Our Ref C2206/21/E/3228
15th July 2022

Environmental
Geotechnical
Specialists

RGS

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For the attention of Richard Smith

Dear Sir,

Ref: Gas Monitoring – Cliff Hill, Denby Dale, Huddersfield.

This letter has been issued to supplement the data presented within the following reports:

- Report on a Geo-environmental Investigation at Cliff Hill Denby Dale (ref C2206/21/E, dated May 2022.

Monitoring

The monitoring of standpipes commenced on the 22nd April 2022 and comprised a regime of 6 readings over 3 months. The results of the gas monitoring undertaken to date are tabulated below.

Table 8: Gas Monitoring

Location	Date	CH_4 (%)	CO_2 (%)	O_2 (%)	Flow (l/h)	Barometric Pressure (mb)	Water Level (m)	Standpipe Depth (m)
WS03	22.04.2022	0.1	1.4	20.0	0.0	991↓	_	1.5
	29.04.2022	0.1	1.3	20.5	0.0	1011↓	_	
	06.05.2022	0.1	1.2	20.1	**0.1**	1002↓	_	
	13.05.2022	0.1	1.2	20.2	**0.1**	994↑	_	
	13.06.2022	0.1	1.3	20.0	0.0	1003↑	_	
	11.07.2022	0.1	1.0	20.4	0.0	1002↓	_	
WS04	22.04.2022	0.1	**0.0**	21.4	0.0	993↓	_	**0.9**
	29.04.2022	0.1	0.1	21.1	0.0	1012↓	_	
	06.05.2022	0.1	0.3	21.0	**0.1**	1003↓	_	
	13.05.2022	0.1	0.3	20.9	**0.1**	995↑	_	
	13.06.2022	0.1	0.6	20.4	0.0	1004↑	_	
	11.07.2022	0.1	0.5	20.0	0.0	1003↓	_	
WS05	22.04.2022	0.1	0.9	20.7	0.0	993↓	_	1.5
	29.04.2022	0.1	0.8	20.7	0.0	1012↓	_	
	06.05.2022	**0.2**	0.7	20.8	**0.1**	1004↓	_	
	13.05.2022	0.1	0.6	20.7	0.0	996↑	_	
	13.06.2022	0.1	0.7	20.4	0.0	1005↑	_	
	11.07.2022	0.1	0.5	19.9	0.0	1004↓	_	
WS06	22.04.2022	0.1	2.4	18.7	**0.1**	992↓	_	1.5
	29.04.2022	0.1	2.2	20.9	0.0	1013↓	_	
	06.05.2022	0.1	1.9	19.3	**0.1**	1004↓	_	
	13.05.2022	0.1	1.4	20.0	0.0	997↑	_	

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	13.06.2022	0.1	1.3	19.8	0.0	1006↑	_	
	11.07.2022	0.1	1.2	19.5	0.0	1004↓	_	
WS07	22.04.2022	0.1	1.3	19.5	0.0	992↓	_	2.5
	29.04.2022	0.1	1.4	19.8	0.0	1013↓	_	
	06.05.2022	0.1	1.3	19.9	**0.1**	1002↓	_	
	13.05.2022	0.1	1.2	20.2	0.0	996↑	_	
	13.06.2022	0.1	1.4	20.1	0.0	1005↑	_	
	11.07.2022	0.1	1.4	20.0	0.0	1004↓	_	
WS09	22.04.2022	0.1	8.2	14.3	0.0	992↓	_	3.6
	29.04.2022	0.1	2.6	18.9	0.0	1012↓	_	
	06.05.2022	0.1	6.2	14.5	0.1	1003↓	_	
	13.05.2022	0.1	3.4	17.7	0.0	996↑	_	
	13.06.2022	0.1	7.3	12.3	0.0	1005↑	3.51	
	11.07.2022	N/A	N/A	N/A	N/A	N/A	N/A	
WS10	22.04.2022	0.1	0.1	21.4	**0.1**	992↓	_	1.5
	29.04.2022	**0.0**	0.2	21.2	0.0	1012↓	_	
	06.05.2022	0.1	0.1	21.1	**0.1**	1003↓	_	
	13.05.2022	0.1	0.1	21.0	0.0	996↑	_	
	13.06.2022	0.1	0.1	21.0	0.0	1004↑	_	
	11.07.2022	0.1	0.1	20.3	0.0	1004↓	_	

↑ - rising pressure ↓ - falling pressure ↔ -steady pressure
*Borehole missing: assumed damaged by subsequent contractors.

This work was undertaken using a Geotechnical Instruments (UK) Ltd. GA5000 (serial No G503524).

Gas Concentrations

With respect to ground gas, the results of the completed monitoring regime to date indicated a maximum concentration of 0.1% methane, with concentrations of carbon dioxide ranging between 0% and 8.2% in association with oxygen levels of between 12.3% and 21.4%. It should be appreciated that on non-contaminated sites there is generally about 20% by volume of oxygen, associated with low levels of carbon dioxide. In addition, a maximum flow rate of 0.1 litres per hour was recorded

The principal driving force for initiating the movement of gas in the ground is a change in barometric pressure[1]. The most onerous gas condition on a site is usually observed on days of low or falling barometric pressure, preferably below 1000mb. It has been noted that measurements undertaken solely during high pressure conditions may be of lesser value. At this site the readings undertaken to date were at atmospheric pressures of between 991mb and 1013mb.

Risk Assessment

In order to establish the gas screening value (GSV) for carbon dioxide or methane, the maximum gas concentration (expressed as a decimal) is multiplied by the borehole flow rate (l/hr). In this case 0.1% (0.001) methane was recorded along with 8.2% (0.082) carbon dioxide, in association with a maximum flow rate of 0.1 l/hr. This results in a GSV of 0.0001 l/hr for methane and a GSV of 0.0082 l/hr for carbon dioxide.

In accordance with Table 8.5, *Modified Wilson and Card classification* of the CIRIA report C665, *Assessing risks posed by ground gasses to building,* a low risk from ground gasses is

[1] Although also impacted by changes of barometric pressure, the driving forces of mine gas also includes rising groundwaters in response to the cessation of pumping of waters from the mine. There is strong evidence that groundwaters within the mine will have stabilised a) the length of time elapsed since the mine closed and b) the fact that mine waters are recorded to be emanating from the ground off site to the south c) the relatively shallow groundwater levels recorded on the site.

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present. As such, the site may be provisionally characterised as *Characteristic Situation Level 2* (based on carbon dioxide exceeding the 5% limit)

However, this is only considering the harmful gases dispersed through the soils from the sources identified, (made ground on the site, buried topsoil, off-site sources) and does not account for the movements of large volumes of harmful mine gases which could migrate via permeable broken strata or mine entries. In order to produce a ground gas risk assessment the latest document produced by CLAIRE[2] has been given due consideration. The following details are summarised for clarity.

- A preliminary CSM has been presented within the Desk Study and coal mining risk assessment, and referenced within intrusive Investigation. These documents consider various data sources (Consultants Coal Mining Report, historical maps, aerial imagery) that are referenced within the new CLAIRE guidance document.

- In view of the desk study data, potential sources of ground gas at the site could be attributed to mine workings. It is noted that 3 mine shafts are present on site and have not been treated by capping or grouting. Clearly mine shafts represent credible pathways between the source of mine gas (workings) and receptors (site users). As such, the risk associated with mine gas could be considered 'high'.

  However, other on and off site sources of ground gas have also been identified within the desk study, which also could lead to the migration of ground gas to the site.

- The CSM considers all the 'pathways' between source and receptor. At this stage, the assumed pathways between source and receptor include cracks and fissures within the rock above the workings, and mine shafts.

- Although also impacted by changes of barometric pressure, the driving forces of mine gas also includes rising groundwaters in response to the cessation of pumping of waters from the mine.

- Elevated levels of carbon dioxide have been recorded during the ground gas monitoring that clearly indicate that ground gas precautions to dwelling will be required. It is noted that low and falling barometric pressures were recorded during this works[3].

- Given the information presented above, the levels of ground gas, if left untreated, is likely to affect the end users at the site, such that a 'high' risk should be considered.

- We hereby highlight that the gas monitoring scope, in terms of frequency and number of visits, is likely to require extension, and may encompass periods of continuous ground gas monitoring to fully realise rapid gas release from pressure drops based on the guidance provided within BS8385:2015.Therefore, it would be pragmatic (particularly from a cost point of view) to delay ground gas monitoring until a regime for remediating the site has been proposed. The probe drilling determined that workings will require grouting to stabilise them, which, if undertaken, would affect the conceptual site model. Indeed grouting is likely to reduce the 'source' of mine gas.

- To summarise: remediation of the site with respect to ground gas will be required. We again highlight that a finalised remediation strategy will depend on the results of the gas monitoring, the finalised development plans, and once risks posed by coal

[2] Good Practice for Risk Assessment for Coal Mine Gas Emissions, October 2021 - CLAIRE
[3] At this site the readings undertaken to date were at atmospheric pressures of between 991mb and 1013mb.

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workings (inclusive of the on-site mine shaft) have been remediated, if necessary. Our *outline* guide to gas protection measures were presented in the Geo-environmental report to advise the client of the typical costs for such works, should the development continue.

Conclusions

It should be acknowledged that the mine gas risk assessment should be considered a 'live document', and should be updated by a competent person when the design is fixed and before construction commences. It is recommended that the following works is undertaken as part of a pre-commencement planning condition.

- Review of the mine gas risk once the development proposals have been finalised.
- Remediation of the mine workings via a scheme of drilling and grouting, if deemed necessary.
- Implementation of such ground gas monitoring required to complete the ground gas risk assessment. This could be undertaken post-remediation to confirm the results.
- Production of a remediation statement.
- Production of a validation report.

We trust that this information is of interest and should you have any other requirements do not hesitate to contact us.

For Rogers Geotechnical Services Ltd,

Yours Faithfully

Charlotte Mason BSc FGS
Geo-environmental Engineer

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References

- British Standards Institution (2013), BS 8576 Guidance on Investigations for Ground Gas – Permanent Gases and Volatile Organic Compounds.
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