Our Ref: E22196/GRL

Date: 7th October 2022

BY EMAIL:
Adam Wilson (Shields Wilson Ltd)
and
James Kirk / Summer Le Conte
Kirk Connected Construction Ltd
10 Four Seasons House
Enterprise Way
Pinchbeck
PE11 3YR

For the attention of Adam Wilson and Kirk Connected Construction

Dear Adam / James / Summer,

E22169: Review of Ground Gas Conceptual Site Model, Site Data and Proposed Construction Details for Site at Smithfield, Scoldhall Lane, Surfleet

Elemental GI Ltd have been instructed by Kirk Connected Construction Ltd ('the Client') and by Adam Wilson of Shields Wilson Ltd to review existing reports and other data relating to potential ground gas characteristics of the Site at Smithfield, Scoldhall Lane, Spalding ('the Site').

It is understood that the site is to be redeveloped to support a warehouse and office block and it is also understood that a third party has completed initial desk-based assessments and site investigation works across the site (these are detailed below) and that preliminary discussions have been undertaken with representatives of the Local Authority in relation to ground gas risks at the site (or the potential lack thereof). This letter report presents an overview of the works completed to date in relation to ground gas assessments and suggests a possible approach to confirming the site's ground gas alongside a discussion of potential mitigation measures.

1.0: Site Location

The site is set to the east of Scoldhall Lane, at NGR approx. 526504, 329407. It lies to the north-east of Surfleet and to the north-west of Surfleet Seas End. A Site Location Plan is enclosed.

2.0: Background Information

The following reports have been provided to Elemental GI Ltd:

- Grange GeoConsulting Ltd – Phase I Desk Study, Smithfield, Scoldhall Lane, Surfleet (Ref. R210712 dated Oct. 2021); and
- Grange GeoConsulting Ltd – Phase 2 Ground Investigation Report, Smithfield, Scoldhall Lane, Surfleet (Ref. R210712 dated May 2022).

The above referenced reports present detailed information relating to the site and to previous investigations and assessments. These reports have not been reproduced herein and should be referred to in full, and this letter must not be referred to in isolation.

3.0: Site Geo-Environmental Setting and Initial Conceptual Site Model

The third party Phase I Report stated the following in relation to the site's geo-environmental setting:

- *"The site is recorded to be underlain by superficial Tidal Flat deposits of Quaternary age. These materials are typically described as soft silty clay with subordinate layers of sand, gravel, and peat. The bedrock underlying the site is recorded to comprise mudstone from the Oxford Clay Formation, of Jurassic age. Locally these deposits are typically described as grey silica rich mudstones with sporadic beds of limestone nodules.";*
- *"Both the superficial Tidal Flat deposits and the bedrock from the Oxford Clay Formation have been classified as Unproductive aquifer units";*
- *"The site is within a Lower Probability Radon Area (with less than 1% of homes estimated to be at or above the Action Level). Basic radon protection measures are therefore required in the construction of new homes or buildings in this area.";*
- *"No BGS recorded, Local Authority recorded, or historical landfill sites have been identified by Envirocheck within 1km of the site.";*
- *"No records of potentially infilled land have been identified within 1km."*

The report included consideration of potential ground gas sources beneath the site and within its vicinity. Specific potential gas sources (e.g. landfill sites) were not identified in their report, although they did state the following regarding potential natural sources of ground gas:

> *"It is considered possible that the Tidal Flat deposits which underlie the site could (as a result of deposition characteristics) possess a significant organic component, resulting in ground gas generation potential.".*

The third party went on to include consideration of ground gas risks (including consideration of potential pathways and receptors) within their site-specific conceptual site model). This suggested that ground gas from natural sources may migrate through 'permeable soils', and that this presented potential risks to future site users and the structures within which they may work.

The third party recommended that *"…further examination of the ground gas generation potential, and the likely permeability of the Tidal Flat deposits underlying the site is recommended in order to corroborate the preliminary Conceptual Site Model.".*

4.0: Site Investigation Works

The third party completed site investigation works in early March 2022, which were presented in their Phase 2 Report of May 2022. Their intrusive works included the completion of 5 No. window sampler boreholes (maximum depth of 3.0m) and the excavation of 2 No. hand-dug trial pits (maximum depth of 0.5m. They installed 1 No. gas / groundwater monitoring well at location 'WS3'.

A copy of the third party's exploratory hole records and exploratory hole layout plan (ref. R21071-DWG2) are enclosed.

The third party recorded the site to be underlain by made ground (encountered in 3 No. positions to a maximum depth of 0.5m) or topsoil and subsequently by Tidal Flat Deposits which they described as *"Loose to very loose, light brown, brown, yellow brown, orange and grey mottled, clayey, silty sand, and clayey sand.".*

With regards to groundwater, the third party noted the following:

> *"Groundwater was recorded in the window sample boreholes twenty minutes following the completion of the drilling on site. Groundwater depths within the Tidal Flat Deposits were 1.2m bgl (WS2 and WS5), 1.25m bgl (WS1) and 1.3m bgl (WS3 and WS4). No evidence of contamination was noted in the groundwater. A monitoring well was installed to 2.8m bgl in WS3, with a response zone between 1m and 2.8m bgl. One round of post-investigation monitoring was carried out on 17th March 2022. During this monitoring visit, groundwater was recorded at a depth of 1.4m bgl."*

5.0: Ground Gas Monitoring

The third party described their approach to ground gas monitoring at the subject site in their scope of works within their Phase 2 Report as follows:

> *"1 day of dynamic (window) sampling to excavate 5 No. window sample boreholes (WS1 to WS5) at the site to enable the logging of the soils encountered and the collection of soil samples …* [and]*… the installation of one groundwater and ground gas monitoring well (WS3) with one round of post-investigation monitoring as a precautionary measure.".*

Detailed rationale to explain the consideration / justification of the period of monitoring was not provided, although they did suggest that the single visit was *"… in order to characterise conditions within the standpipe installed during the investigation (WS3).".*

The single gas monitoring visit undertaken by the third party was completed on 17th March 2022. The following were recorded:

- Maximum Methane (CH4) = 0.0 %v/v
- Maximum Carbon Dioxide (CO2) = 0.9 %v/v
- Minimum Oxygen (O2) = 19.1 %v/v
- Maximum Flow = 1.0 l/hr

It is noted that the third party presented the 'peak' readings in their report, and that the ground gas monitoring records (copy enclosed) show that the 'steady' rates were identical to the 'peak' rates with the exception of the flow rate which fell to 0.2 l/hr. Water is recorded at 1.40m depth, indicating an unsaturated response zone in their well from 1.0m to 1.40m depth.

The third party concluded that the gas monitoring concentrations recorded would indicatively merit a classification of 'CS1' and that (effectively) no protection measures would be required. However they added that *"It is acknowledged that the monitoring programme, designed to characterise any ground gas issues, may not be sufficient to fully classify the site in accordance with the methodology established in current guidance. Should such a classification be required, further monitoring visits are likely to be required.".*

6.0: Assessment Options for Ground Gas Classification

At this stage (and with reference to the Clients discussions with representatives of the Local Authority) it is considered that the following main options exist in terms of further potential works to determine the site with respect to ground gas classification(s):

- Completion of additional regular ground gas monitoring visits to meet the minimum number required by the appropriate guidance (taken as CIRIA C665 for initial review purposes); or
- Installation of *in situ* continuous ground gas analysers ('gas clams') to confirm the steady-state ground gas conditions in sealed wells; or
- Consideration of desk-based assessments (e.g. CL:AIRE 'RB17' Assessment).

Following discussions with the Client it is understood that a desk-based assessment is preferable at this stage due to limiting factors associated with their build programme etc.

7.0: Desk-Based Assessment of Ground Gas Generation Potential

The following factors have been considered within this assessment which are important to note:

- Elemental GI Ltd agree with the third party's report which states that there is a risk that organic materials are likely to be present in the natural soils locally. However, no organic materials or odours were recorded by them during their investigations;
- The third party's investigations did not encounter any other potential sources of ground gas or vapours;
- The lab. results presented by the third party showed organic matter (%) ranging from 1.3% to 3.5% which may be considered relatively typical of soils in the general area, and not indicative of unusually high organic matter proportions;
- Generally shallow groundwater was noted during the site works which may inhibit and / or change the ground gas generation potential of any organic materials and / or influence migration.

The CL:AIRE research bulletin 'A Pragmatic Approach to Ground Gas Risk Assessment) ('RB17' dated Nov. 2012) has been reviewed as part of this assessment.

The following points from RB17 are noted with interest and are considered to be relevant to this assessment:

- *"Sites where routine gas monitoring is less likely to be required include the following: …*
    - *2. Natural soils that are known to contain methane, e.g. Alluvium, Peat, etc, providing pockets of trapped gas cannot be released quickly due to changes in groundwater level (which is rare and not likely on most sites)"*
- *"The development of a conceptual model is important and this should be based on an understanding of the history of a site and the nature of the source material. It should identify and consider all the relevant aspects of gas generation and transport processes, including the source of gas, the site specific pathways of flow and transport and all of the potential receptors."*
- *"Alluvial soils and buried peat can quite often give high concentrations of methane and carbon dioxide in monitoring wells, often methane concentrations can reach up to 90%. This is because the gas has been generated historically and is trapped in the pores due to limited transport (at low diffusion rates). The methane accumulates at increasing depth in peat columns, but this does not indicate high rates of production (Clymo and Bryant, 2008; Fritz et al., 2011)…… **In all these situations experience has shown that provision of passive venting or positive pressurisation below the floor slab combined with a gas resistant membrane (installed correctly and independently verified) is sufficient to mitigate the risk posed by the presence of gas in the ground**."*

A fresh and updated summary of the site's ground gas conceptual site model has been prepared below:

- Sources:
  - Generally absent.
  - Ground investigation has not encountered potential gas-generating materials or materials likely to volatilise.
  - Lab. analysis of soil samples has not recorded excessively high organic matter.
  - Potential for organic materials at greater depths than those reached by the recent investigations remains possible.
  - Potential for organic materials in natural soils within the site's vicinity remains possible.
- Pathways:
  - The ground beneath the site is described as being generally granular, but with a typically high cohesive content ("*Loose to very loose, light brown, brown, yellow brown, orange and grey mottled, clayey, silty sand, and clayey sand*."). It is considered likely that this cohesive content may generally reduce or even inhibit significant gas migration.
  - Shallow groundwater was recorded by the third party. It is considered likely that saturated ground is likely to generally reduce or even inhibit significant gas migration.
  - The possibility exists that preferential pathways may be present locally (natural or anthropogenic) which have not been identified thus far.
  - The Client informs us that the future structures will benefit from a ventilated suspended floor slab and a well-fitted 'Visqueen' membrane suitable to meet a typical CS2 requirement and that this shall be fitted by suitably experienced / qualified fitters and shall be protected after installation, which is likely to significantly reduce pathways into structures.
- Receptors:
  - The site is to be redeveloped to support a warehouse and office block. Future site users including workers and maintenance staff are considered as primary receptors.
  - The structures within which these people shall work have also been considered as receptors in relation to potential ground gas risks.
  - Current guidance acknowledges that commercial / administrative buildings typically produce less risky environments than other end-uses (e.g. residential) as they are occupied less frequently and typically experience better ventilation etc.

We have considered the above CSM in the context of the RB17 guidance. We have also compared the site 'organic matter' results to Table 1 of RB17 (although it is acknowledged that this is highly conservative as this is for organic matter in made ground and not natural soils, which are highlighted by the third party as the main potential source of ground gas).

Table 1 of RB17 would conservatively yield a classification of CS2 for the site assuming a thickness of materials beneath the site of 5.0m and a typical TOC (%) in the region of 1.3% to 3.5%.

8.0: Conclusions and Recommendations

The site is in an area where natural ground gas sources may be present locally, although none have been recorded during the recent investigation. Laboratory results from the recent site investigation do not indicate a high amount of organic matter in the shallow soils beneath the site, and a ground gas monitoring visit undertaken by the third party did not record any significant gas concentrations or flows. However, caution is justified with regards to the interpretation of these results due to the relatively shallow nature of the investigation boreholes and the single / isolated monitoring data available.

Notwithstanding the above, any slight to moderate ground gas risks which may be *theoretically* present to the identified receptors should be robustly and conservatively addressed by the proposed design details and gas protection measures being installed which shall include a well ventilated sub-floor void and a membrane (sufficient to meet a 'CS2' criteria) which shall be fitted in accordance with criteria for a site classified as CS2 (e.g. service penetrations sealed etc.).

We have reviewed the site's conceptual site model and design proposals to the RB17 guidance, which indicates that gas risks are not likely to be present to the identified receptors at this stage, subject to regulatory approval.

Copies of this letter report should be presented to the regulators (as necessary) to seek their approval and ensure that they are kept informed on site works before further works are undertaken.

Yours sincerely,

James Regan
Managing Director

Enc. Site Location Plan (001)
Third Party Exploratory Hole Logs
Third Party Exploratory Hole Plan
Third Party Ground Gas Monitoring Data



CLIENT:	TITLE:	DATE:	SCALE@SIZE:
KIRK CONNECTED CONSTRUCTION	Site Location Plan	Oct. 2022	NOT TO SCALE
		DRAWING No: E22196_001	DESIGN/DRAWN: JR

Elemental GI Ltd

Window Sample Log

WS No: **1**

Client: Kirk Homes Ltd
Project: Smithfield, Scoldhall Lane, Surfleet

Sheet: 1 of 1
Method: Dynamic Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Topsoil, dark brown, sandy SILT.		
0.5			Loose to very loose, light brown, clayey, silty, SAND. (Tidal Flat Deposits)		
1	SPT	N = 4		1	
1.5					
2	SPT	N = 2	becoming grey.	2	
2.5					
3	SPT	N = 4		3	
			End of borehole.	4	
				5	

General Comments:

1. Groundwater at 1.25m after 20 minutes.
2. No visual or olfactory evidence of contamination.
3.

Scale:
Date: 09/03/2022
Logged by: AH
Checked: SW
Job No: R21071

Grange Geo Consulting Ltd

Window Sample Log

WS No: 2

Client: Kirk Homes Ltd
Project: Smithfield, Scoldhall Lane, Surfleet

Sheet: 1 of 1
Method: Dynamic Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Topsoil, dark brown, sandy SILT.		
0.5			Loose, yellow brown and grey mottled, slightly clayey, very silty SAND. (Tidal Flat Deposits)		
1	SPT	N = 5		1	
			Loose to very loose, brown, clayey SAND.		
2	SPT	N = 2		2	
2.5			Becoming grey in colour.		
3	SPT	N = 2		3	
			End of borehole.		

General Comments:

1. Groundwater at 1.20m after 20 minutes.
2. No visual or olfactory evidence of contamination.
3.

Scale:
Date: 09/03/2022
Logged by: AH
Checked: SW
Job No: R21071

Grange Geo Consulting Ltd

Window Sample Log

WS No: **3**

Client: Kirk Homes Ltd
Project: Smithfield, Scoldhall Lane, Surfleet

Sheet: 1 of 1
Method: Dynamic Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Topsoil, dark brown, sandy SILT.		
0.5			Loose to very loose, yellow brown and grey mottled, slightly clayey, very silty SAND. (Tidal Flat Deposits)		
1	SPT	N = 4		1	
1.5					
2	SPT	N = 2	Becoming grey.	2	
2.5					
3	SPT	N = 2		3	
			End of borehole.		

General Comments:

1. Groundwater at 1.3m after 20 minutes.
2. Ground gas and groundwater monitoring well installed to 2.8m bgl. Response zone from 1m to 2.8m bgl.
3. No visual or olfactory evidence of contamination.

Scale:
Date: 09/03/2022
Logged by: AH
Checked: SW
Job No: R21071

Grange Geo Consulting Ltd

Window Sample Log

WS No: 4

Client: Kirk Homes Ltd
Project: Smithfield, Scoldhall Lane, Surfleet

Sheet: 1 of 1
Method: Dynamic Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Topsoil, dark brown, sandy SILT.		
0.5			Yellow brown and grey mottled, clayey, SAND. (Tidal Flat Deposits)		
1	SPT	N = 2		1	
1.5					
2	SPT	N = 2		2	
2.5					
3	SPT	N = 3		3	
			End of borehole.		

General Comments:

1. Groundwater at 1.3m after 20 minutes.
2. No visual or olfactory evidence of contamination.
3.

Scale:
Date: 09/03/2022
Logged by: AH
Checked: SW
Job No: R21071

Grange Geo Consulting Ltd

Window Sample Log

WS No: 5

Client: Kirk Homes Ltd
Project: Smithfield, Scoldhall Lane, Surfleet

Sheet: 1 of 1
Method: Dynamic Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Made Ground, brown, gravelly, SAND. Gravels of fine to coarse concrete and sub-rounded quartzite.		
			Orange brown, silty, SAND. (Tidal Flat Deposits)		
0.5					
			Very loose, brown, clayey SAND. (Tidal Flat Deposits)		
1	SPT	N = 2		1	
1.5					
2	SPT	N = 2	Becoming grey.	2	
2.5					
3	SPT	N = 1		3	
			End of borehole.		

General Comments:

1. Groundwater at 1.2m after 20 minutes.
2. No visual or olfactory evidence of contamination.
3.

Scale:
Date: 09/03/2022
Logged by: AH
Checked: SW
Job No: R21071

Grange Geo Consulting Ltd

Hand Pit Log

HP No: **1**

Client: Kirk Homes Ltd
Project: Smithfield, Scoldhall Lane, Surfleet

Sheet: 1 of 1
Method: Hand Excavated

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Made Ground, brown, silty CLAY with rare ash.		
			Brown, slightly sandy, clayey, SAND.		
0.5					
			End of trial pit.		
1				1	

General Comments:

1. No groundwater encountered.
2. Rare ash noted in the Made Ground.
3. Hole backfilled.

Scale:
Date: 09/03/2022
Logged by: AH
Checked: SW
Job No: R21071

Hand Pit Log

HP No: 2

Client: Kirk Homes Ltd
Project: Smithfield, Scoldhall Lane, Surfleet

Sheet: 1 of 1
Method: Hand Excavated

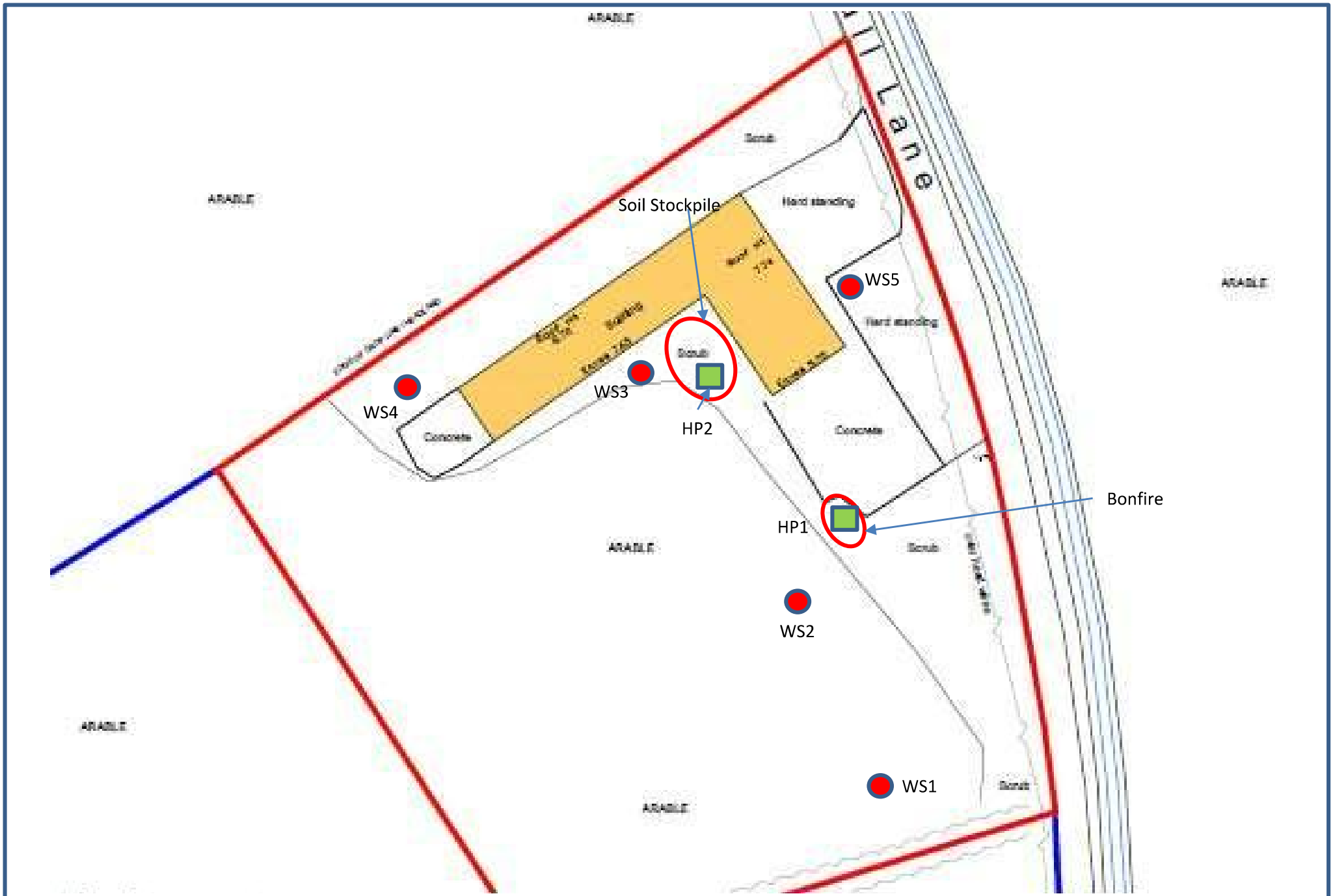
Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Made Ground, brown, slightly sandy, silty, CLAY.		
0.5					
				1	
1					

General Comments:

1. No groundwater encountered.
2. No visual or olfactory evidence of contamination encountered.
3. Hole backfilled.

Scale:
Date: 09/03/2022
Logged by: AH
Checked: SW
Job No: R21071

Grange Geo Consulting Ltd



Grange Geo	**Exploratory Hole Location Plan** Smithfield, Scoldhall Lane, Surfleet	**Client:** Kirk Homes **Date:** May 2022	North	R21071-DWG2

Grange Geo GAS AND GROUNDWATER MONITORING

Site:		Surfleet
Client:		
Job No.:		R21071
Date:		17/03/2022
Start / End Time:		11.30am
Engineer:		A.Hare
Monitoring Equipment:	**Gas Meter ID**	**GG001**
	PID ID	
	Dip Tape	**In-Situ 30m**
	Other	

NR = Not Recorded
Dry = No Groundwater

Weather Conditions	Start	End
(Dry / Raining)	dry	dry
Cloud Cover (Oktas)	1/8	1/8
Wind Strength (mph)	13.0	12.0
Wind Direction (from)	NW	NW
Temperature (°C)	11.0	11.0
Barometric Pressure (mb)	1020	1019
(Rising/ Falling)	Falling	
PID - Air	0	
PID - Calibration Gas	100	

Location Reference	Relative Pressure (mbar)	Flow (l/hr)		Methane (%v/v)		Carbon Dioxide (%v/v)		Oxygen (%v/v)		Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)		Depth to water (m)	Base of Response Zone (m)	Free-Phase Product Level Top (m)	Groundwater Elevation (m AOD)	Notes
		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady								
Ambient Air Start (Calibration)																	
Ambient Air Finish (Calibration)																	
WS3		1.0	0.2	0.0	0.0	0.9	0.9	19.1	19.1				1.40	2.80			