

## Report on a Ground Investigation

|            |                                            |              |           |
|------------|--------------------------------------------|--------------|-----------|
| Location:  | Land off Banks Road, Linthwaite<br>HD7 5LP |              |           |
| For:       | James Bamforth                             |              |           |
| Report No. | GES 1399-21                                | Report date: | June 2021 |

For and on behalf of **GeoEnviro Solutions Ltd**

|                                                               |                                           |
|---------------------------------------------------------------|-------------------------------------------|
| <b>REDACTED</b>                                               | <b>REDACTED</b>                           |
| <b>Daniel Speight</b> BSc(Hons)<br>Geo-environmental Engineer | <b>Rob Lewis</b> BSc(Hons)FGS<br>Director |

| Issue | Date     | Description | Prepared | Reviewed | Approved |
|-------|----------|-------------|----------|----------|----------|
| 01    | 09/06/21 | Final       | DS       | RL       | RL       |
|       |          |             |          |          |          |

## Contents

---

|      |                                                            |    |
|------|------------------------------------------------------------|----|
| 1.0  | Introduction.....                                          | 4  |
| 2.0  | Proposed Development.....                                  | 4  |
| 3.0  | Physical Setting.....                                      | 4  |
| 4.0  | Preliminary Conceptual Site Model and Risk Assessment..... | 7  |
| 5.0  | Fieldworks .....                                           | 9  |
| 6.0  | Geology & Ground Conditions.....                           | 9  |
| 7.0  | Groundwater Conditions.....                                | 10 |
| 8.0  | Visual and Olfactory Observations .....                    | 10 |
| 9.0  | Geotechnical Laboratory Testing .....                      | 10 |
| 10.0 | Construction consideration.....                            | 11 |
| 11.0 | Contamination .....                                        | 13 |
| 12.0 | Site Investigation Findings .....                          | 18 |
| 13.0 | Updated Conceptual Site Model and Risk Assessment .....    | 20 |
| 14.0 | Recommendations .....                                      | 22 |
| 15.0 | Limitations .....                                          | 24 |
| 14.0 | References .....                                           | 24 |

## Appendices

Appendix 1: Site Plan and Exploratory Hole Plan

Appendix 2: Borehole Logs

Appendix 3: Geotechnical Laboratory Results

Appendix 4: Soil Contamination Laboratory Results

Appendix 5: Gas Monitoring Results

## 1. Introduction

---

*GeoEnviro Solutions* (GES) was instructed by James Bamforth to conduct a Site Investigation (SI) at a site known as Land off Banks Road, Linthwaite, HD7 5LP.

The SI undertaken is as a result of recommendations made by Rogers Geotechnical Services (RGS) in our previously issued Phase 1: Environmental Desk Study Report for the site (Report Reference: C1575/21/E/2457, Issued: March 2021), to which this report should be read in conjunction with. As such this report seeks to address the potential pollutant linkages identified within the Preliminary Conceptual Site Model contained within our Phase 1: Environmental Desk Study Report.

We are content that as a result of the actual site investigation works and subsequent soil testing undertaken, as outlined within this report, we have characterised the ground conditions and consequently the potential for contamination to exist on site. These works and ensuing assessment have been detailed in this report.

The information contained in this report is intended for the use of the named client (or their approved contractors). Should any part of this report be relied on by a third party, that party does so wholly at its own risk and GES disclaims any liability to such parties. Should the purposes for which the report is used, or the proposed use of the site change, this report may no longer be valid and further use of, or reliance upon the report in those circumstances shall be at the client's sole and own risk. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. GES should in all such altered circumstances be commissioned to review and update this report accordingly.

## 2. Proposed Developments

---

We understand current plans for the development of the site include:

- The development of a semi-detached house with gardens and driveway.

The proposed redevelopment plans for the site, at the time of issuing this report can be reviewed within Appendix 1.

## 3. Physical Setting

---

### 3.1 Site Information

The site is approximately rectangular in shape and slopes relatively steeply and occupies a position off Banks road.

### 3.2 Geology

There are no records of superficial deposits underlying the site. Underlying the site is bedrock comprised of Millstone Grit Group, comprising mudstones, siltstones and sandstones.

### 3.3 Hydrogeology

As a result of the bedrock geology on site, the aquifer is designated as being a Secondary A Aquifer. This is defined as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

### 3.4 Hydrology

#### Groundwater Vulnerability

Table 3.1 presents Environment Agency groundwater vulnerability definitions:

|                      |                                                                                                                                                                                                                                                         |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| High Vulnerability   | <ul style="list-style-type: none"> <li>Areas able to easily transmit pollution to groundwater. They are likely to be characterised by high leaching soils and the absence of low permeability superficial deposits.</li> </ul>                          |
| Medium Vulnerability | <ul style="list-style-type: none"> <li>Intermediate between high and low vulnerability.</li> </ul>                                                                                                                                                      |
| Low Vulnerability    | <ul style="list-style-type: none"> <li>Areas that provide the greatest protection from pollution. They are likely to be characterised by low leaching soils and/or the presence of superficial deposits characterised by a low permeability.</li> </ul> |

Table 3.1: Groundwater Vulnerability Definitions

The groundwater vulnerability in the vicinity of the site is classified as High due to the productive bedrock aquifer and well-connected fractures underlying the site.

### 3.5 Contaminant Sources

#### On Site Sources

The following possible on-site sources have been identified from the historical study:

- None identified.

The following possible on-site sources have been identified from the Enviro + Geo Insight data:

- None identified.

## Off Site Sources

The following off site sources have been identified from the historical Enviro + Geo Insight data:

- Unspecified works/factories/features within 250m of the site
- Electricity substation 61m north of the site
- Road Vehicle fuelling, service and repairs 106m southwest of the site
- Unspecified tanks 94m west of site

There are further entries present, but these are considered far enough from the site to pose no risk.

The following contaminants are potentially associated with the on-site sources:

- Heavy Metals;
- TPH and PAH;
- PCBs.

The following contaminants are potentially associated with the off-site sources.

- Heavy Metals;
- PAH and TPH;
- PCBs.

In practice, a broad contaminant screen should be analysed for in any intrusive investigation recommended to ensure that potential contaminants are not omitted.

## 4. Preliminary Conceptual Site Model and Risk Assessment

This presented Conceptual Site Model has been re-issued from the previous Phase 1: Desktop study (C1575/21/E/2456), to provide information regarding the possible **sources** of contamination on site, the **pathway** in which the contamination can migrate and a vulnerable **receptor** to the contamination, all of which need to be present for there to be a risk. Given the continued end use of the site the generic land use of 'residential with homegrown produce' has been applied. Consequently, the following Source – Pathway – Receptor relationships have been identified.

**Table: Conceptual Site Model and Preliminary Qualitative Risk Assessment**

| Table: Conceptual Site Model and Preliminary Qualitative Risk Assessment |                       |                                                                                         |                             |                                                                                                                                                                                           |
|--------------------------------------------------------------------------|-----------------------|-----------------------------------------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pathways                                                                 | CONCEPTUAL SITE MODEL |                                                                                         | PRELIMINARY RISK ASSESSMENT |                                                                                                                                                                                           |
|                                                                          | Receptor              | Linkage Present?                                                                        | Risk Rating                 | Notes                                                                                                                                                                                     |
|                                                                          | Operative             | Yes – operatives are key to come in contact with the soil.                              | Moderate                    | There are potential on and off site sources of contamination that may have caused contamination on of the site.                                                                           |
| Direct contact/dermal absorption/soil ingestion                          | End User              | Yes – end users are key to come in contact with the soil.                               | Moderate                    | Any on site sources of contamination could migrate to neighbouring properties.                                                                                                            |
|                                                                          | Neighbours            | Yes – possible source on site and immediate neighbours are present.                     | Moderate                    | Further testing required to reach a firm conclusion.                                                                                                                                      |
|                                                                          | Operative             | Yes – contact with soil key during works and vapours may accumulate in enclosed spaces. | Moderate                    | There are potential on and off site sources of contamination that may have caused contamination on of the site.                                                                           |
| Inhalation of Dust/Vapours                                               | End User              | Yes – vapours may accumulate in enclosed spaces.                                        | Moderate                    | Any on site sources of contamination could migrate to neighbouring properties.<br>Construction activities may create dust on and off site, which, if contaminated, could adversely affect |

|                                             |            |                                                                                                          |          |                                                                                                                                                                                                                                                |
|---------------------------------------------|------------|----------------------------------------------------------------------------------------------------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | Neighbours | Yes - neighbouring properties present and possible inhalation of dust during the works.                  | Moderate | operatives, end users and neighbours.<br><br>In the event that harmful vapours are present they may accumulate in enclosed spaces, affecting operatives, end users and neighbours.<br><br>Further testing required to reach a firm conclusion. |
|                                             | Operative  | Yes - Gardens and soft landscaping proposed as part of new development. Site currently used garden area. | Moderate |                                                                                                                                                                                                                                                |
| Ingestion of fruit/vegetables and/or waters | End User   | Yes - gardens and soft landscaping proposed as part of the new development.                              | Moderate | There are potential on and off site sources of contamination that may have caused contamination of the site. Further testing required to reach a firm conclusion.                                                                              |
|                                             | Neighbours | Yes - residential dwellings present within 250m of the proposed development.                             | Moderate |                                                                                                                                                                                                                                                |

Table 4.1: Preliminary Conceptual Site Model.

## 5. Fieldworks

---

### 5.1 Site Investigation

All SI works were completed from April 8<sup>th</sup> 2021 under the supervision of a Geo-Environmental Engineer from GES. In summary the investigation included:

- A two man team ascertained the routes of any below ground services in close proximity to the proposed exploratory hole positions, using a CAT scan and lifting up of any man hole covers. Following the CAT scan, hand dug starter pits were completed to a depth of 1.2 metres below ground level (mbgl).
- Three (3no.) windowless sampler boreholes (WS01 to WS03) were completed, by means of a competitor dart rig, to depths of 4.45mbgl, the depth being limited due to encountering high strength soils (bedrock) at shallow depth, which prevented further penetration of the underlying deposits. The locations of exploratory positions were selected relative to the historic land use and the current proposed redevelopment plans for the site.
- The windowless sampler boreholes were logged with any groundwater conditions noted and representative soil samples removed in accordance with current guidelines.
- Soil samples were removed from shallow sub surface locations, with further samples taken at depth at every 0.5mbgl or when the underlying stratum changed. Samples were subsequently placed in suitable containers including 1kg tubs and 250ml glass jars and placed in cool boxes with cool packs prior to storage within our *in-house* laboratory fridges and then subsequent forwarding to our designated laboratory for analysis.
- Standard Penetration Tests were undertaken during the drilling to provide an assessment of the strength of the underlying deposits with depth.
- Upon completion, all exploratory holes were back filled, compacted and made good to existing levels and finishes, with any surplus spoil bagged up and removed from site.

The positions of exploratory holes in relation to the existing site layout can be reviewed within Appendix 1, with borehole logs located in Appendix 2.

## 6. Geology and Ground Conditions

The succession has been shown to include the following:

| <b>Table 6.1: Generalised Strata Profile</b>                       |                                                                                                    |                        |                                                    |
|--------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|------------------------|----------------------------------------------------|
| <b>Maximum Depth</b><br>m below ground level to underside of layer | <b>Strata Type</b>                                                                                 | <b>Positions Layer</b> | <b>Groundwater Strikes</b><br>m below ground level |
| 1.40                                                               | Variable MADE GROUND.                                                                              | Positions              | None                                               |
| 2.70                                                               | From light brown mottled brown sandy gravelly CLAY. Gravelly fine to coarse angular of sandstone.  | Positions              | None                                               |
| 4.45+                                                              | Extremely weak, mottled brown micaceous MUDSTONE: Recovered as silty GRAVEL. (EXTREMELY WEATHERED) | Positions              | None                                               |

+ denotes that the strata extended below the term natural depth of the investigated positions, thus the extent of the deposits only proven to the depths indicated.

## 7. Groundwater Conditions

Groundwater was not encountered during investigative works undertaken. However, it should be noted that groundwater levels are dependent upon seasonal variations and can change after periods of prolonged rainfall or drought. However, as a consequence of the anticipated depth to standing water level such seasonal variations are unlikely to have an effect on site development.

## 8. Visual and Olfactory Observations

With the exception of general anthropogenic material identified, no visual and/or olfactory evidence of potential contamination was noted within any soils encountered as part of the investigative works undertaken.

## 9. Geotechnical Laboratory Testing

### 9.1 Atterberg Limits and Natural Moisture Content

Two (2no.) samples from the naturally occurring deposits were submitted for determination of their Natural Moisture Content and Plasticity Index. Natural Moisture Contents of these samples were between 12% and 13%. Modified Plasticity Indices of 16% and 22% were recorded for the results. As a consequence, the deposits encountered can be generally classed as ranging being of low volume change potential, in accordance with NHBC guidelines.

All geotechnical laboratory certificates can be reviewed within Appendix 3.

## 9.2 Sulphates

Three (3no.) samples of the underlying naturally occurring deposits in WS01 at 2.0mbgl, WS02 at 1.0mbgl and WS03 at 3.0mbgl were submitted for assessment of water-soluble sulphate, total sulphate, pH value and total sulphur concentrations.

Water-soluble sulphate concentrations of <10mg/l to 18 were recorded, total (acid) sulphate concentrations of 0.074% to 0.23%, total sulphur concentrations of 0.081% to 0.17%, with a pH value of between 7.4 and 7.8 units. Total Potential Sulphates were up to 0.24% to 0.51%.

Reference to BRE Special Digest 1 indicates a Design Sulphate Class of DS-1. Consequently, concrete may be designed to AC-1 concrete classification.

## 10. Construction Consideration

---

The made ground and topsoil are not considered suitable for the construction of shallow foundations due to the risk of unacceptable total and differential settlement occurring under moderately light surface loading.

The investigation recorded extremely weak mudstone at shallow depth. On this basis, it is considered that foundations could include the provision of strip and spread footings. The results of this investigation indicate that extremely weak sandstone will be revealed at depths of from 1.0mbgl to 2.0mbgl. This material would possess a significant bearing capacity, probably being in excess of 200kN/m<sup>2</sup>. Therefore, at a typical foundation load for a house the factor of safety against general shear failure will be high, probably exceeding 10. In addition, it is considered that nominal settlements will occur under the action of the proposed increase in load.

Should made ground or any weak zones be revealed in the excavation bases, they should be removed and replaced by suitably compacted granular soil or lean-mixed concrete. Should excavations be required to stand open for any length of time, it will be necessary to place a blinding layer of lean-mixed concrete over the sub-grade. This expedient will reduce loosening or softening of the underling soil due to both physical disturbance and the ingress of surface water.

Should seepages of groundwater be encountered it is considered that they could be dealt with using a simple form of de-watering. Such a system could include the excavation of sumps from which the water could be pumped.

The stability of the excavation faces cannot be guaranteed thus temporary support to the excavation faces may become necessary unless the foundations are constructed using trench-fill techniques. In this method the foundation trenches should be excavated, inspected and backfilled with concrete as a

continuous operation. Under no circumstances should operatives be allowed to enter unsupported excavations.

## 10.1 Retaining structures

It is understood that retaining structures will be constructed in the mudstone rock recorded. It is considered that traditional gravity wall could be employed. These will require checks for overall stability in the design and the mudstone deposits should provide adequate stability to suitably designed structures. As part of the works the temporary support to the Banks Road should be considered during construction.

## 10.2 Excavations

No Groundwater was encountered during the investigation and subsequent monitoring. However, it should be appreciated that groundwater levels are subject to seasonal variation or changes on local drainage conditions.

Groundwater is unlikely to represent a particular problem to the construction of the development at this site particularly if encountered with excavations in the sand. However, it should be recognized that slight seepages and minor water entries may combine in any long trench excavations to create a significant volume of water which may cause local problems during the construction phase. Any minor groundwater seepages or significant standing water within excavations made upon this site may be removed by using a simple form of de-watering. Such a system could include the excavation of sumps from which the water could be pumped. Advice on Groundwater Control is given in CIRIA Report No 515 – Groundwater Control Design and Practice.

The stability of the excavation faces cannot be guaranteed thus temporary support to the excavation faces may become necessary unless the foundations are constructed using trench-fill techniques. In this method the foundation trenches should be excavated, inspected and backfilled with concrete as a continuous operation. Under no circumstances should operatives be allowed to enter unsupported excavations.

Subject to space constraints, excavations could be battered back to a suitable angle of repose (typically 1:1 for a 2.00m deep excavation). Alternatively, if there is a requirement to protect nearby structures or services, appropriate supports may be required. Due to the cohesive nature of the soils encountered, it is likely that any support required could be installed following excavation. Advice on excavation support is given in CIRIA Report No 97 – Trenching Practice.

# 11. Contamination

## 11.1 Soil Testing

A total of five (5no.) samples have been analysed by Chemtest Ltd in their UKAS and MCERTS accredited laboratory-testing facility in accordance with laboratory protocol.

The testing completed comprised of a focused suite of heavy metals, speciated Total Petroleum Hydrocarbons (TPH CWG Aromatic/aliphatic split) and speciated Polycyclic Aromatic Hydrocarbons (PAH) including the more carcinogenic benzo(a)pyrene (BaP) and naphthalene, asbestos, soil organic matter (SOM) content, VOCs, sVOCs, MTBE & BTEX, cyanide, pH and sulphates.

The results of this laboratory testing have been compared to the Soil Guideline Values (SGVs) as well as the CIEH 'LQM' guideline values for inorganic and organic contaminants in soils. The proposed development of the site is intended to comprise of residential and therefore screening has been made against a land use of 'residential with homegrown produce'.

## 11.2 Selection of Screening Criteria

The on-site receptors for the study site are considered to be:

- Construction workers (during redevelopment of the site only);
- Future maintenance workers (following redevelopment);
- Future end users and site visitors (following redevelopment); and
- Trespassers (during redevelopment).

Risks to construction workers during the redevelopment process will be mitigated by adhering to appropriate health and safety legislation, and the wearing of appropriate personal protective equipment (PPE). During redevelopment, the site will be securely fenced to prevent trespassers from accessing the site, and good site management practices will be implemented to mitigate exposure to off-site receptors.

The potential pathways for contaminants within the soil to human health receptors following redevelopment are considered to be:

- Direct ingestion of soil and soil derived dust;
- Dermal contact with soil outside and soil derived dust inside;
- Inhalation of soil derived dust inside and outside; and
- Inhalation of soil derived vapours inside and outside.

The potential pathways for contaminants within the soil to off-site human health receptors following redevelopment are considered to be:

- Direct ingestion of soil and soil derived dust;
- Dermal contact with soil outside and soil derived dust inside;
- Inhalation of soil derived dust inside and outside; and
- Inhalation of soil derived vapours inside and outside if contamination within soil is able to migrate across the site boundary within.

In the first instance, the results of this laboratory testing have been compared to generic assessment criteria (GAC) for the residential with homegrown produce land use scenario. These incorporate the following pathways:

- Direct ingestion of soil and soil derived dust;
- Dermal contact with soil outside and soil derived dust inside;
- Inhalation of soil derived dust inside and outside; and
- Inhalation of soil derived vapours inside and outside.

Contaminants have been screened against revised LQM/CIEH S4UL criteria<sup>1</sup> where available. These GAC have been designed for use under planning, using Health Criteria Values based on minimal risk, and updated exposure parameters. The S4UL are intended to replace the previous LQM/CIEH GAC. The S4UL are based on the assumption of a sandy loam soil the 1.0% soil organic matter (SOM) criteria have been used, where available and appropriate, in the first instance. All soil samples were analysed for %SOM, the range was from 1.2-10.0%, and so this conservative approach is considered appropriate for initial screening.

Where no S4UL are available, the EIC/ AGS/ CL:AIRE/ GAC<sup>2</sup> have been used. The toxicological criteria within these are also based on minimal risk. It is recognised that these criteria have not recently been updated, and in particular, do not incorporate the slightly higher inhalation rates that have been used within the S4UL. However, given that they incorporate additional pathways, they are considered suitable for an initial screen. The EIC/ AGS/ CL:AIRE/ GAC are also based on a sandy loam soil and the 1% SOM criteria have been used in the first instance.

There is neither an S4UL nor a EIC/ AGS/ CL:AIRE/ GAC available for lead. In the absence of a GAC based on minimal risk, the C4SL for lead has been used. It is recognised that this is based on a “low level of toxicological concern” rather than on a minimal risk level. However, it is considered appropriate for use under planning, especially for a site where there will effectively be no pathways for inorganic metals following redevelopment.

All the GAC are based on a sandy loam soil. This is considered appropriate for use for initial screening. Although it is apparent from the laboratory soil descriptions, that the Made Ground, by its very nature is heterogeneous, and often has a significant sand/gravel component, especially at shallow depths, it is noted that many of the soil descriptions have a significant clay component at increasing depth.

All of the GAC assume unsaturated soils. However, the use of the GAC are considered to be conservative, because they assume a certain air-filled porosity and water-filled porosity.

The GAC also assume that no free phase product is present, and are not intended for use in this instance. No free product was observed within soils during the site investigation.

---

<sup>1</sup> Nathanael et al. (2015) The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, 2015. Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL3495

<sup>2</sup> CL:AIRE (2010) The EIC/AGS/CL:AIRE Generic Assessment Criteria for Human Health Risk Assessment

### 11.3 Soil Testing Results and Screening

All metals, PAHs, and TPH CWG analytes are presented in the following tables with units in mg/kg unless otherwise stated. Other potential contaminants of concern are only shown where there is at least one result exceeding the limit of detection.

All of the soil contamination laboratory analytical results are presented within **Appendix 4**.

#### Metalloids

| Determinant    | Min   | Max   | GAC               | Number of exceedances |
|----------------|-------|-------|-------------------|-----------------------|
| Arsenic        | 1.9   | 20    | 37*               | 0                     |
| Cadmium        | <0.1  | 0.17  | 11*               | 0                     |
| Chromium total | 17    | 35    | 910*              | 0                     |
| Chromium (VI)  | <0.50 | <0.50 | 6*                | 0                     |
| Copper         | 16    | 38    | 2400*             | 0                     |
| Lead           | 12    | 65    | 200*              | 0                     |
| Mercury        | <0.10 | 0.26  | 40* <sup>a</sup>  | 0                     |
| Nickel         | 16    | 45    | 180* <sup>b</sup> | 0                     |
| Selenium       | 0.39  | 0.56  | 250*              | 0                     |
| Zinc           | 52    | 95    | 3700*             | 0                     |
| Total Phenols  | <0.1  | <0.1  | 420*              | 0                     |
| Total Cyanide  | <0.5  | <0.5  | 140*              | 0                     |

Table 9.1: Metalloids Soil Exceedances

\*LQM/CIEH GAC for Residential with homegrown produce land use scenario based on a sandy loam soil and 1% SOM.

- Based on the inorganic mercury GAC as the conceptual site model does not suggest that other forms of mercury are likely to be present on site.
- LQM issued an update to the nickel S4ULs in August 2015 and this has been taken into account.

#### Organics

| Determinant    | Min  | Max  | GAC  | Number of exceedances |
|----------------|------|------|------|-----------------------|
| Naphthalene    | <0.1 | <0.1 | 2.3* | 0                     |
| Acenaphthylene | <0.1 | <0.1 | 170* | 0                     |

|                        |      |      |       |   |
|------------------------|------|------|-------|---|
| Acenaphthene           | <0.1 | <0.1 | 210*  | 0 |
| Fluorene               | <0.1 | <0.1 | 170*  | 0 |
| Phenanthrene           | <0.1 | 1.7  | 95*   | 0 |
| Anthracene             | <0.1 | 0.36 | 2400* | 0 |
| Fluoranthene           | <0.1 | 1.1  | 280*  | 0 |
| Pyrene                 | <0.1 | 1.4  | 620*  | 0 |
| Benzo(a)anthracene     | <0.1 | 0.5  | 7.2*  | 0 |
| Chrysene               | <0.1 | 0.57 | 15*   | 0 |
| Benzo(b)fluoranthene   | <0.1 | 0.52 | 2.6*  | 0 |
| Benzo(k)fluoranthene   | <0.1 | 0.19 | 77*   | 0 |
| Benzo(a)pyrene         | <0.1 | 0.40 | 2.2*  | 0 |
| Indeno(1,2,3-cd)pyrene | <0.1 | <0.1 | 27*   | 0 |
| Dibenz(a,h)anthracene  | <0.1 | <0.1 | 0.24* | 0 |
| Benzo(ghi)perylene     | <0.1 | <0.1 | 320*  | 0 |

Table 9.2: PAH Soil Exceedances

There were no exceedances noted from the screening undertaken on PAH congeners.

| Determinant          | Min   | Max   | GAC    | Number of exceedances |
|----------------------|-------|-------|--------|-----------------------|
| Aliphatic >C5 – C6   | < 1.0 | < 1.0 | 42*    | 0                     |
| Aliphatic >C6 - C8   | < 1.0 | < 1.0 | 100*   | 0                     |
| Aliphatic >C8 - C10  | < 1.0 | < 1.0 | 27*    | 0                     |
| Aliphatic >C10 - C12 | < 1.0 | < 1.0 | 130*   | 0                     |
| Aliphatic >C12 - C16 | < 1.0 | < 1.0 | 1100*  | 0                     |
| Aliphatic >C16 – C21 | < 1.0 | < 1.0 | 65000* | 0                     |
| Aliphatic >C21 – C35 | < 1.0 | < 1.0 | 65000* | 0                     |
| Aromatic >C5 - C7    | < 1.0 | < 1.0 | 70*    | 0                     |
| Aromatic >C7 - C8    | < 1.0 | < 1.0 | 130*   | 0                     |
| Aromatic >C8 - C10   | < 1.0 | < 1.0 | 34*    | 0                     |
| Aromatic >C10 - C12  | < 1.0 | < 1.0 | 74*    | 0                     |
| Aromatic >C12 - C16  | < 1.0 | < 1.0 | 140*   | 0                     |
| Aromatic >C16 - C21  | < 1.0 | 44    | 260*   | 0                     |
| Aromatic >C21 - C35  | < 1.0 | 330   | 1500*  | 0                     |

Table 9.3: TPH CWG Aliphatic/Aromatic Soil Exceedances

\* LQM/CIEH GAC Residential with Homegrown Produce land use scenario based on a sandy loam soil and 1.0% SOM. It is noted that the LQM/CIEH S4UL guidance recommends an additive approach for the TPH fraction, so that a hazard index approach is used. Based on a preliminary conservative comparison of maximum concentrations to S4ULs, no forward modelling is necessary to prove that this would still result in no exceedances at the site.

There are no exceedances noted from the screening undertaken on the respective TPH CWG bands.

### Others

- The asbestos screening returned a negative result for the presence of fibrous material from all samples analysed.
- BTEX/MTBE screening returned a negative result for any congeners.

The soil contamination laboratory certificates can be reviewed within **Appendix 4**.

## 11.4 Gas Monitoring Results

Gas monitoring is to be carried out on three separate occasions using a Gas monitor (GA5000). Readings will be taken from all three (3no.) installed window sampler boreholes.

The standpipes will be tested for the presence of methane, oxygen, carbon dioxide and hydrogen sulphide. The flow rates of the gas and barometric pressure will also be recorded. four (4no.) monitoring visits were completed, and full results can be viewed in Appendix 5.

Ground conditions were wet and moist on two occasions, with wind recorded as being light and moderate during monitoring. All the rounds of monitoring were completed during steady pressure conditions.

Oxygen concentrations range from a minimum of 15.4% to a maximum of 19.9%.

Concentration of methane has remained at 0.0% recorded in all three (4no.) boreholes.

The maximum peak concentration of carbon dioxide obtained to date is 2.1% from installation WS01 during the 2nd round of monitoring completed.

Flow rates are recorded during each round of monitoring from all installations. To date, readings range from a minimum of 0.2l/hr to a maximum of 0.3l/hr. Negligible concentrations of hydrogen sulphide were returned from the rounds of monitoring undertaken. Monitoring returned concentrations at 0ppmv.

Barometric pressure ranges from a low of 985mBars during the 1<sup>st</sup> and 2<sup>nd</sup> rounds of monitoring to a high of 1006mBars attained during the 3<sup>rd</sup> round of monitoring.

The recorded concentrations of methane and carbon dioxide have been used to calculate a Gas Screening Value (GSV) for the gassing regime at this site. This value has been subsequently compared against CIRIA values supplied within CIRIA Document C665 *Assessing risks posed by hazardous ground gases to buildings* (2007) using Situation B for carbon dioxide and methane.

The values used represent the worst-case CO<sub>2</sub> and CH<sub>4</sub> concentrations across all installations. The maximum flow rate was 0.4l/hr and this was taken from all locations and/or monitoring visits to date.

The GSV is calculated as:

(Worst case CO<sub>2</sub> and CH<sub>4</sub> concentration / 100) x worst case flow rate = GSV

| Peak Flow Rate (l/hr) | Worst Case CO <sub>2</sub> | CO <sub>2</sub> GSV | Worst Case CH <sub>4</sub> | CH <sub>4</sub> GSV |
|-----------------------|----------------------------|---------------------|----------------------------|---------------------|
| +0.3                  | 2.1%                       | 0.0063l/hr          | 0.0%                       | 0.0l/hr             |

Table 13.6: Calculated GSV's

This GSV is a conservative estimate based on the maximum concentrations and flow rate.

## 12. Site Investigation Findings

### 12.1 Risk to Human Health

With the exception of the Made Ground identified, no visual and/or olfactory evidence of potential contamination was noted within any soils encountered during the SI works undertaken, which focussed in the proposed private garden areas and also underneath the footprint of the proposed dwellings.

Therefore, it would be reasonable to conclude that there is a negligible risk to human health receptors and is therefore considered that no remediation works should be required.

### 12.2 Risk to Plants and Wildlife

A negligible risk has been attributed given the concentrations of phytotoxic contaminants below elevated concentrations often below the limit of detection returned.

### 12.3 Risk to Site Workers

Precautions should be taken to minimise exposure of site workers during ground works through the implementation of site safety procedures and the use of suitable personal protective equipment (PPE). Such precautions should include, but not be limited to:

- Personal hygiene, washing and changing procedures;
- Availability of site welfare;
- Provision of PPE appropriate to the task; and
- Daily safety briefings and tool box talks.

All site works will be undertaken in accordance with the guidelines prepared by the Health and Safety Executive (1991) and all work will be carried out in accordance with the Principal Contractor's Health and Safety Plan.

#### 12.4 Risk to Proposed Structures

A low risk has been attributed given the lack of hydrocarbons returned from the laboratory thus giving a low risk for potential volatilisation. Furthermore, on site there is historical development and potentially infilled land and ground workings that pose a risk for ground gas generation.

### 13. Updated Conceptual Site Model and Risk Assessment

The Conceptual Site Model has been re-formulated based upon the results from the SI in accordance with BS10175:2015. It aims to provide information regarding the sources of contamination and the pathways in which contamination can migrate to a vulnerable receptor, all of which need to be present for there to be a risk. This is in relation to the proposed end use being classified as 'residential with homegrown produce'. The following linkages have been identified:

| Contaminant Source                                                                                                                         | Pathways                                                                   | Receptor                                                  | Potential Severity | Probability of Risk | Level of Risk | Justification                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-----------------------------------------------------------|--------------------|---------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>On Site:</b><br>Made Ground soils on site possibly containing elevated metals, other organics such as TPH, PAH, phenols, VOC and SVOCs. | Ingestion, derma contact, inhalation of dusts/vapours                      | Future end users and stakeholders                         | Medium             | Unlikely            | Low<br>●      | A low level of risks considered due to the lack of returned exceedances in samples selected for testing.                                                                                                                                                        |
|                                                                                                                                            |                                                                            | Construction Workers                                      | Medium             | Unlikely            | Low<br>●      | A low level of risks considered due to the lack of returned exceedances in samples selected for testing.                                                                                                                                                        |
|                                                                                                                                            | Leaching through soils and migration via groundwater or soil pore moisture | Controlled Waters                                         | Medium             | Unlikely            | Low<br>●      | A low level of risks considered due to the lack of returned exceedances in samples selected for testing.                                                                                                                                                        |
|                                                                                                                                            | Permeation of water pipes                                                  | Construction materials, future end users and stakeholders | Medium             | Unlikely            | Low<br>●      | Hydrocarbons, especially aromatics are known to permeate plastic pipes. Provision of water supply pipes and connectors formed from proprietary "barrier pipe" materials (e.g. polyethylene-aluminium-polyethylene) may be required by the water supply company. |
|                                                                                                                                            | Uptake                                                                     | Plant and Wildlife                                        | Medium             | Unlikely            | Low<br>●      | A low risk rating has been assessed due to the limited history of potential contamination and uses on site.                                                                                                                                                     |
| <b>On Site:</b><br>Asbestos at/near ground surface in Made Ground soils.                                                                   | Inhalation of fibres in airborne dust                                      | Future end users and stakeholders                         | Medium             | Unlikely            | Low<br>●      | A Low risk is assessed due to the lack of any ACMs identified by testing scheduled.                                                                                                                                                                             |
|                                                                                                                                            |                                                                            | Construction Workers                                      | Medium             | Unlikely            | Low<br>●      | A Low risk is assessed due to the lack of any ACMs identified by testing scheduled.                                                                                                                                                                             |

|                                                                                                                                                                                    |                                                                            |                                           |        |        |          |                                                                                                                                                                                                                                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|-------------------------------------------|--------|--------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>On Site:</b><br>Ground Gases (CH <sub>4</sub> , CO <sub>2</sub> ) from on-site Made Ground.                                                                                     | Gas migration and build up within buildings (explosion/asphyxiation risk)  | Future end users and building structures. | Low    | Un key | Low<br>● | A low risk rating has been assessed given limited made ground potential and no nearby landfills present.<br><br>Current guidance indicates that Made Ground is generally classified as low risk in terms of potential for gas generation. |
| <b>Off Site:</b><br>Historical and uses and activities, Made Ground/natural material possibly containing elevated metals, other inorganic, TPH, PAH, PCBs, phenols, VOC and SVOCs. | Leaching through soils and migration via groundwater or soil pore moisture | Future end users and structures           | Medium | Un key | Low<br>● | A low level of risks considered due to the lack of returned exceedances in samples selected for testing.                                                                                                                                  |
|                                                                                                                                                                                    | Ingestion, dermal contact, inhalation of dusts/vapours                     | Future end users and structures           | Medium | Un key | Low<br>● | A low level of risks considered due to the lack of returned exceedances in samples selected for testing.                                                                                                                                  |
| <b>Off Site:</b><br>Ground Gases (CH <sub>4</sub> , CO <sub>2</sub> , H <sub>2</sub> S) from off-site historical and ongoing activities.                                           | Gas migration and build up within buildings (explosion/asphyxiation risk)  | Future end users and building structures. | Low    | Un key | Low<br>● | Given the lack of generating sources on and off site the risk from ground gases considered low.                                                                                                                                           |

Table 11.1: Updated Conceptual Site Model.

## 14. Recommendations

---

In view of the above it is considered that there is a low risk to the end user and no further action is required.

### 14.1 Watching Brief and Discovery Strategy

A watching brief should be maintained by the Main Contractor at all times during the groundworks stage. Should any unforeseen contamination, such as oils or soils/groundwater with an unusual colour or odour, be encountered during groundworks then the following procedure should be implemented:

- Work to cease in that area to prevent exposure to ground workers and potential contaminants being spread around;
- Notify a Geo-Environmental Consultant, to attend site and sample material;
- Notify the Environmental Health Department / Contaminated Land Officer(s) of the Local Planning Authority.

If the nature and extent of the contamination is unmanageable under the procedure set out above, then a suitable management, mitigation or remediation procedure will be agreed with the CLO. However, this is considered unlikely at this particular site.

### 14.2 Asbestos

Although screening has revealed no asbestos to be present within the samples analysed from exploratory holes undertaken, it cannot be guaranteed that asbestos is not present within the soils across the remainder of the site. Consequently, we would recommend that a watching brief be adopted with regards to the site for the potential of finding any Asbestos Containing Materials (ACMs). If any ACMs are identified these need to be dealt with accordingly in relation to the Hazardous Waste Regulations 2005.

### 14.3 Services

If new services will be installed as part of the redevelopment of the site, we would recommend the local water board be contacted to determine their specification for the type of pipework which should be used on this site.

All services and in particular potable water supply pipework should comprise of material that is resistant to attack and degradation to chemical attack.

Further information can be found within the published guidance for the '*Selection of Water Supply Pipes to be used in Brownfield Sites*', issued in January 2011 by the UK Water Industry Research (UKWIR),

this supersedes the Water Regulations Advisory Scheme (WRAS) Information and Guidance Note – *'Laying Pipes in Contaminated Land'* which has been withdrawn.

#### 14.4 Surface Water

It should be noted that the Environment Agency does not recommend that soakaways be placed within Made Ground, potentially contaminative land or in ground previously identified as contaminated.

#### 14.6 Gas Protection Measures

Based on the maximum calculated GSV of 0.0063l/hr to date, the site can be characterised by Table 8.6 of CIRIA C665 for classification A, characteristic situation 1 and as 'very low risk'. Based on this data, the indication is that there is no indication of an active gas regime identified and consequently, no special precautions are required for gas protective measures.

### 15. Limitations

---

GES have prepared this report with all reasonable skill, care and diligence. The work undertaken to provide the basis of this report comprised a study of available documented information from a variety of sources.

The opinions given in this report have been dictated by the finite data on which are they based and are relevant only to the purpose for which the report was commissioned.

Information reviewed should not be considered exhaustive and has accepted in good faith as providing true and representative data with respect to site conditions. Should additional information become available which may influence the opinion expressed in this report, GES reserves the right to review such information and, if warranted, to alter the opinions accordingly.

It should be noted that any risks identified in this report are perceived risks based on the information reviewed.

The recommendations contained in this report represent our professional opinions. These opinions were arrived at in accordance with currently accepted industry practices at this time and as such is not a guarantee that the study site is free of hazardous conditions.

This report has been prepared solely for the use of the named client and may not be relied upon by other parties without written consent from GES. GES disclaims any responsibility to the client and others in respect of any matters outside the agreed scope of the work.

## 16. References

---

- British Standards Institution (1990) BS1377: *British standard methods of test for soils for civil engineering purposes*, B.S.I., London.
- British Standards Institution (2015) BS5930: *Code of practice for site investigations*, B.S.I., London.

---

## Appendix 1

### Site Location and Exploratory Hole Plan

---

General Notes

THIS DRAWING HAS BEEN PREPARED FROM SURVEY INFORMATION PROVIDED BY OTHERS AND IS FOR INFORMATION PURPOSES ONLY. DO NOT SCALE FROM DRAWING, USE FIGURED DIMENSIONS ONLY. ALL DIMENSIONS MUST BE CHECKED AND VERIFIED ON SITE PRIOR TO COMMENCEMENT OF WORK AND DESIGNER NOTIFIED OF ANY DISCREPANCIES.



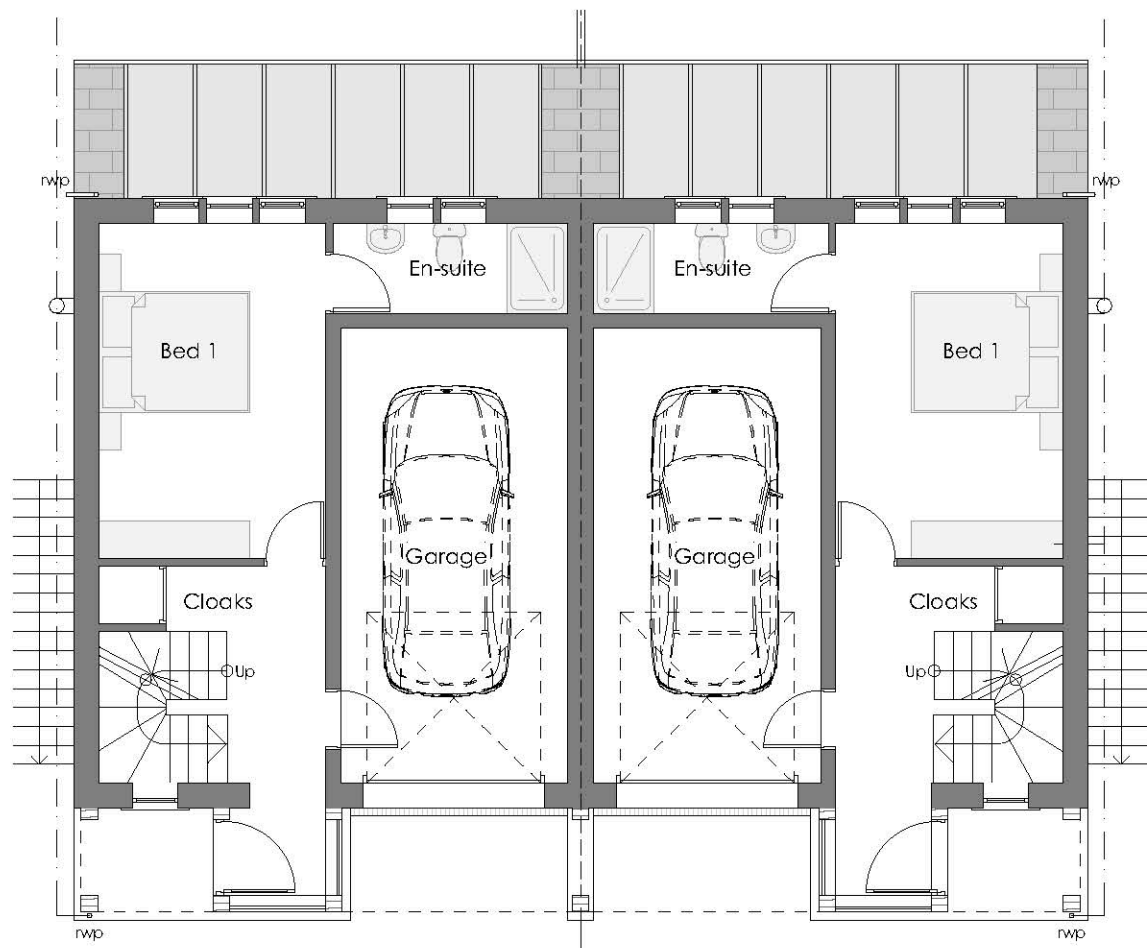
First Floor  
1:100



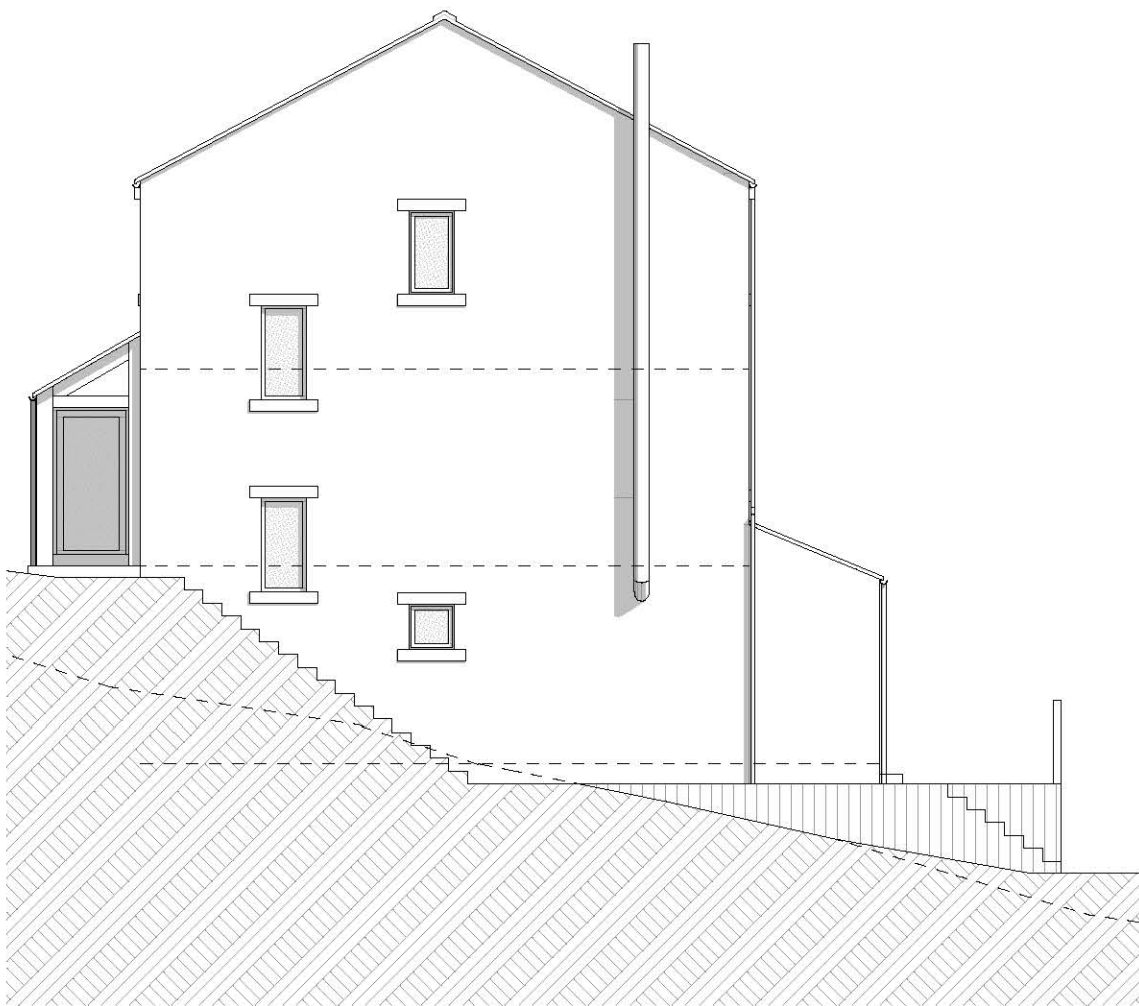
South Elevation  
1:100



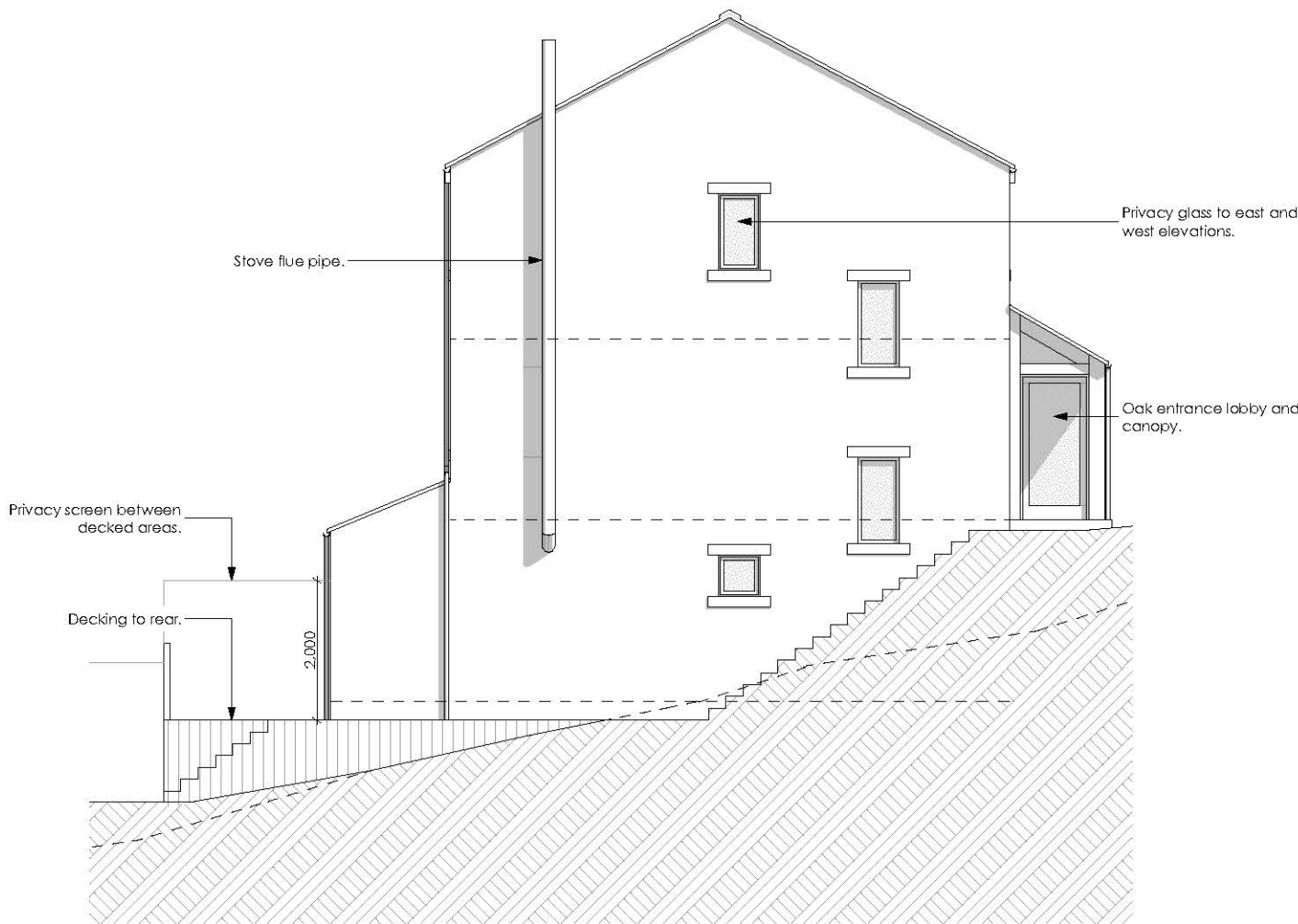
North Elevation  
1:100



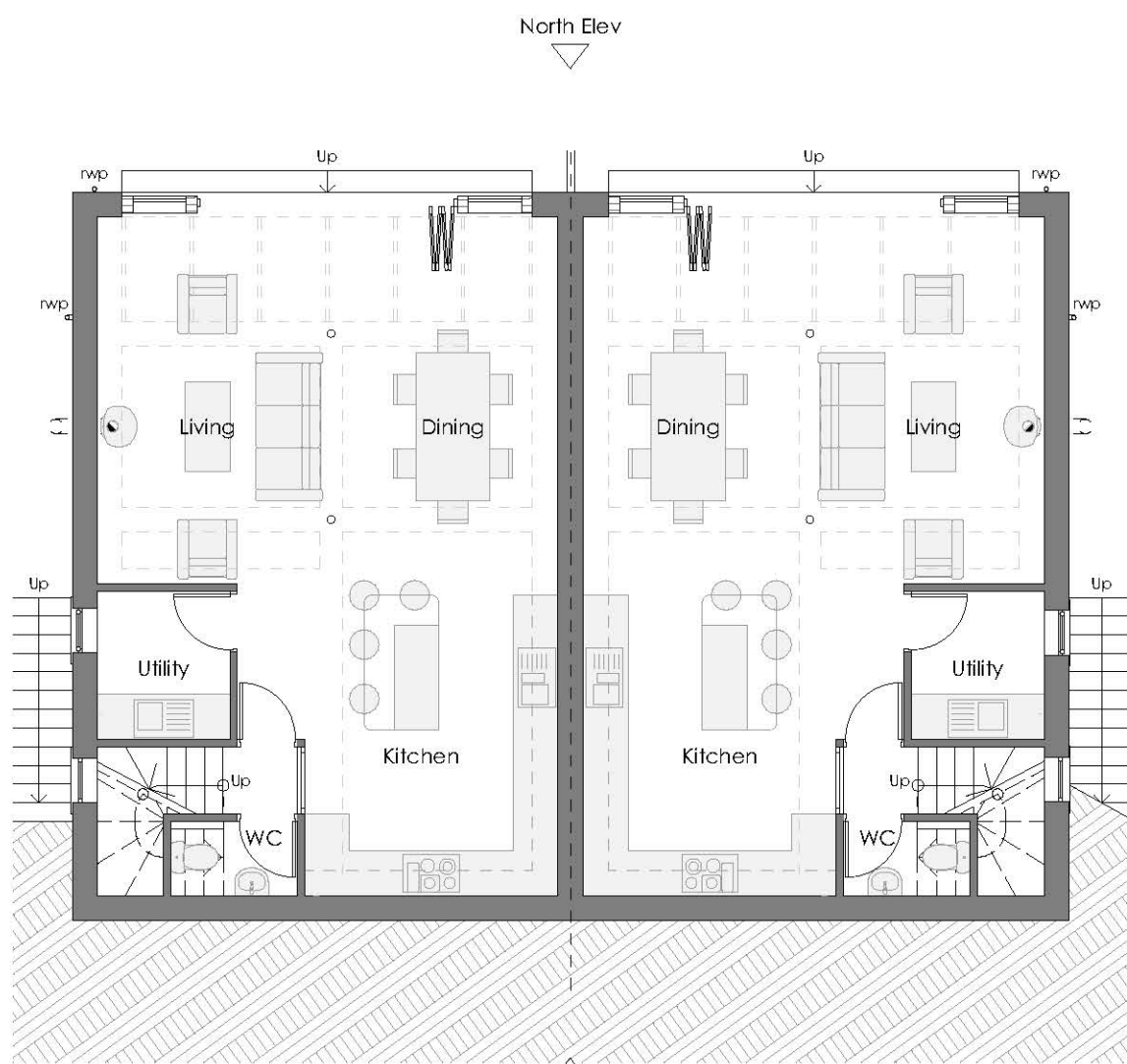
Ground Floor  
1:100



East Elevation  
1:100



West Elevation  
1:100



Lower Ground Floor  
1:100

PLANNING APPROVED

| Revision | Description                                                            | AB | Issued | Checked | Date       |
|----------|------------------------------------------------------------------------|----|--------|---------|------------|
| A        | Updated to incorporate soft landscaping to front and increased canopy. | AB |        |         | 15/02/2021 |

**Client:**

**Project:**

Linthwaite, Huddersfield.

**Drawing:**

Proposed semi detached dwellings

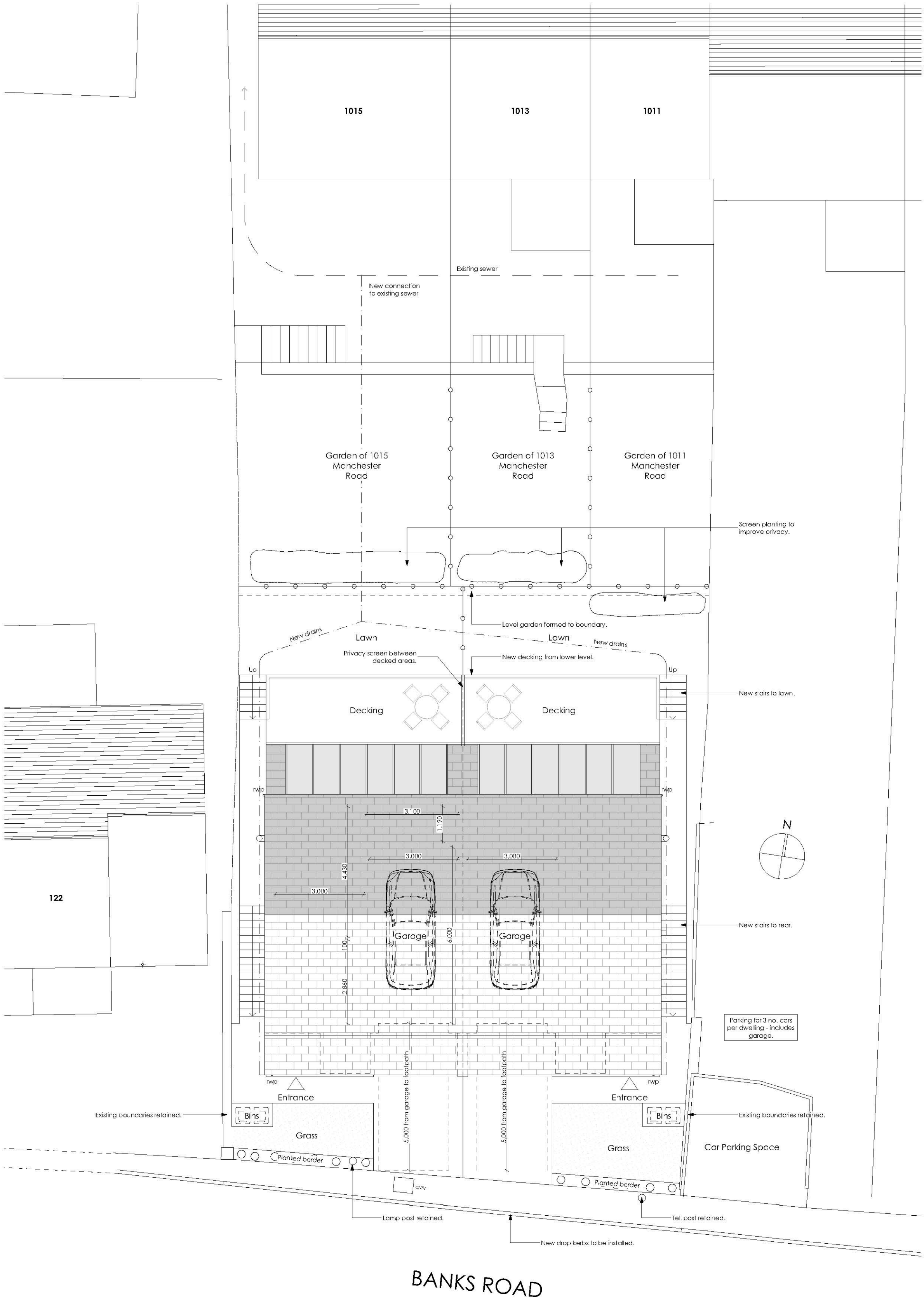
Drawing Status:

PLANNING

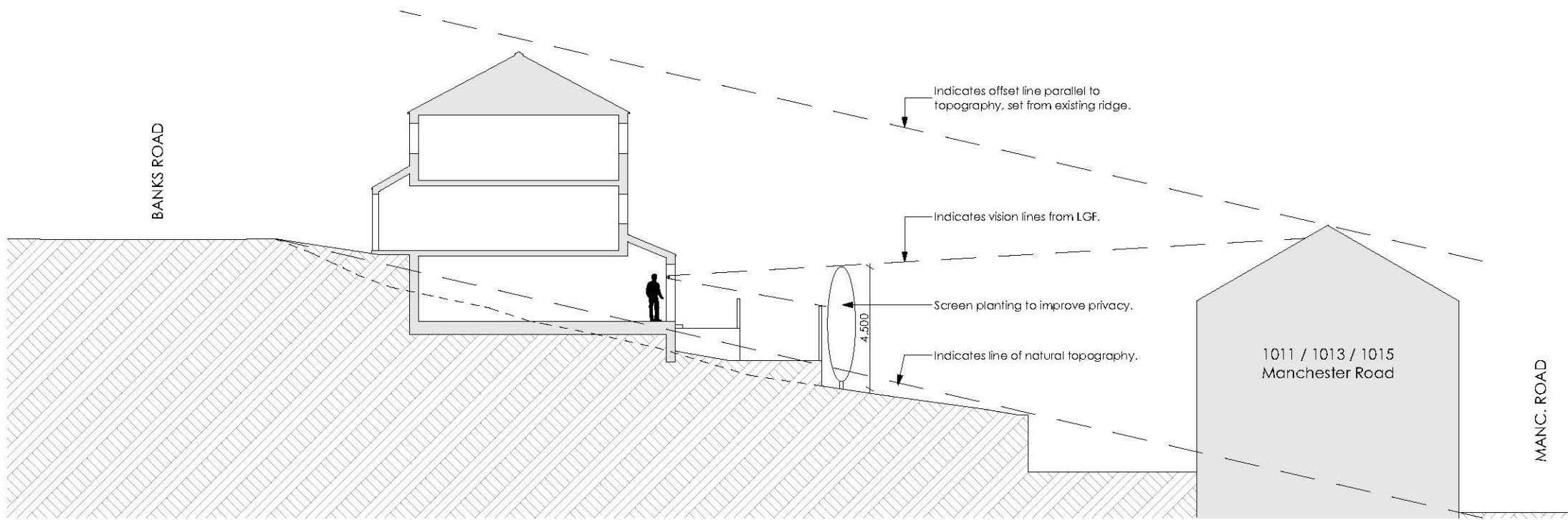
| Date:       | Scale @ A1: | Drawn by: |
|-------------|-------------|-----------|
| JAN 21      | 1:100       | AB        |
| Project No: | Drawing No: | Revision: |
| 158         | (0-) 01     | A         |

General Notes

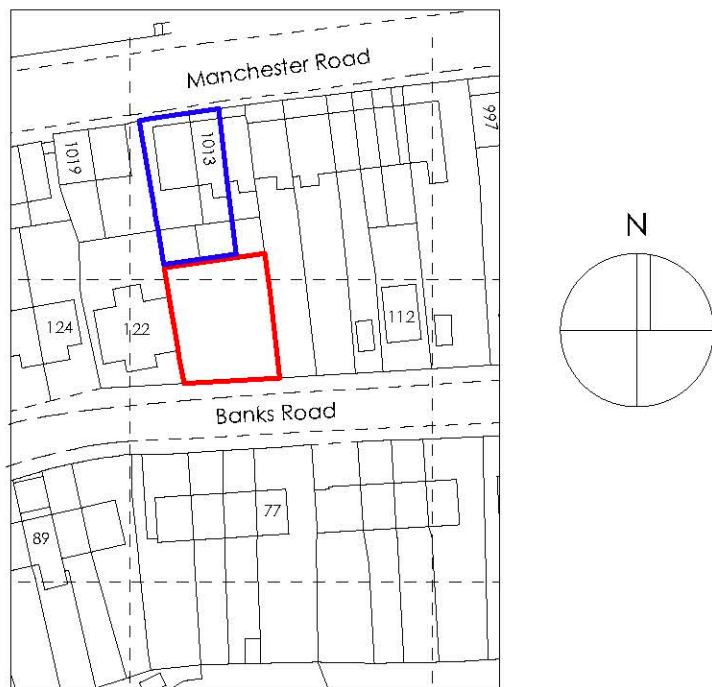
THIS DRAWING HAS BEEN PREPARED FROM SURVEY INFORMATION PROVIDED BY OTHERS AND IS FOR INFORMATION PURPOSES ONLY. DO NOT SCALE FROM DRAWING, USE FIGURED DIMENSIONS ONLY. ALL DIMENSIONS MUST BE CHECKED AND VERIFIED ON SITE PRIOR TO COMMENCEMENT OF WORK AND DESIGNER NOTIFIED OF ANY DISCREPANCIES.



Site Plan  
1:100



Site Section  
1:200



Site Location Plan  
1:1250

| Revision | Description                                                            | AB | Issued | Checked | Date       |
|----------|------------------------------------------------------------------------|----|--------|---------|------------|
| A        | Updated to incorporate soft landscaping to front and increased canopy. | AB |        |         | 15/02/2021 |

|                                                                      |
|----------------------------------------------------------------------|
| <b>Client:</b><br>Mr & Mrs Bamforth                                  |
| <b>Project:</b><br>Land off Banks Road,<br>Linthwaite, Huddersfield. |
| <b>Drawing:</b><br>Site Plan / Location Plan / Site Section          |

Drawing Status:

PLANNING

| Date:       | Scale @ A1:    | Drawn by: |
|-------------|----------------|-----------|
| JAN 21      | 1:100/200/1250 | AB        |
| Project No: | Drawing No:    | Revision: |
| 158         | (0-) 02        | A         |



Location Plan Scale 1:1000



| Survey Control Co-ordinates |            |            |           |                |
|-----------------------------|------------|------------|-----------|----------------|
| Reference                   | East       | North      | Elevation | Description    |
| H01                         | 408631.920 | 413952.492 | 160.63    | Survey Station |
| H02                         | 408619.007 | 413952.403 | 160.18    | Survey Station |
| H03                         | 408608.476 | 413952.244 | 159.97    | Survey Station |

**Site Survey Control & Datum Information**  
Grid Orientation:  
Survey related to Ordnance Survey "OSGB36" at control point GP501 and the survey data was processed on a plane grid. (No Scale Factor)  
Level Datum:  
OS Orthometric IHS

#### Control & Datum Information

Co-ordinates and levels are based upon OSGB 1936 National Grid (OSGB36) and Ordnance Survey Datum Newlyn (ODN).  
They are derived using real-time on site GPS survey, that utilizes the National Grid Transformation OSTN15GB and the National Geoid Model OSGM15GB.  
The data obtained for use in this drawing involved the use of real-time GPS survey and total station survey.  
Contours are shown at 0.5m intervals.

| Rev   | Description |          |      | By   | Date |
|-------|-------------|----------|------|------|------|
|       |             |          |      |      |      |
|       |             |          |      |      |      |
|       |             |          |      |      |      |
| Surv. | Drawn       | Date     | Chkd | Date |      |
| NH    | NH          | 07.09.20 |      |      |      |

This drawing may not be reproduced, made use of or issued to a third party without permission of:  
**Bamford Architecture Ltd**

**BA**  
Bamford Architectural Ltd.  
Holmfirth 07725 022034 enquiry@bamfordarchitectural.co.uk

**Holden Surveys Ltd**  
Topographical Building & Site Surveys - CAD Services

T: 0773 4936469 E: holdensurveys@msn.com

Title: Site Plan  
Site: 1011,1013 &1015  
Manchester Road  
Linthwaite  
Huddersfield  
West Yorkshire

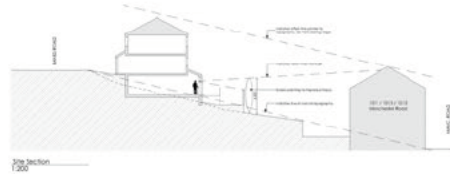
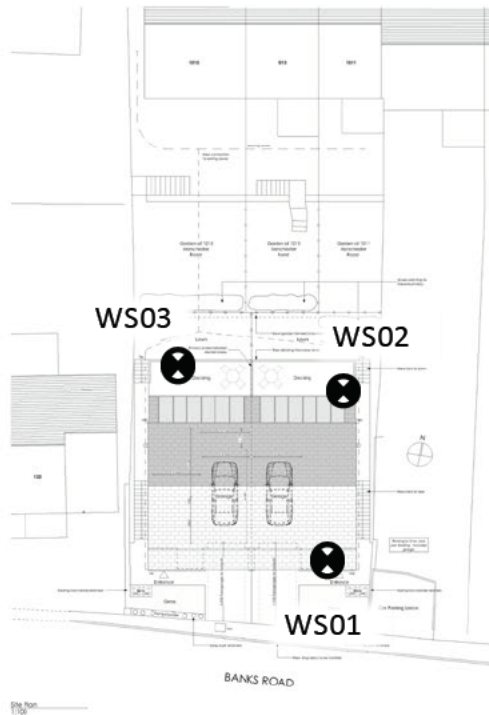
COMPUTER GENERATED DRAWING - DO NOT ALTER

Dwg No. BA\_06\_Manchester Rd

Sheet No. 1

| SCALE | 1/100 | REV. |  |
|-------|-------|------|--|
|-------|-------|------|--|

General Notes  
 This document contains information that is confidential and proprietary to Borehole Solutions Limited. It is to be used for the purpose of the investigation only and is not to be distributed outside the project team. All information contained herein is to be kept confidential and is not to be used for any other purpose without the written consent of Borehole Solutions Limited.



| Rev | Description            | Date       | By | Check |
|-----|------------------------|------------|----|-------|
| 01  | Issue for Approval     | 15/03/2024 | BA |       |
| 02  | Issue for Construction | 15/03/2024 | BA |       |
| 03  | Issue for Construction | 15/03/2024 | BA |       |

| PLANNING |         |            |    |
|----------|---------|------------|----|
| Rev      | Issue # | Date       | By |
| 01       | 1       | 15/03/2024 | BA |
| 02       | 2       | 15/03/2024 | BA |
| 03       | 3       | 15/03/2024 | BA |

**BA** Borehole Solutions Limited

Title: **Investigation Location Plan**



Site Name:  
**Land Off Banks Road, Linthwaite**

Job No:  
**GES 1399-21**

---

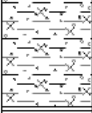
## Appendix 2

### Borehole Logs

---

# Percussion Drilling Log

|                                   |                  |                        |           |                     |                             |
|-----------------------------------|------------------|------------------------|-----------|---------------------|-----------------------------|
| Project Name: Land off Banks Road |                  | Client: James Bamforth |           | Date: 06/05/2021    |                             |
| Location: Linthwaite, HD7 5LP     |                  | Contractor:            |           |                     |                             |
| Project No. : 1399-21             |                  | Crew Name:             |           | Drilling Equipment: |                             |
| Borehole Number<br>WS01           | Hole Type<br>WLS | Level                  | Logged By | Scale<br>1:50       | Page Number<br>Sheet 1 of 1 |

| Well                                                                              | Water Strikes | Sample and In Situ Testing |        |                         | Depth (m) | Level (m) | Legend                                                                            | Stratum Description                                                                                              |    |
|-----------------------------------------------------------------------------------|---------------|----------------------------|--------|-------------------------|-----------|-----------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|----|
|                                                                                   |               | Depth (m)                  | Type   | Results                 |           |           |                                                                                   |                                                                                                                  |    |
|  |               | 0.00 - 0.50                | D      |                         | 0.30      |           |  | MADE GROUND: Dark brown, silty sandy gravelly CLAY. Gravel is fine to coarse of brick and mixed lithology.       |    |
|                                                                                   |               | 0.50 - 1.00                | C      |                         |           |           |  | Firm to stiff, light brown mottled brown silty very gravelly CLAY. Gravel is fine to coarse angular of mudstone. |    |
|                                                                                   |               | 1.00 - 1.45                | SPTL S |                         | 1.10      |           |  | Extremely weak, mottled brown micaceous MUDSTONE: Recovered as silty GRAVEL. (EXTREMELEY WEATHERED)              | 1  |
|                                                                                   |               | 1.00 - 2.00                | C      |                         |           |           |                                                                                   |                                                                                                                  |    |
|                                                                                   |               | 1.20                       | SPT    | N=8 (2,2/2,2,2,2)       |           |           |                                                                                   |                                                                                                                  |    |
|                                                                                   |               | 2.00 - 2.45                | SPTL S |                         |           |           |                                                                                   |                                                                                                                  | 2  |
|                                                                                   |               | 2.00                       | SPT    | 50 (10,12/50 for 200mm) | 2.45      |           |                                                                                   | End of Borehole at 2.450m                                                                                        |    |
|                                                                                   |               |                            |        |                         |           |           |                                                                                   |                                                                                                                  | 3  |
|                                                                                   |               |                            |        |                         |           |           |                                                                                   |                                                                                                                  | 4  |
|                                                                                   |               |                            |        |                         |           |           |                                                                                   |                                                                                                                  | 5  |
|                                                                                   |               |                            |        |                         |           |           |                                                                                   |                                                                                                                  | 6  |
|                                                                                   |               |                            |        |                         |           |           |                                                                                   |                                                                                                                  | 7  |
|                                                                                   |               |                            |        |                         |           |           |                                                                                   |                                                                                                                  | 8  |
|                                                                                   |               |                            |        |                         |           |           |                                                                                   |                                                                                                                  | 9  |
|                                                                                   |               |                            |        |                         |           |           |                                                                                   |                                                                                                                  | 10 |

| Hole Diameter |          | Casing Diameter |          | Chiselling |            |          |      | Inclination and Orientation |            |             |             |
|---------------|----------|-----------------|----------|------------|------------|----------|------|-----------------------------|------------|-------------|-------------|
| Depth Base    | Diameter | Depth Base      | Diameter | Depth Top  | Depth Base | Duration | Tool | Depth Top                   | Depth Base | Inclination | Orientation |
|               |          |                 |          |            |            |          |      |                             |            |             |             |

|                                                                                                                       |  |  |  |  |  |  |  |  |  |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|---------------------------------------------------------------------------------------|
| <b>Remarks</b><br>No Groundwater encountered. Refusal encountered at 2.45mbgl. Monitoring well installed to 2.00mbgl. |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|---------------------------------------------------------------------------------------|

# Percussion Drilling Log

|                                   |                  |                        |           |                     |                             |
|-----------------------------------|------------------|------------------------|-----------|---------------------|-----------------------------|
| Project Name: Land off Banks Road |                  | Client: James Bamforth |           | Date: 06/05/2021    |                             |
| Location: Linthwaite, HD7 5LP     |                  | Contractor:            |           |                     |                             |
| Project No. : 1399-21             |                  | Crew Name:             |           | Drilling Equipment: |                             |
| Borehole Number<br>WS02           | Hole Type<br>WLS | Level                  | Logged By | Scale<br>1:50       | Page Number<br>Sheet 1 of 1 |

| Well                                                                              | Water Strikes                                                                     | Sample and In Situ Testing |       |                        | Depth (m) | Level (m) | Legend                                                                            | Stratum Description                                                                                                                                                                                                            |   |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|----------------------------|-------|------------------------|-----------|-----------|-----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
|                                                                                   |                                                                                   | Depth (m)                  | Type  | Results                |           |           |                                                                                   |                                                                                                                                                                                                                                |   |
|  |  | 0.00 - 0.30                | D     |                        |           |           |                                                                                   | MADE GROUND: Dark brown, silty sandy gravelly CLAY. Gravel is fine to coarse of brick and mixed lithology.<br>Firm to stiff, light brown mottled brown silty very gravelly CLAY. Gravel is fine to coarse angular of mudstone. | 1 |
|                                                                                   |                                                                                   | 0.30 - 1.00                | D     |                        | 0.30      |           |  |                                                                                                                                                                                                                                |   |
|                                                                                   |                                                                                   | 1.00 - 1.45                | SPTL  |                        |           |           |                                                                                   | Extremely weak, mottled brown micaceous MUDSTONE: Recovered as silty GRAVEL. (EXTREMELEY WEATHERED)                                                                                                                            | 2 |
|                                                                                   |                                                                                   | 1.00 - 2.00                | S     |                        | 1.00      |           |  |                                                                                                                                                                                                                                |   |
|                                                                                   |                                                                                   | 1.20                       | C SPT | N=32 (7,8/8,8,8,8)     |           |           |  |                                                                                                                                                                                                                                |   |
|                                                                                   |                                                                                   | 2.00 - 2.45                | SPTL  |                        |           |           |                                                                                   | End of Borehole at 2.450m                                                                                                                                                                                                      | 3 |
|                                                                                   |                                                                                   | 2.00                       | S SPT | N=54 (5,5/11,12,13,18) | 2.45      |           |  |                                                                                                                                                                                                                                |   |
|                                                                                   |                                                                                   |                            |       |                        |           |           |                                                                                   |                                                                                                                                                                                                                                |   |
|                                                                                   |                                                                                   |                            |       |                        |           |           |                                                                                   |                                                                                                                                                                                                                                |   |
|                                                                                   |                                                                                   |                            |       |                        |           |           |                                                                                   |                                                                                                                                                                                                                                |   |

| Hole Diameter |          | Casing Diameter |          | Chiselling |            |          |      | Inclination and Orientation |            |             |             |
|---------------|----------|-----------------|----------|------------|------------|----------|------|-----------------------------|------------|-------------|-------------|
| Depth Base    | Diameter | Depth Base      | Diameter | Depth Top  | Depth Base | Duration | Tool | Depth Top                   | Depth Base | Inclination | Orientation |
|               |          |                 |          |            |            |          |      |                             |            |             |             |

|                                                                                                                       |  |  |  |  |  |  |  |  |  |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|---------------------------------------------------------------------------------------|
| <b>Remarks</b><br>No Groundwater encountered. Refusal encountered at 2.45mbgl. Monitoring well installed to 2.00mbgl. |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|---------------------------------------------------------------------------------------|

# Percussion Drilling Log

|                                   |                  |                        |           |                     |                             |
|-----------------------------------|------------------|------------------------|-----------|---------------------|-----------------------------|
| Project Name: Land off Banks Road |                  | Client: James Bamforth |           | Date: 06/05/2021    |                             |
| Location: Linthwaite, HD7 5LP     |                  | Contractor:            |           |                     |                             |
| Project No. : 1399-21             |                  | Crew Name:             |           | Drilling Equipment: |                             |
| Borehole Number<br>WS03           | Hole Type<br>WLS | Level                  | Logged By | Scale<br>1:50       | Page Number<br>Sheet 1 of 1 |

| Well                                                                               | Water Strikes | Sample and In Situ Testing |        |                        | Depth (m) | Level (m) | Legend | Stratum Description                                                                                                            |    |
|------------------------------------------------------------------------------------|---------------|----------------------------|--------|------------------------|-----------|-----------|--------|--------------------------------------------------------------------------------------------------------------------------------|----|
|                                                                                    |               | Depth (m)                  | Type   | Results                |           |           |        |                                                                                                                                |    |
|  |               | 0.00 - 1.00                | D      |                        |           |           |        | MADE GROUND: Dark brown, silty sandy gravelly CLAY. Gravel is fine to coarse of brick and mixed lithology.                     |    |
|                                                                                    |               | 1.00 - 1.45                | SPTL S |                        |           |           |        |                                                                                                                                | 1  |
|                                                                                    |               | 1.00 - 2.00                | C      |                        |           |           |        |                                                                                                                                |    |
|                                                                                    |               | 1.20                       | SPT    | N=7 (1,1/1,2,2,2)      | 1.40      |           |        | Firm light brown mottled brown sandy gravelly CLAY. Gravel is fine to coarse angular of sandstone.                             |    |
|                                                                                    |               | 2.00 - 2.45                | SPTL S |                        |           |           |        |                                                                                                                                | 2  |
|                                                                                    |               | 2.00 - 3.00                | C      |                        |           |           |        |                                                                                                                                |    |
|                                                                                    |               | 2.00                       | SPT    | N=16 (2,2/4,4,4,4)     | 2.70      |           |        | <u>Cobble of SANDSTONE</u>                                                                                                     |    |
|                                                                                    |               | 3.00 - 3.45                | SPTL S |                        |           |           |        |                                                                                                                                | 3  |
|                                                                                    |               | 3.00 - 4.00                | C      |                        |           |           |        | Extremely weak, light brown mottled brown, micaceous, sandy MUDSTONE: Recovered as clayey silty GRAVEL. (EXTREMELEY WEATHERED) |    |
|                                                                                    |               | 3.00                       | SPT    | N=16 (2,2/3,4,4,5)     |           |           |        |                                                                                                                                | 4  |
|                                                                                    |               | 4.00 - 4.45                | SPTL S |                        |           |           |        |                                                                                                                                |    |
|                                                                                    |               | 4.00                       | SPT    | N=63 (5,8/12,13,18,20) | 4.45      |           |        |                                                                                                                                |    |
| End of Borehole at 4.450m                                                          |               |                            |        |                        |           |           |        |                                                                                                                                | 5  |
|                                                                                    |               |                            |        |                        |           |           |        |                                                                                                                                | 6  |
|                                                                                    |               |                            |        |                        |           |           |        |                                                                                                                                | 7  |
|                                                                                    |               |                            |        |                        |           |           |        |                                                                                                                                | 8  |
|                                                                                    |               |                            |        |                        |           |           |        |                                                                                                                                | 9  |
|                                                                                    |               |                            |        |                        |           |           |        |                                                                                                                                | 10 |

| Hole Diameter |          | Casing Diameter |          | Chiselling |            |          |      | Inclination and Orientation |            |             |             |
|---------------|----------|-----------------|----------|------------|------------|----------|------|-----------------------------|------------|-------------|-------------|
| Depth Base    | Diameter | Depth Base      | Diameter | Depth Top  | Depth Base | Duration | Tool | Depth Top                   | Depth Base | Inclination | Orientation |
|               |          |                 |          |            |            |          |      |                             |            |             |             |

|                                                                                                                       |  |  |  |  |  |  |  |  |  |                                                                                       |
|-----------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|---------------------------------------------------------------------------------------|
| <b>Remarks</b><br>No Groundwater encountered. Refusal encountered at 4.45mbgl. Monitoring well installed to 4.00mbgl. |  |  |  |  |  |  |  |  |  |  |
|-----------------------------------------------------------------------------------------------------------------------|--|--|--|--|--|--|--|--|--|---------------------------------------------------------------------------------------|

---

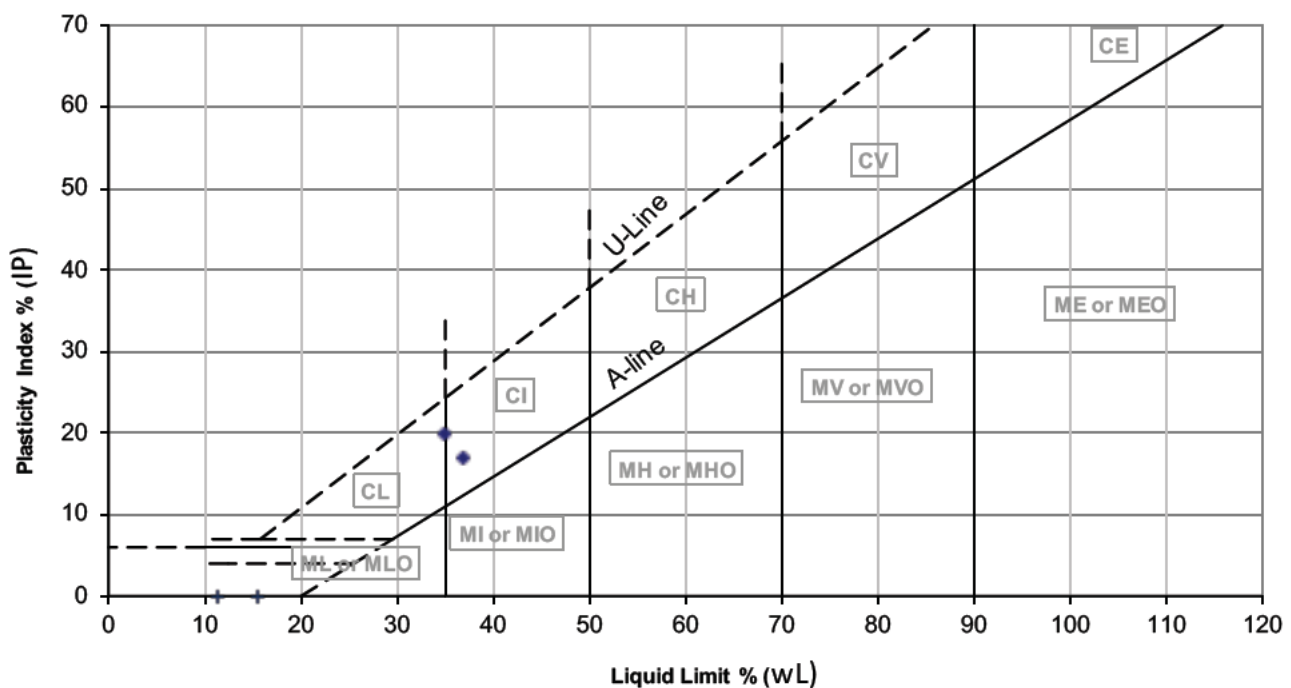
## Appendix 3

### Geotechnical Laboratory Results

---

### Interpretation of Moisture Content, Liquid and Plastic Limits

| Location | Depth<br>(m) | Moisture<br>Content<br>(w)<br>(%) | Liquid<br>Limit<br>(w <sub>L</sub> )<br>(%) | Plastic<br>Limit<br>(w <sub>P</sub> )<br>(%) | Plasticity<br>Index<br>(I <sub>P</sub> )<br>(%) | Retained by<br>425mm<br>(%) | Modified<br>(w)<br>(w')<br>(%) | Modified<br>(I <sub>P</sub> )<br>(I' <sub>P</sub> )<br>(%) | Liquidity/<br>Consistency<br>(I <sub>L</sub> )<br>(%)   (I <sub>C</sub> )<br>(%) |     | Casagrande<br>Class | N.H.B.C<br>Class<br>(%) |
|----------|--------------|-----------------------------------|---------------------------------------------|----------------------------------------------|-------------------------------------------------|-----------------------------|--------------------------------|------------------------------------------------------------|----------------------------------------------------------------------------------|-----|---------------------|-------------------------|
| WS01     | 1.00         | 12                                | 37                                          | 20                                           | 17                                              | 4                           | 13                             | 16                                                         | -0.5                                                                             | 1.5 | C I                 | LOW                     |
| WS03     | 2.00         | 13                                | 35                                          | 15                                           | 20                                              | 2                           | 13                             | 20                                                         | -0.1                                                                             | 1.1 | C I                 | LOW                     |



---

## Appendix 4

### Soil Contamination Laboratory Results

---



2183

## Final Report

---

**Report No.:** 21-17753-1  
**Initial Date of Issue:** 02-Jun-2021  
**Client** Borehole Solutions North Ltd  
**Client Address:** Unit 7 , Springvale Works  
Brookfoot lane  
Brighouse  
HD62RA  
**Contact(s):** [dan@boreholesolutions.com](mailto:dan@boreholesolutions.com)  
**Project** Land off Banks Road, Linthwaite  
**Quotation No.:**  
**Order No.:** 1399-21  
**No. of Samples:** 8  
**Turnaround (Wkdays):** 5  
**Date Approved:** 02-Jun-2021

**Date Received:** 26-May-2021  
**Date Instructed:** 26-May-2021  
**Results Due:** 02-Jun-2021

Approved By:

REDACTED

**Details:**  Glynn Harvey, Technical Manager

---

## Results - Soil

**Project: Land off Banks Road, Linthwaite**

|                                             |                             |            |              |            |             |             |             |                      |                      |                      |                      |                      |
|---------------------------------------------|-----------------------------|------------|--------------|------------|-------------|-------------|-------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| <b>Client: Borehole Solutions North Ltd</b> | <b>Chemtest Job No.:</b>    |            |              |            | 21-17753    | 21-17753    | 21-17753    | 21-17753             | 21-17753             | 21-17753             | 21-17753             | 21-17753             |
| <b>Quotation No.:</b>                       | <b>Chemtest Sample ID.:</b> |            |              |            | 1208732     | 1208733     | 1208734     | 1208735              | 1208736              | 1208737              | 1208738              | 1208739              |
| <b>Order No.: 1399-21</b>                   | <b>Client Sample Ref.:</b>  |            |              |            | D1          | D2          | D3          | ES1                  | ES2                  | ES3                  | ES4                  | ES5                  |
|                                             | <b>Client Sample ID.:</b>   |            |              |            | D1          | D2          | D3          | ES1                  | ES2                  | ES3                  | ES4                  | ES5                  |
|                                             | <b>Sample Location:</b>     |            |              |            | WS01        | WS02        | WS03        | WS01                 | WS02                 | WS02                 | WS03                 | WS03                 |
|                                             | <b>Sample Type:</b>         |            |              |            | SOIL        | SOIL        | SOIL        | SOIL                 | SOIL                 | SOIL                 | SOIL                 | SOIL                 |
|                                             | <b>Top Depth (m):</b>       |            |              |            | 2           | 1           | 3           | 0.15                 | 0.3                  | 2                    | 1                    | 3.5                  |
|                                             | <b>Bottom Depth (m):</b>    |            |              |            | 2           | 1           | 3           | 0.15                 | 0.3                  | 2                    | 1                    | 3.5                  |
|                                             | <b>Date Sampled:</b>        |            |              |            | 18-May-2021 | 18-May-2021 | 18-May-2021 | 18-May-2021          | 18-May-2021          | 18-May-2021          | 18-May-2021          | 18-May-2021          |
|                                             | <b>Time Sampled:</b>        |            |              |            | 12:00       | 12:00       | 12:00       | 12:00                | 12:00                | 12:00                | 12:00                | 12:00                |
|                                             | <b>Asbestos Lab:</b>        |            |              |            |             |             |             | DURHAM               | DURHAM               | DURHAM               | DURHAM               | DURHAM               |
| <b>Determinand</b>                          | <b>Accred.</b>              | <b>SOP</b> | <b>Units</b> | <b>LOD</b> |             |             |             |                      |                      |                      |                      |                      |
| ACM Type                                    | U                           | 2192       |              | N/A        |             |             |             | -                    | -                    | -                    | -                    | -                    |
| Asbestos Identification                     | U                           | 2192       |              | N/A        |             |             |             | No Asbestos Detected | No Asbestos Detected | No Asbestos Detected | No Asbestos Detected | No Asbestos Detected |
| ACM Detection Stage                         | U                           | 2192       |              | N/A        |             |             |             | -                    | -                    | -                    | -                    | -                    |
| Moisture                                    | N                           | 2030       | %            | 0.020      | 12          | 14          | 14          | 17                   | 15                   | 12                   | 24                   | 13                   |
| pH                                          | U                           | 2010       |              | 4.0        | 7.4         | 7.4         | 7.8         | 7.4                  | 7.5                  | 6.4                  | 7.7                  | 7.8                  |
| Sulphate (2:1 Water Soluble) as SO4         | U                           | 2120       | g/l          | 0.010      | 0.018       | 0.013       | < 0.010     | < 0.010              | < 0.010              | < 0.010              | < 0.010              | < 0.010              |
| Sulphate (2:1 Water Soluble) as SO4 mg/l    | U                           | 2120       | mg/l         | 10.000     | 18          | 13          | < 10        |                      |                      |                      |                      |                      |
| Total Sulphur                               | U                           | 2175       | %            | 0.010      | 0.15        | 0.081       | 0.17        |                      |                      |                      |                      |                      |
| Cyanide (Total)                             | U                           | 2300       | mg/kg        | 0.50       |             |             |             | < 0.50               | < 0.50               | < 0.50               | < 0.50               | < 0.50               |
| Sulphate (Total)                            | U                           | 2430       | %            | 0.010      | 0.23        | 0.074       | 0.23        |                      |                      |                      |                      |                      |
| Arsenic                                     | U                           | 2450       | mg/kg        | 1.0        |             |             |             | 8.0                  | 2.4                  | 1.9                  | 20                   | 4.6                  |
| Cadmium                                     | U                           | 2450       | mg/kg        | 0.10       |             |             |             | 0.17                 | 0.16                 | 0.10                 | < 0.10               | 0.12                 |
| Chromium                                    | U                           | 2450       | mg/kg        | 1.0        |             |             |             | 35                   | 17                   | 21                   | 25                   | 22                   |
| Copper                                      | U                           | 2450       | mg/kg        | 0.50       |             |             |             | 28                   | 16                   | 21                   | 38                   | 26                   |
| Mercury                                     | U                           | 2450       | mg/kg        | 0.10       |             |             |             | 0.12                 | < 0.10               | < 0.10               | 0.26                 | < 0.10               |
| Nickel                                      | U                           | 2450       | mg/kg        | 0.50       |             |             |             | 20                   | 16                   | 30                   | 18                   | 45                   |
| Lead                                        | U                           | 2450       | mg/kg        | 0.50       |             |             |             | 50                   | 20                   | 12                   | 65                   | 29                   |
| Selenium                                    | U                           | 2450       | mg/kg        | 0.20       |             |             |             | 0.45                 | 0.39                 | 0.55                 | 0.56                 | 0.41                 |
| Zinc                                        | U                           | 2450       | mg/kg        | 0.50       |             |             |             | 63                   | 94                   | 73                   | 52                   | 95                   |
| Chromium (Hexavalent)                       | N                           | 2490       | mg/kg        | 0.50       |             |             |             | < 0.50               | < 0.50               | < 0.50               | < 0.50               | < 0.50               |
| Organic Matter                              | U                           | 2625       | %            | 0.40       |             |             |             | 1.6                  | 1.6                  | 2.9                  | 7.9                  | 2.1                  |
| Aliphatic TPH >C5-C6                        | N                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Aliphatic TPH >C6-C8                        | N                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Aliphatic TPH >C8-C10                       | U                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Aliphatic TPH >C10-C12                      | U                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Aliphatic TPH >C12-C16                      | U                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Aliphatic TPH >C16-C21                      | U                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Aliphatic TPH >C21-C35                      | U                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Aliphatic TPH >C35-C44                      | N                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Total Aliphatic Hydrocarbons                | N                           | 2680       | mg/kg        | 5.0        |             |             |             | < 5.0                | < 5.0                | < 5.0                | < 5.0                | < 5.0                |
| Aromatic TPH >C5-C7                         | N                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Aromatic TPH >C7-C8                         | N                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Aromatic TPH >C8-C10                        | U                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |
| Aromatic TPH >C10-C12                       | U                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0                | < 1.0                | < 1.0                | < 1.0                | < 1.0                |

## Results - Soil

### Project: Land off Banks Road, Linthwaite

|                                             |                             |            |              |            |             |             |             |             |             |             |             |             |             |
|---------------------------------------------|-----------------------------|------------|--------------|------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| <b>Client: Borehole Solutions North Ltd</b> | <b>Chemtest Job No.:</b>    |            |              |            | 21-17753    | 21-17753    | 21-17753    | 21-17753    | 21-17753    | 21-17753    | 21-17753    | 21-17753    | 21-17753    |
| <b>Quotation No.:</b>                       | <b>Chemtest Sample ID.:</b> |            |              |            | 1208732     | 1208733     | 1208734     | 1208735     | 1208736     | 1208737     | 1208738     | 1208739     | 1208739     |
| <b>Order No.: 1399-21</b>                   | <b>Client Sample Ref.:</b>  |            |              |            | D1          | D2          | D3          | ES1         | ES2         | ES3         | ES4         | ES5         | ES5         |
|                                             | <b>Client Sample ID.:</b>   |            |              |            | D1          | D2          | D3          | ES1         | ES2         | ES3         | ES4         | ES5         | ES5         |
|                                             | <b>Sample Location:</b>     |            |              |            | WS01        | WS02        | WS03        | WS01        | WS02        | WS02        | WS03        | WS03        | WS03        |
|                                             | <b>Sample Type:</b>         |            |              |            | SOIL        | SOIL        | SOIL        | SOIL        | SOIL        | SOIL        | SOIL        | SOIL        | SOIL        |
|                                             | <b>Top Depth (m):</b>       |            |              |            | 2           | 1           | 3           | 0.15        | 0.3         | 2           | 1           | 3.5         | 3.5         |
|                                             | <b>Bottom Depth (m):</b>    |            |              |            | 2           | 1           | 3           | 0.15        | 0.3         | 2           | 1           | 3.5         | 3.5         |
|                                             | <b>Date Sampled:</b>        |            |              |            | 18-May-2021 | 18-May-2021 | 18-May-2021 | 18-May-2021 | 18-May-2021 | 18-May-2021 | 18-May-2021 | 18-May-2021 | 18-May-2021 |
|                                             | <b>Time Sampled:</b>        |            |              |            | 12:00       | 12:00       | 12:00       | 12:00       | 12:00       | 12:00       | 12:00       | 12:00       | 12:00       |
|                                             | <b>Asbestos Lab:</b>        |            |              |            |             |             |             | DURHAM      | DURHAM      | DURHAM      | DURHAM      | DURHAM      | DURHAM      |
| <b>Determinand</b>                          | <b>Accred.</b>              | <b>SOP</b> | <b>Units</b> | <b>LOD</b> |             |             |             |             |             |             |             |             |             |
| Aromatic TPH >C12-C16                       | U                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0       | < 1.0       | < 1.0       | < 1.0       | < 1.0       | < 1.0       |
| Aromatic TPH >C16-C21                       | U                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0       | < 1.0       | < 1.0       | 44          | < 1.0       | < 1.0       |
| Aromatic TPH >C21-C35                       | U                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0       | < 1.0       | < 1.0       | 330         | < 1.0       | < 1.0       |
| Aromatic TPH >C35-C44                       | N                           | 2680       | mg/kg        | 1.0        |             |             |             | < 1.0       | < 1.0       | < 1.0       | < 1.0       | < 1.0       | < 1.0       |
| Total Aromatic Hydrocarbons                 | N                           | 2680       | mg/kg        | 5.0        |             |             |             | < 5.0       | < 5.0       | < 5.0       | 370         | < 5.0       | < 5.0       |
| Total Petroleum Hydrocarbons                | N                           | 2680       | mg/kg        | 10.0       |             |             |             | < 10        | < 10        | < 10        | 370         | < 10        | < 10        |
| Naphthalene                                 | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      |
| Acenaphthylene                              | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      |
| Acenaphthene                                | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      |
| Fluorene                                    | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      |
| Phenanthrene                                | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | 1.7         | < 0.10      | < 0.10      |
| Anthracene                                  | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | 0.36        | < 0.10      | < 0.10      |
| Fluoranthene                                | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | 1.1         | 0.94        | 0.94        |
| Pyrene                                      | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | 1.4         | 0.95        | 0.95        |
| Benzo[a]anthracene                          | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | 0.50        | 0.50        |
| Chrysene                                    | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | 0.57        | 0.57        |
| Benzo[b]fluoranthene                        | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | 0.52        | 0.52        |
| Benzo[k]fluoranthene                        | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | 0.19        | 0.19        |
| Benzo[a]pyrene                              | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | 0.40        | 0.40        |
| Indeno(1,2,3-c,d)Pyrene                     | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      |
| Dibenz(a,h)Anthracene                       | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      |
| Benzo[g,h,i]perylene                        | U                           | 2700       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      |
| Total Of 16 PAH's                           | U                           | 2700       | mg/kg        | 2.0        |             |             |             | < 2.0       | < 2.0       | < 2.0       | 4.6         | 4.1         | 4.1         |
| Benzene                                     | U                           | 2760       | µg/kg        | 1.0        |             |             |             | < 1.0       | < 1.0       | < 1.0       | < 1.0       | < 1.0       | < 1.0       |
| Toluene                                     | U                           | 2760       | µg/kg        | 1.0        |             |             |             | < 1.0       | < 1.0       | < 1.0       | < 1.0       | < 1.0       | < 1.0       |
| Ethy benzene                                | U                           | 2760       | µg/kg        | 1.0        |             |             |             | 1.4         | < 1.0       | 2.0         | < 1.0       | < 1.0       | < 1.0       |
| m & p-Xylene                                | U                           | 2760       | µg/kg        | 1.0        |             |             |             | < 1.0       | < 1.0       | 8.9         | < 1.0       | < 1.0       | < 1.0       |
| o-Xylene                                    | U                           | 2760       | µg/kg        | 1.0        |             |             |             | 1.3         | < 1.0       | 7.3         | < 1.0       | < 1.0       | < 1.0       |
| Methyl Tert-Butyl Ether                     | U                           | 2760       | µg/kg        | 1.0        |             |             |             | < 1.0       | < 1.0       | < 1.0       | < 1.0       | < 1.0       | < 1.0       |
| Total Phenols                               | U                           | 2920       | mg/kg        | 0.10       |             |             |             | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      | < 0.10      |

## Test Methods

| SOP  | Title                                                               | Parameters included                                                                                                                                                                                                                                           | Method summary                                                                                                                                                                         |
|------|---------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2010 | pH Value of Soils                                                   | pH                                                                                                                                                                                                                                                            | pH Meter                                                                                                                                                                               |
| 2030 | Moisture and Stone Content of Soils(Requirement of MCERTS)          | Moisture content                                                                                                                                                                                                                                              | Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.                                                                                   |
| 2040 | Soil Description(Requirement of MCERTS)                             | Soil description                                                                                                                                                                                                                                              | As received soil is described based upon BS5930                                                                                                                                        |
| 2120 | Water Soluble Boron, Sulphate, Magnesium & Chromium                 | Boron; Sulphate; Magnesium; Chromium                                                                                                                                                                                                                          | Aqueous extraction / ICP-OES                                                                                                                                                           |
| 2175 | Total Sulphur in Soils                                              | Total Sulphur                                                                                                                                                                                                                                                 | Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.                                                                                             |
| 2192 | Asbestos                                                            | Asbestos                                                                                                                                                                                                                                                      | Polarised light microscopy / Gravimetry                                                                                                                                                |
| 2300 | Cyanides & Thiocyanate in Soils                                     | Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate                                                                                                                                                                               | Al kaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.                                                                                   |
| 2430 | Total Sulphate in soils                                             | Total Sulphate                                                                                                                                                                                                                                                | Acid digestion followed by determination of sulphate in extract by ICP-OES.                                                                                                            |
| 2450 | Acid Soluble Metals in Soils                                        | Metals, including: Arsenic; Barium; Beryllium; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Vanadium; Zinc                                                                                                      | Acid digestion followed by determination of metals in extract by ICP-MS.                                                                                                               |
| 2490 | Hexavalent Chromium in Soils                                        | Chromium [VI]                                                                                                                                                                                                                                                 | Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide. |
| 2625 | Total Organic Carbon in Soils                                       | Total organic Carbon (TOC)                                                                                                                                                                                                                                    | Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.                                                                                             |
| 2680 | TPH A/A Split                                                       | Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44                                                                                 | Dichloromethane extraction / GCxGC FID detection                                                                                                                                       |
| 2700 | Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-FID | Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenzo[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene | Dichloromethane extraction / GC-FID (GC-FID detection is non-selective and can be subject to interference from co-eluting compounds)                                                   |
| 2760 | Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS       | Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule                                                                                                                          | Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.                             |
| 2920 | Phenols in Soils by HPLC                                            | Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.                                                                                                             | 60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.                                                                               |

## **Report Information**

---

### **Key**

|     |                                                                                                               |
|-----|---------------------------------------------------------------------------------------------------------------|
| U   | UKAS accredited                                                                                               |
| M   | MCERTS and UKAS accredited                                                                                    |
| N   | Unaccredited                                                                                                  |
| S   | This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis     |
| SN  | This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis |
| T   | This analysis has been subcontracted to an unaccredited laboratory                                            |
| I/S | Insufficient Sample                                                                                           |
| U/S | Unsuitable Sample                                                                                             |
| N/E | not evaluated                                                                                                 |
| <   | "less than"                                                                                                   |
| >   | "greater than"                                                                                                |
| SOP | Standard operating procedure                                                                                  |
| LOD | Limit of detection                                                                                            |

Comments or interpretations are beyond the scope of UKAS accreditation

The results relate only to the items tested

Uncertainty of measurement for the determinands tested are available upon request

None of the results in this report have been recovery corrected

All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis

All Asbestos testing is performed at the indicated laboratory

Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

---

### **Sample Deviation Codes**

- A - Date of sampling not supplied
- B - Sample age exceeds stability time (sampling to extraction)
- C - Sample not received in appropriate containers
- D - Broken Container
- E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

---

### **Sample Retention and Disposal**

All soil samples will be retained for a period of 45 days from the date of receipt

All water samples will be retained for 14 days from the date of receipt

Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:

[customerservices@chemtest.com](mailto:customerservices@chemtest.com)

---

## Appendix 5

### Gas Monitoring Results

---







# Ground Gas and Groundwater Monitoring Record Sheet



**JOB DETAILS**  
**Client** Land O Banks Road  
**Site** James Bam orth  
**Date** Linthwaite  
3 6 21

**Job No** 1399-21  
**Visit No** 4 of 4  
**Operator** SE **Project Manager** 0

| Monitoring Point | GAS CONCENTRATIONS |        |      |        |                       |        |                        |        |                          |        |               |        | VOLATILES      |                        | FLOW DATA        |     |                                     |                                  | Worst-credible GSVs |            | WELL AND WATER DATA |                   |                      |                    |               |  | Comments |
|------------------|--------------------|--------|------|--------|-----------------------|--------|------------------------|--------|--------------------------|--------|---------------|--------|----------------|------------------------|------------------|-----|-------------------------------------|----------------------------------|---------------------|------------|---------------------|-------------------|----------------------|--------------------|---------------|--|----------|
|                  | Methane (%v/v)     |        | %LEL |        | Carbon dioxide (%v/v) |        | Carbon monoxide (ppmv) |        | Hydrogen sulphide (ppmv) |        | Oxygen (%v/v) |        | PID Peak (ppm) | Product thickness (mm) | Flow rate (l/hr) |     | Differential borehole Pressure (Pa) | Time for flow to equalise (secs) | Methane (l/hr)      | CO2 (l/hr) | Water level (mbgl)  | Depth of well (m) | Reduced level (mAOD) | Water level (mAOD) | Response Zone |  |          |
|                  | Peak               | Steady | Peak | Steady | Peak                  | Steady | Peak                   | Steady | Peak                     | Steady | Min.          | Steady |                |                        |                  |     |                                     |                                  |                     |            |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  |                     |            |                     |                   |                      |                    |               |  |          |
| WS01             | 0.0                | 0.0    |      |        | 2.6                   | 2.6    | 0                      | 1      | 0                        | 0      | 14.5          | 14.5   |                |                        | 0.2              | 0.2 |                                     |                                  | 0                   | 0.0052     | ND                  | 2.00              |                      | Dry                |               |  |          |
| WS02             | 0.0                | 0.0    |      |        | 2.3                   | 0.6    | 0                      | 0      | 0                        | 0      | 14.6          | 19.9   |                |                        | 0.2              | 0.2 |                                     |                                  | 0                   | 0.0012     | ND                  | 2.00              |                      | Dry                |               |  |          |
| WS03             | 0.0                | 0.0    |      |        | 1.1                   | 1.1    | 0                      | 0      | 0                        | 0      | 19.9          | 19.8   |                |                        | 0.3              | 0.3 |                                     |                                  | 0                   | 0.0033     | ND                  | 4.00              |                      | Dry                |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     | 12                                  |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
|                  |                    |        |      |        |                       |        |                        |        |                          |        |               |        |                |                        |                  |     |                                     |                                  | 0                   | 0          |                     |                   |                      |                    |               |  |          |
| Max              | 0.0                | 0.0    | ND   | ND     | 2.6                   | 2.6    | 0                      | 1      | 0                        | 0      | 19.9          | 19.9   | ND             | ND                     | 0.3              | 0.3 | 12.0                                | NA                               | 0.0000              | 0.0052     | DRY                 | 4.00              | NR                   | NR                 |               |  |          |
| Min              | 0.0                | 0.0    | 0.0  | 0.0    | 1.1                   | 0.6    | 0                      | 0      | 0                        | 0      | 14.5          | 14.5   | 0.0            | 0.0                    | 0.2              | 0.2 | 12.0                                | 0                                | 0.0000              | 0.0000     | 0.00                | 2.00              | 0.00                 | 0.00               |               |  |          |

ND - Not detected  
NR - Not recorded  
NA - Non applicable

**NB:** Where no flow (ND) recorded, GSVs are calculated using equipment limit of detection (0.1l/hr). Where negative flows recorded, these are converted to positive values for calculation of GSVs.

| Worst-possible GSVs |        |
|---------------------|--------|
| 0                   | 0.0078 |

MG - Made ground  
NAT - Natural  
C - Cohesive  
G - Granular

## METEOROLOGICAL AND SITE INFORMATION

(Select correct box with X or enter data, as applicable)

State o ground ☒ Dry ☐ Moist ☐ Wet ☐ Snow ☐ Frozen  
Wind ☐ Calm ☒ Light ☐ Moderate ☐ Strong  
Cloud cover ☒ None ☐ Slight ☐ Cloudy ☐ Overcast  
Precipitation ☒ None ☐ Slight ☐ Moderate ☐ Heavy  
ime monitoring per omed ☐ 08 30 Start ☐ End  
Barometric pressure (mbar) ☐ 999 Start ☐ 999 End  
Pressure trend (Daily) ☐ Falling ☒ Steady ☐ Rising  
Source ☐ Wunderground ☐ Be ore ☐ A ter  
Air emperature (Deg C) ☐ 12