	1021-1022 (Falling trend*)	Dry	0.0	0.0	0.0	20.0	<0.1
4			2.94	0.0	0.0	0.5	19.7	<0.1
5			1.61	0.0	0.0	1.2	18.7	<0.1
8			1.37	0.0	0.0	1.0	19.3	<0.1
11			1.67	0.0	0.0	1.2	18.9	<0.1
1	21/10/16	1019-1020 (Steady trend*)	Dry	0.0	0.0	0.2	19.7	<0.1
4			0.91	0.0	0.0	1.1	16.8	<0.1
5			1.42	0.0	0.0	0.9	18.9	<0.1
8			1.23	0.0	0.0	0.9	19.0	<0.1
11			1.41	0.0	0.0	1.4	18.0	<0.1

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

In addition to the gas analyser, a PID survey was also undertaken on selected visits using an Ion Science Photocheck 2000 Photo Ionisation Detector (PID) meter with a 10.6eV lamp, calibrated to isobutylene (standard measurement scale). The PID measures ionisable vapour concentrations and gives an indication of the presence of volatile organic compounds (VOC's). Negligible levels (≤3ppm) of volatile organic compounds (VOC's) were recorded in BH04 during the PID survey indicating there is no vapour production below the site associated with lighter fraction hydrocarbons or solvents.

From the results, detectable levels of Carbon Dioxide (CO_2) have been recorded up to a maximum level of 1.8% *v/v* with depleted Oxygen (O_2) concentrations also recorded down to a minimum of 16.8% *v/v*. No concentrations of Methane (CH_4) have been recorded to date. The determination of risk is based on the limiting borehole gas volume flow for Methane and Carbon Dioxide, known as the Gas Screening Value (GSV), which in turn determines the level of any gas protection required. Therefore, to complete the risk assessment, the maximum GSV (Gas Screening Value) for the CH_4 and CO_2 levels recorded have been determined as follows:

- Methane (CH_4) – Unable to calculate a GSV.
- Carbon Dioxide (CO2) - multiplying the maximum concentration by the maximum flow rate which gives a GSV of 0.0018 l/hr - calculated from 1.8% (0.018) x 0.1 l/hr maximum flow rate) for CO_2.

From the results, the calculated GSV value for CO_2 does not exceed the GSV assessment value of 0.07 l/hr (Characteristic Situation 1) or Green classification (NHBC Traffic Light System) which negate the requirement for gas protection measures.

However, based on the contamination screening undertaken, although not manifested in the monitoring wells and PID survey, volatile organic compounds have been identified in the shallow soils which may result in the requirement for vapour protection measures (i.e. an upgraded gas membrane (hydrocarbon and volatile vapour resistant membrane) and vented sub-floor voids).

Re: Proposed Retirement Apartments - Roundel Kitchens, Harton Centre, 52 Harton Lane, South Shields, Tyne & Wear – Hazardous Ground Gas Risk Assessment Addendum Report

When considering the results of the Ground Contamination Screening it has been determined that the proposed development will require vapour protection measures associated with potential Volatile and Semi-volatile Organic Compound (VOC's / SVOC's). The measures should be sufficient to remove the potential migration pathway into the new residential apartments from potentially volatile vapours, and therefore provide the necessary protection to the proposed end users.

The design details and specification for this site should be designed in accordance with BS8576:2013: Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds, BRE414:2001: Protective measures for housing on gas contaminated land and BS8485:2015 – 'Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings'.

The design details and specification requirements discussed in the aforementioned BRE414 and BS8485 reports are also outlined within the Yorkshire and Lincolnshire Pollution Advisory Group (YALPAG) Technical Guidance document 'Verification Requirements for Gas Protection Systems', December 2016.

As good practice, it must be ensured that the remediation works to install the gas protection measures and subsequent validation of these measures is undertaken in accordance with the YALPAG document and CIRIA C735 'Good practice on the testing and verification of protection systems for buildings against hazardous ground gases', August 2014.

The guidance also documents the requirements for approved/qualified contractors with the necessary qualification/experience to install the gas protection measures. The design drawings & product specifications should be submitted to the Local Authority and NHBC for approval.

The implementation of the adopted protection measures must be witnessed, photographed and validated by an experienced and suitably qualified Engineer to ensure that all works are being completed in strict accordance with the adopted Remediation Strategy (to be discussed / approved with NCC), the proposed design details, BS8485 and CIRIA C735.

We trust the information provided 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

J P. Dit

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John Ditchburn *BEng (Hons) CSci MIEnvSc FGS*
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Site:	Harton Lane, South Shields
Ref:	16-136

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)
										R/F/S	Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	Hex %	PID Cf	PID (Isobutylene)	H_2S	CO	
1	19/04/2016	11:50am	GFM435	Sunny	IH	Bailed out BH 5,8,11 after monitoring	1	<0.1	1022			0.0		0.0		0.0		20.1			0			DRY
							4	<0.1	1022			0.0		0.0		0.1		19.4			1			3.61
							5	<0.1	1022	R		0.0		0.0		0.2		20.0			0			1.48
							8	<0.1	1022			0.0		0.0		0.2		20.0			0			1.24
							11	<0.1	1022			0.0		0.0		0.4		19.7			0			1.10
2	03/05/2016	10:30am	GFM435	Cloudy, sunny spells	IH	Bailed out BH 5,8,11 after monitoring	1	<0.1	1013			0.0		0.0		0.0		20.1			0			DRY
							4	<0.1	1013			0.0		0.0		0.3		19.4			1			2.90
							5	<0.1	1013	R		0.0		0.0		0.5		19.8			0			1.49
							8	<0.1	1013			0.0		0.0		0.6		19.4			0			1.24
							11	<0.1	1013			0.0		0.0		0.8		19.3			0			1.58
3	13/05/2016	12:10pm	GFM435	Cloudy	IH	Bailed out BH 5,8,11 after monitoring	1	<0.1	1005			0.0		0.0		0.0		20.0			0			DRY
							4	<0.1	1005			0.0		0.0		0.5		19.5			1			2.91
							5	<0.1	1005	S		0.0		0.0		0.7		19.2			0			1.52
							8	<0.1	1005			0.0		0.0		0.6		19.7			0			1.27
							11	<0.1	1005			0.0		0.0		1.1		19.0			0			1.60
4	17/06/2016	11:55am	GFM435	Light rain	IH	Bailed out BH 5 and 8 after monitoring	1	<0.1	1000			0.0		0.0		0.0		19.6			0			DRY
							4	<0.1	1000			0.0		0.0		0.4		19.4			0			1.87
							5	<0.1	1000	R		0.0		0.0		0.0		20.1			0			1.50
							8	<0.1	1000			0.0		0.0		0.6		19.6			0			1.24
							11	<0.1	1000			0.0		0.0		1.8		18.1			0			1.68
5	22/07/2016	1:00pm	GFM435	Sunny	IH	Bailed out BH5 and 8 after monitoring	1	<0.1	1005			0.0		0.0		0.0		19.9			0			DRY
							4	<0.1	1005			0.0		0.0		0.7		19.3			0			2.93
							5	<0.1	1006	R		0.0		0.0		1.0		18.8			0			1.57
							8	<0.1	1006			0.0		0.0		0.9		19.6			0			1.34
							11	<0.1	1005			0.0		0.0		1.6		18.3			0			1.63
6	04/08/2016	11:35am	GFM435	Overcast	IH	Biled out BH 4,5,8 after monitoring	1	<0.1	995			0.0		0.0		0.0		20.3			0			DRY
							4	<0.1	994			0.0		0.0		0.2		19.5			3			1.15
							5	<0.1	995	F		0.0		0.0		0.6		20.2			0			1.44
							8	<0.1	995			0.0		0.0		1.2		19.2			0			1.24
							11	<0.1	994			0.0		0.0		0.9		19.6			0			DRY

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)

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Site:	Harton Lane, South Shields
Ref:	16-136

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)
										R/F/S	Initial	Steady	Initial	Steady	Initial	Steady	Initial	Steady	Hex %	PID Cf	PID (Isobutylene)	H_2S	CO	
7	26/08/2016	11:45am	GFM435	Sunny, wet	IH	Bailed out BH 4 and 8 after monitoring	1	<0.1	1005			0.0		0.0		0.0		20.2			0			DRY
							4	<0.1	1005			0.0		0.0		0.4		19.2			0			1.26
							5	<0.1	1005	F		0.0		0.0		0.8		19.9			0			1.51
							8	<0.1	1005			0.0		0.0		1.6		18.7			0			1.30
							11	<0.1	1005			0.0		0.0		0.8		19.9			0			DRY
8	07/10/2016	1:00pm	GFM430	Overcast	IH	Bailed out BH8 after monitoring	1	<0.1	1021			0.0		0.0		0.0		20.0			0			DRY
							4	<0.1	1021			0.0		0.0		0.5		19.7			0			2.94
							5	<0.1	1021	F		0.0		0.0		1.2		18.7			0			1.61
							8	<0.1	1022			0.0		0.0		1.0		19.3			0			1.37
							11	<0.1	1022			0.0		0.0		1.2		18.9			0			1.67
9	21/10/2016	11:00am	GFM430	Overcast, wet	IH		1	<0.1	1020			0.0		0.0		0.2		19.7			0			DRY
							4	<0.1	1019			0.0		0.0		1.1		16.8			2			0.91
							5	<0.1	1020	S		0.0		0.0		0.9		18.9			0			1.42
							8	<0.1	1020			0.0		0.0		0.9		19.0			0			1.23
							11	<0.1	1019			0.0		0.0		1.4		18.0			0			1.41

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

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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)