

Piggery to the south of Chapelgate, Sutton St James, Spalding, Lincolnshire, PE12 0EF

Phase 1 and Phase 2 Intrusive Ground Investigation Report

Report on behalf of Kirk Homes Ltd

April 2018
Final Report
R17053

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Client: **Kirk Homes Ltd**

Project: **Piggery to the south of Chapelgate, Sutton St James, Spalding, Lincolnshire**

Title: Phase 2 Intrusive Ground Investigation Report

Status: Final Report

Date: April 2018

Document Production Record

Issue Number: 1	Name	Signature
Approved	Andrew Hare (BSc MSc DIC FGS)	Andrew Hare

Document Revision Record

Issue number	Date	Revision Details
1	3rd April 2018	Original issue

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EXECUTIVE SUMMARY

SITE INFORMATION & SETTING	**Purpose of This Report**	Phase 2 Intrusive Ground Investigation Report
	Client	Kirk Homes Ltd
	Site	Piggery to the south of Chapelgate, Sutton St James, Spalding, Lincolnshire, PE12 0EF
	Site Location	Sited approximately 20km to the south-east of Spalding, the site is located to the south of Chapelgate (the B1165 road) within the village of Sutton St James. The approximate National Grid Reference for the site is 539040, 318060.
	Current Land Use & Description	The site covers approximately 1.8 hectares and is occupied by an active piggery. It includes working areas, yards, storage facilities and paddocks. At the time of writing in March 2018, the piggery was no longer active although the eastern area of the site was used for the grazing of a horse, two sheep and a goat.
	Proposed Development	Forty-two new homes with residential gardens, parking facilities and soft landscaping are proposed at the site.
DESK STUDY	**Site History**	The site was occupied by rural, undeveloped land until the early 1970s, when a piggery was constructed within the western portion of the site. Extension of the piggery took place in the early 1990s. The east of the site has remained as rural, undeveloped land since mapping records began, but was divided into paddocks in the early 2000s. The surrounding area has remained predominantly rural in nature with residential properties, undeveloped land, farms and some small areas of woodland located in the vicinity. Many field drains are present in the surrounding area.
	Unexploded Ordnance	The Zetica UXB map indicates that the site and immediate vicinity is in an area with a low bomb risk.
	Geology and Mining	Made Ground is present at the site, associated with the existing piggery. The site is underlain by Tidal Flat Deposits comprising beach deposits of shingle, Sand, Silt and Clay. The upper bedrock at the site is the West Walton Formation which is typically, a silty Mudstone with occasional Limestone bands. The stratum is typically 15m thick, although the thickness on site is anticipated to be less, due to the proximity of the outcropping Ampthill Clay Formation, which formers the deeper bedrock at the site, immediately to the east. The Ampthill Clay Formation is a grey Mudstone, with argillaceous Limestone (cementstone) nodules. The site is not present within an area affected by coal mining and there are no BGS Recorded Mineral Sites within 2km.
	Ground Stability	No significant ground stability hazards are noted at the site, though there is a Moderate risk of compressible ground and running sands associated with the underlying geology.
	Hydrogeology, Hydrology and Flood Risk	The site is not within a Source Protection Zone and is underlain by Unproductive strata. There are no licensed groundwater abstractions within 2km. Due to the presence of Unproductive Strata beneath the site, the site and the immediate vicinity is drained via a large network of culverts, streams and field drains. The closest surface water features to the site are listed as field drains on the eastern, western and southern site boundaries. The site is listed as being at risk of flooding from rivers or seas without defences (Zone 3). Portions of the site have a medium risk (100-year return) for flooding from surface water. The site is not listed as being at risk from groundwater flooding.

OVERVIEW OF GROUND INVESTIGATION PHASES	**Grange GeoConsulting Limited Intrusive Works**	<u>Phase 1</u> The intrusive works comprised ten trial pits (to a maximum depth of 2.3m bgl) to obtain information on the ground and groundwater conditions at the site. The collection of samples for chemical analysis (soil and water) and in-situ testing (hand shear vane) was also carried out. <u>Phase 2</u> The intrusive works comprised eleven window sample boreholes (to a maximum depth of 4m bgl) to obtain information on the ground and groundwater conditions at the site and further characterise the site following the Phase 1 findings. The collection of samples for chemical analysis (soil and water) and in-situ testing (SPT tests) was also carried out. Six monitoring wells were also installed, and a programme of ground gas and groundwater monitoring was carried out on six occasions following the investigation.
	Findings of the Ground Investigation	<u>Topsoil</u> Varied between a dark brown, slightly sandy, silty Clay with live roots and a stiff, dark brown, slightly sandy and gravelly Clay. The gravel was fine to medium, sub-angular Flint. <u>Made Ground</u> Made Ground was encountered within the western portion of the site within the developed piggery area. Typically comprised brown, grey and mottled, slightly sandy, occasionally gravelly, slightly silty Clay with abundant rootlets. The gravel present was fine to coarse sub-rounded to angular Flint, concrete and brick. Fragments of string, plastic and plastic bags, pig bones and iron were also present. <u>Tidal Flat Deposits</u> Firm to stiff, brown, orange and grey mottled, silty Clay. A thin layer of peat was observed in TP10 and in WS9. Silty sandy layers also noted. With depth, the deposits were often orange or blue to grey in colour and logged as soft, silty Clay. Occasional shell fragments noted. <u>Evidence of contamination</u> Evidence of plastic bags and occasional pig bones was encountered in TP4 between 0.6m and 1.2m bgl. Evidence of plastic, iron, brick and string from ground level to 0.9m bgl was noted in TP6 and string, brick, plastic and bone were observed in TP8 between 0.6m and 1.8m bgl. TP8. Evidence of rare plastic was found in TP9 from ground level to 0.6m bgl. Evidence of pig bones was encountered in WS7 between 1.4m and 1.6m bgl and in WS11 between 1.3m and 1.5m bgl. No further visual or olfactory evidence of contamination was encountered in the shallow soils, this included evidence of hydrocarbon contamination and evidence of potentially asbestos-containing materials. <u>Groundwater</u> Groundwater seepages were recorded in five trial pits between 1.6m and 2m bgl. Strong groundwater inflow was recorded in TP8 inflow between 1.5m and 1.8m bgl. In the window sample boreholes, slight groundwater strikes were recorded between 1.3m and 2.5m bgl and a groundwater strike was recorded in WS1 at 2m bgl. No visual or olfactory evidence of contamination was recorded in the groundwater.
ASSESSMENT & CONCLUSIONS	**Contamination Testing Results**	The testing results for both phases of the investigation have been screened against Grange GeoConsulting Limited GAC screening values (provided in Appendix E) to carry out an assessment of potential risks associated with contamination. <u>Phase 1</u> One sample from the Made Ground recorded a concentration of benzo(a)pyrene of 3.2 mg / kg marginally exceeding the GAC of 3 mg / kg. No GACs for nitrogen or ammonium for the residential with plant uptake scenario are available, though it was noted that extremely high concentrations of nitrogen and ammonium concentrations were noted.

		One sample was found to contain asbestos. Loose chrysotile (white asbestos) was detected at concentrations of <0.001% in the Made Ground. Extremely high concentrations of bacterial contaminants were recorded in the samples taken. A discussion with the biological laboratory confirmed that the concentrations recorded are tremendously high and indicate the presence of soils rich in faecal content and bacteria. The concentrations of Faecal Streptococci and Clostridia were noted to be exceptionally high. The laboratory noted that the concentrations of bacteria within these samples were so great that they exceeded the upper limits of detection of the laboratory apparatus. One marginally elevated concentration of copper in TP8 of 15 µg/kg was recorded in groundwater in one sample. This concentration exceeded the EQS threshold of 5 ug/kg. Seven contaminants were recorded in groundwater at concentrations above the UK drinking water standards in one or more samples. Significant exceedances of the UK DWS were recorded for some contaminants. <u>Phase 2</u> Four of the eleven soil samples tested as part of the Phase 2 ground investigation were found to contain asbestos. Loose chrysotile fibres (white asbestos) were detected in the Made Ground in WS7 (0.4m bgl), WS8 (0.2m bgl), WS9 (0.3m bgl) and WS11 (1.4m bgl). Some slightly elevated concentrations of benzo(a)pyrene were recorded, however all concentrations were below the GAC of 3 mg / kg. No PAH exceedances were recorded in the soil samples taken. No GACs for nitrogen or ammonium for the residential with plant uptake scenario are available, though it was noted that extremely high concentrations of nitrogen (including 2,400 mg / kg in WS9 and 2,600 mg / kg in WS7) were recorded. Similarly, very high ammonium concentrations (including 41 mg / kg in WS9) were recorded. While WS7 contained a high concentration of nitrogen, the ammonium content was below the detection limit of the analysing equipment; < 0.5 mg/kg. All four of the samples were found to contain concentrations of copper exceeding the EQS of 5 µg/L which were not highly elevated. The EQS for zinc of 50 µg (based on average water hardness) was exceeded in two samples, taken from WS8 and WS9 where concentrations of 1,300 µg/L and 210 µg/L were recorded. Manganese and ammonium were recorded in groundwater at concentrations above the UK Drinking Water Standards (DWS) in two samples. Elevated concentrations of manganese were recorded in WS8 and WS9. The concentration recorded in WS8 was ten times the UK DWS. Elevated concentrations of ammonium (as NH4) up to 13 times the UK DWS were recorded in WS8.
	Geoenvironmental Conclusions and Recommendations	**Former Pig Farm Area** No soil samples were found to contain contaminant concentrations that exceeded the Residential with Plant Uptake GACs. Four samples of the Made Ground were found to contain Chrysotile asbestos. One of these samples was scheduled for asbestos quantification and recorded an asbestos by hand picking percentage and total asbestos in the sample of <0.001%. Given the proposed development at the site (residential with gardens) there is the potential for site end users and ground workers to encounter site soils, with the potential to uncover previously unidentified contamination on site. Given the presence of asbestos fibres in the soil on site the contractor should make adequate safety provisions during the works to protect works and surround sites and people from the risks of exposure from asbestos and should comply with the CAR2012 regulations. Given the proposed development at the site (residential properties with garden) there is the potential for site end users and groundworkers to come into contact with the bacteria rich soils in the shallow Made Ground in soft landscaping areas. There are currently no GACs for Bacteria levels within soil however we would recommend placement of a sufficient thickness and quality of clean topsoil layer in all areas of soft landscaping and residential gardens will be required to provide a barrier between the site end users and the residual contamination in

		the shallow site soils. This clean imported topsoil should be a minimum of 600mm thick and underlain by a geo-textile marker layer within the former Pig Farm area. Testing of soils within the Pig Farm area have tested negative for Salmonella and Anthrax. **Current Grass Paddock Area** No visual or olfactory evidence of contamination was encountered in any of the boreholes or trial pits on in the grass paddock in soils or groundwater. None of the samples taken were found to contain asbestos and all of the samples recorded concentrations of any inorganic or organic contaminants below the relevant residential with plant uptake screening criteria. The proposed development will be occupied by residential properties with gardens and associated infrastructure including access and parking facilities. Therefore, there is the potential for exposure to unforeseen contamination at the site, though based on the results of the ground investigation this is considered unlikely. It is considered that the risks to ground workers from potentially unidentified substances will be mitigated through appropriate Health & Safety precautions, regular dust control during the demolition and construction works (particularly to minimise the generation of potential airborne asbestos fibres) and the use of personal protective equipment (PPE) are adopted during the site works and that a watching brief for contamination is maintained during the earthworks. Good practice should always be adopted during works on site (during construction and during any future maintenance works). The site has a low potential for ground gas generation relating to carbon dioxide and methane ground gases (proposed development Situation B). The ground gas regime on site is classified as Green Amber 1 in accordance with the NHBC Traffic Light Classification and as Characteristic Situation 1 in accordance with CIRIA C655. Based on these classifications, no mitigation against carbon dioxide and methane ground gases is required at the site. No further remediation measures are considered necessary for the proposed end use within the current grass paddock section of the site.
	Geotechnical Conclusions and Recommendations	The proposed development is to construct a number of detached residential dwellings. The exploratory holes encountered Topsoil or Made Ground to depths of between 0.3 and 1.8mbgl over Tidal Flat Deposits to a depth of between 0.3 and 4.0mbgl. The Made Ground is an unsuitable bearing strata. The Tidal Flat Deposits may be adequate to support the proposed development using strip, trench fill or piled foundations. Groundwater levels have been recorded between 0.72 and 1.65m bgl. **Shallow and Trenchfill Foundations** Shallow foundations should be placed within Tidal Flat Deposits. Within these materials an allowable bearing pressure of 50kN/m2 can be assumed which includes a factor of safety of 3.0 against general shear failure and will limit total foundation settlement to less than 25mm for foundation widths up to 1m bearing at a minimum 1m depth. However, given the variability of composition of the Tidal Flat Deposits, the shallow groundwater conditions, the presence of thick Made Ground in some areas and the presence of very soft ground at depth it may be more suitable to consider pile foundations. **Piled Foundations** In the light of the presence of the depth of the Made Ground, shallow groundwater and the presence of soft ground at depth the underlying West Walton Formation Formation is likely to be a suitable as support to pile foundations. Piles should be designed to penetrate into the West Walton Formation, gaining support from shaft adhesion and end bearing.

This Executive Summary forms part of Grange GeoConsulting Limited report number R17053/001 (Issue 1) and should not be used as a separate document.

2.0 INTRODUCTION

2.1 Terms of Reference

Grange GeoConsulting Limited was commissioned by Kirk Homes Ltd in 2017 to undertake a ground investigation, associated with the redevelopment of the piggery to the south of Chapelgate in Sutton St James, Spalding, Lincolnshire. The site is located on the western side of the village of Sutton St James and to the south of Chapelgate (the B1165 road) in the South Holland district of Lincolnshire. Sutton St James is a small village, located in a rural area. The site is within the Lincolnshire Fens, approximately 20km to the south-east of Spalding. A Site Location Plan (Drawing R17053-DWG1) is presented in Appendix A.

The site covers approximately 1.8 hectares and comprises two distinct areas. The eastern portion of the site is open land and is divided into paddocks. At the time of writing in March 2018, the site was being used for grazing, with a horse, two sheep and a goat residing on site. The western portion of the site is occupied by a former piggery and includes working areas, yards, storage facilities and pig stalls. By late 2017, the piggery was no longer active, and in March 2018 no pigs were being kept on site.

A Phase 1 Desk Study was undertaken for the site by Grange GeoConsulting Limited in June 2017, the findings of which have informed the design of the ground investigation at the site. The Desk Study should be read in conjunction with this report.

This Intrusive Ground Investigation Report summarises the findings of two phases of ground investigation and the associated laboratory testing that have been carried out at the site in the past nine months by Grange GeoConsulting Limited. An initial phase of ground investigation, comprising ten trial pits (TP1 to TP10) was undertaken at the site in June 2017 to obtain information on the ground and groundwater conditions to support the proposed redevelopment plans. The initial works (Phase 1) identified several issues and particular areas of concern on site and concluded that a second phase of intrusive works would be required to obtain additional information and further characterise the site. These works were summarised in a Factual Report by Grange GeoConsulting (with all content summarised in this report). Additional ground investigation (Phase 2) was undertaken at the site in January and February 2018 and comprised eleven window sample boreholes (WS1 to WS11) with a subsequent groundwater and ground gas monitoring programme.

The proposed development comprises forty-two new homes (to include two bungalows and forty houses) with residential gardens, parking facilities and associated soft landscaping. A Proposed Development Layout (Drawing R17053-DWG2) is presented in Appendix A.

2.2 Objectives

The overall project objective was to carry out a ground investigation and assessment of the site to inform the client of potential ground-related risks associated with the redevelopment opportunity. This included the determination of the underlying ground and groundwater conditions, including an assessment of the level of contamination at the site and the provision of initial geotechnical design recommendations. Phase 2 of the ground investigation aimed to

investigate in more detail the potential areas of concern identified in the Phase 1 investigation, such as the animal burial area at the south-west of the site.

2.3 Scope of Works

The scope of works, as outlined in the Grange Geoconsulting Limited proposals, dated 16th June 2017 (Phase 1) and 7th November 2017 (Phase 2), is summarised below.

Phase 1

- One day of up to ten machine-excavated trial pits across the site to enable the logging of the soils encountered and the collection of soil samples for chemical analysis; and
- Chemical (contamination analysis) testing of soils and groundwater.

Phase 2

- 2 days of dynamic (window) sampling and testing to enable the logging of the soils encountered and the collection of soil samples for geotechnical and chemical analysis. In-situ penetration testing (SPTs) to be undertaken to assess the density of the underlying ground, and to inform the design of the foundations for any new proposed buildings on site;
- Ground gas and groundwater monitoring installation wells to be installed within six of the window sample hole locations to a depth of up to 4m below ground level (bgl);
- Ground gas monitoring and groundwater level monitoring within the six installation wells (six visits over a six-week period);
- Chemical (contamination analysis) testing of soils (and groundwater if encountered);
- Biological chemical testing of soils within the animal burial area on site;
- Geotechnical testing of soils; and
- Collaboration of the findings within an Interpretative Report.

2.4 Provided Information

The following has been provided to Grange GeoConsulting Limited by Kirk Homes Limited, for use in the preparation of this Interpretative Report:

- Landmark Information Group Sitecheck Combined Report dated 7th June 2017;
- Proposed Residential to the rear of Havencombe, Chapelgate, Sutton St James for Mr & Mrs Heanes (reference S015-040/1) dated February 2016; and
- Topographical Survey for the land to the rear of Avalon and Havencombe, Chapelgate, Sutton St James (reference 37815/02) dated December 2015.

2.5 Limitations

This report is based upon information obtained from third party sources, together with observations from the site walkover survey, and data from the recent ground investigation. The third-party data has been accepted at face value and has not been independently verified. Grange GeoConsulting Limited can therefore give no warranty, representation or assurance as to the accuracy or completeness of such information.

The spacing of the exploratory holes, and the sampling and analysis undertaken as part of the ground investigation, is considered to have provided a reasonable level of certainty about the ground conditions. However, it is important to recognise that contamination can be both widespread and relatively localised, depending upon its source and nature. No investigation, however comprehensive, can be expected to determine the nature and extent of all contamination that could be present, and there will always be an element of uncertainty. The potential for currently undetected contamination to be present must therefore be considered not only in the risk assessment presented within this report, but also in consideration of future development activities, i.e. health and safety planning and risk management.

This report has been prepared for the sole internal use and reliance of the client, Kirk Homes Limited, and shall not be relied upon by other parties without the express written authority of Grange GeoConsulting Limited. If an unauthorised third party comes into possession of this report, then they rely on it at their own risk.

3.0 PHASE 1 GROUND INVESTIGATION

3.1 Ground Investigation Rationale

The intrusive ground investigation rationale, summarised in Table 2.1, is based on the findings of the Preliminary Risk Assessment and Conceptual Model, undertaken as part of the Phase 1 Desk Study for the site.

Table 2.1: Investigation Rationale

Trial Pits	Purpose
TP1 to TP10 To a maximum depth of 2.3m below ground level (bgl)	• Enable logging of the soils encountered and assess shallow ground and groundwater conditions • Allow the collection of soil and groundwater samples for chemical (contamination analysis)

3.2 Intrusive Works Undertaken

The intrusive works were undertaken on the 23rd June 2017. The approximate positions of the trial pits were surveyed using a tape measure, with distances measured from features present on or adjacent to the site. The locations of the trial pits are shown in the Phase 1 Trial Pit Location Plan (Drawing R17053_DWG3) provided in Appendix C.

The Phase 1 intrusive works are summarised in Table 2.2. The trial pit logs, including details of ground conditions, soil and groundwater sampling, water strikes, any visual or olfactory evidence of contamination and in-situ testing, are presented in Appendix C.

Table 2.2: Summary of Intrusive Works

Trial Pits	Method	Depth (m)	In-situ testing	Comments and Installations
TP1	Machine-excavated trial pit	1.9m bgl	None undertaken.	No groundwater encountered. No visual or olfactory evidence of contamination.
TP2	Machine-excavated trial pit	2m bgl	None undertaken.	No groundwater encountered. No visual or olfactory evidence of contamination.
TP3	Machine-excavated trial pit	1.8m bgl	None undertaken.	Slight seepage of groundwater below 1.7m bgl. No visual or olfactory evidence of contamination.
TP4	Machine-excavated trial pit	2.2m bgl	None undertaken.	No groundwater encountered. Evidence of plastic bags and occasional pig bones between 0.6m and 1.2m bgl.
TP5	Machine-excavated trial pit	2.3m bgl	Hand shear vane readings at 0.5m (70Kpa), 1m (85Kpa) and 1.2m bgl (55Kpa).	Slight seepage of groundwater below 1.8m bgl. No visual or olfactory evidence of contamination.
TP6	Machine-excavated trial pit	2m bgl	Hand shear vane reading at 1.2m bgl (48Kpa).	Evidence of plastic, iron, brick and string from ground level to 0.9m bgl.

Trial Pits	Method	Depth (m)	In-situ testing	Comments and Installations
TP7	Machine-excavated trial pit	2m bgl	None undertaken.	Slight seepage of groundwater below 1.8m bgl. No visual or olfactory evidence of contamination.
TP8	Machine-excavated trial pit	2m bgl	None undertaken.	Strong groundwater inflow between 1.5m and 1.8m bgl. Evidence of string, brick, plastic and bone between 0.6m and 1.8m bgl.
TP9	Machine-excavated trial pit	1.7m bgl	None undertaken.	Slight seepage of groundwater below 1.6m bgl. Evidence of rare plastic from ground level to 0.6m bgl.
TP10	Machine-excavated trial pit	2m bgl	Hand shear vane readings at 0.5m (100Kpa), 1m (50Kpa), 1.5m (35Kpa) and 2m bgl (15Kpa).	No groundwater encountered. No visual or olfactory evidence of contamination.

3.3 Ground Conditions

The ground conditions, as proven during the Phase 1 intrusive works, are in accordance with the published geological literature. The ground conditions are presented in the trial pit logs in Appendix C and summarised in Table 2.3.

Table 2.3: Strata Encountered During Phase 1 Intrusive Works

Stratum Description	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)
Topsoil – varied between a dark brown, slightly sandy, silty Clay and a stiff, dark brown, slightly gravelly Clay. The gravel was fine to medium, sub-angular flint.	0m bgl	0.3m bgl	0.2m to 0.3m
Made Ground – typically comprised brown, grey and mottled, slightly sandy, occasionally gravelly, slightly silty Clay with abundant rootlets. The gravel present was fine to coarse sub-rounded to angular flint, concrete and brick. Fragments of string, plastic and plastic bags, pig bones and iron were present.	0m bgl	0.6m to 1.8m bgl	0.6m to 1.8m
Tidal Flat Deposits – stiff, brown and grey mottled, silty Clay. A thin layer of peat was observed in TP10. Silty sandy layers also noted. With depth, the deposits were often orange or blue to grey in colour and logged as soft, silty Clay. Occasional shell fragments.	0.2m to 1.8m bgl	Unproven (present at 2.3m bgl in WS5)	Unproven (present at 2.3m bgl in WS5)

3.3.1 Topsoil

Topsoil was present at ground level in five of the trial pits (TP1, TP2, TP3, TP5 and TP10). The Topsoil encountered in TP1, TP2, TP3 and TP10 was logged as a dark brown, slightly sandy, silty Clay with live roots. The thickness varied between 0.2m and 0.3m. In TP5, the Topsoil was logged as stiff, dark brown, slightly gravelly Clay. The gravel was fine to medium, sub-angular Flint. It was present from ground level to 0.3m bgl.

3.3.2 Made Ground

Made Ground was present from ground level in five trial pits (TP4, TP6, TP7, TP8 and TP9). TP4, TP6 and TP8 were all located at the south of the site, while TP9 was located within the central portion of the site. The Made Ground typically comprised brown, grey and mottled, slightly sandy, occasionally gravelly, slightly silty Clay with abundant rootlets. The gravel present was fine to coarse sub-rounded to angular flint, concrete and brick.

The thickness of the Made Ground varied between 0.6m and 1.8m thick. The greatest thickness of Made Ground was recorded in TP8. The lower layer of the Made Ground was predominantly brown Clay and contained fragments of string, brick, plastic, bone and pockets of black organic matter and was present to 1.8m bgl. In TP4 the Made Ground contained plastic bags and occasional pig bones between 0.6m and 1.2m bgl. Fragments of plastic, iron, string and brick were present to 0.9m bgl in TP6. Rare plastic was observed to 0.6m bgl in TP9.

3.3.3 Tidal Flat Deposits

The Tidal Flat Deposits observed at the site were described as stiff, brown and grey mottled, silty Clay. A thin layer of peat (0.1m thick) was observed in TP10 at 1.6m bgl within the deposits. Silty sandy layers were also noted. With depth, the deposits were often orange or blue to grey in colour and logged as soft, silty Clay. Occasional shell fragments were noted. The Tidal Flat Deposits were present to the base of all trial pits. The underlying bedrock was not encountered.

3.3.4 Trial Pit Stability

In TP4, the pit began to collapse between 0.3m and 1.6m bgl. No further signs of instability were noted during the excavation of the trial pits.

3.4 Visual and Olfactory Evidence of Contamination

Evidence of plastic bags and occasional pig bones was encountered in TP4 between 0.6m and 1.2m bgl. Evidence of plastic, iron, brick and string from ground level to 0.9m bgl was noted in TP6 and string, brick, plastic and bone were observed in TP8 between 0.6m and 1.8m bgl. TP8. Evidence of rare plastic was found in TP9 from ground level to 0.6m bgl. No further visual or olfactory evidence of contamination was encountered in the shallow soils, this included evidence of hydrocarbon contamination and evidence of potentially asbestos-containing materials.

It should be noted that as identified during the Desk Study several of the pig sty units on site have sheeted cement asbestos roofing. Piles of asbestos sheeting were also present on site. Asbestos containing materials within the existing fabric of the site buildings (roofing materials) could also be present. Heaps of construction rubble, which could also potentially contain asbestos-containing materials were noted on site. While it has been recommended that an asbestos survey be undertaken prior to the demolition of the buildings on site, the sources within the buildings and the construction rubble will be removed off-site as part of the redevelopment scheme. At present, these sources remain on site and remain a source of contamination with the potential to impact the site soils and site receptors.

3.5 Groundwater

3.5.1 Groundwater Strikes

The groundwater strikes encountered during the excavation of the trial pits are summarised in Table 2.4. Two groundwater samples were taken following the excavation of the trial pits and sent for laboratory analysis, the results of which are discussed in Section 5 of this report.

No visual or olfactory evidence of contamination was recorded in the groundwater in any of the trial pits.

Table 2.4: Phase 1 Groundwater Strikes

Trial Pits	Date	Depth to Groundwater (m bgl)	Description
TP3	23.06.2017	1.7m bgl	Slight seepage of groundwater below 1.7m bgl.
TP5	23.06.2017	1.8m bgl	Slight seepage of groundwater below 1.8m bgl.
TP6	23.06.2017	1.9m bgl	Slight seepage of groundwater below 1.9m bgl.
TP7	23.06.2017	2m bgl	Slight seepage of groundwater below 1.8m bgl.
TP8	23.06.2017	1.5m bgl	Strong groundwater inflow between 1.5m and 1.8m bgl.
TP9	23.06.2017	1.6m bgl	Slight seepage of groundwater below 1.6m bgl.

4.0 PHASE 2 GROUND INVESTIGATION

4.1 Intrusive Works Rationale

The intrusive ground investigation rationale, summarised in Table 3.1, is based on the findings of the Phase 1 ground investigation which identified areas of concern that required further delineation across the site.

Table 3.1: Investigation Rationale

Boreholes	Purpose
WS1 to WS11 To a maximum depth of 4m below ground level (bgl)	• Enable logging of the soils encountered and assess shallow ground conditions • Carry out in-situ penetration testing (SPTs) to assess the density of the underlying ground • Allow the collection of soil samples for chemical (contamination analysis), biological and geotechnical testing • Install monitoring wells within six window sample locations to facilitate ground gas monitoring, groundwater level monitoring (six occasions) and groundwater sampling (one occasion).

4.2 Intrusive Works Undertaken

The intrusive works were undertaken on the 30th and 31st January and the 1st February 2018. The approximate positions of the window sample boreholes were surveyed using a tape measure, with distances measured from features present on or adjacent to the site. The locations of the boreholes are shown in the Phase 2 Borehole Location Plan (Drawing R17053_DWG4) provided in Appendix D.

The Phase 2 intrusive works are summarised in Table 3.2. The window sample logs, including details of ground conditions, soil and groundwater sampling, water strikes, any visual or olfactory evidence of contamination and in-situ testing, are presented in Appendix D.

Table 3.2: Summary of Phase 2 Intrusive Works

Boreholes	Method	Depth (m)	In-situ testing	Comments and Installations
WS1	Window sample borehole	4m bgl	Standard Penetration Tests (SPTs) undertaken at 1m intervals from 1m bgl. Low SPTs recorded.	Groundwater strike at 2m bgl and associated collapse below 2m bgl. Monitoring well installed to 4m bgl (response zone between 1m and 4m bgl). No visual or olfactory evidence of contamination.
WS2	Window sample borehole	4m bgl	SPTs undertaken at 1m intervals from 1m bgl. Low SPTs recorded.	Slight groundwater strike at 2m bgl. Groundwater at 1.5m bgl after 20 minutes with borehole collapse below 2m bgl. No visual or olfactory evidence of contamination.
WS3	Window sample borehole	4m bgl	SPTs undertaken at 1m intervals from 1m bgl. Low SPTs recorded.	Slight groundwater strike at 2.5m bgl. Groundwater at 1.6m bgl after 20 minutes with borehole collapse below 1.7m bgl. No visual or olfactory evidence of contamination.
WS4	Window sample borehole	2.2m bgl	SPTs undertaken at 1m intervals from	Monitoring well installed to 3m bgl (response zone between 1m and 3m

Boreholes	Method	Depth (m)	In-situ testing	Comments and Installations
			1m bgl. Low SPTs recorded.	bgl). No visual or olfactory evidence of contamination.
WS5	Window sample borehole	2.3m bgl	SPTs undertaken at 1m intervals from 1m bgl. Low SPTs recorded.	No groundwater strikes. Monitoring well installed to 2.8m bgl (response zone between 0.8m and 2.8m bgl). No visual or olfactory evidence of contamination.
WS6	Window sample borehole	4m bgl	SPTs undertaken at 1m intervals from 1m bgl. Low SPTs recorded.	No groundwater strikes. Monitoring well installed to 3.9m bgl (response zone between 0.9m and 3.9m bgl). No visual or olfactory evidence of contamination.
WS7	Window sample borehole	2.5m bgl	SPTs undertaken at 1m intervals from 1m bgl. Low SPTs recorded.	Slight groundwater strike at 1.4m bgl. Groundwater at 0.5m bgl after 20 minutes. Evidence of pig bones found between 1.4m and 1.6m bgl.
WS8	Window sample borehole	4m bgl	SPTs undertaken at 1m intervals from 1m bgl. Low SPTs recorded.	Monitoring well installed to 3.6m bgl (response zone between 0.6m and 3.6m bgl). No visual or olfactory evidence of contamination.
WS9	Window sample borehole	4m bgl	SPTs undertaken at 1m intervals from 1m bgl. Low SPTs recorded.	Monitoring well installed to 3.6m bgl (response zone between 0.6m and 3.6m bgl). No visual or olfactory evidence of contamination.
WS10	Window sample borehole	4m bgl	SPTs undertaken at 1m intervals from 1m bgl. Low SPTs recorded.	Slight groundwater strike at 2.1m bgl. Groundwater at 1.4m bgl after 20 minutes. No visual or olfactory evidence of contamination.
WS11	Window sample borehole	3m bgl	SPTs undertaken at 1m intervals from 1m bgl. Low SPTs recorded.	Slight groundwater strike at 1.3m bgl. Groundwater at 0.4m bgl after 20 minutes. Evidence of pig bones found between 1.3m and 1.5m bgl.

4.3 Ground Conditions

The ground conditions, as proven during the Phase 2 ground investigation and in accordance with the published geological literature and Phase 1 ground investigation findings. The ground conditions are presented in the borehole logs in Appendix D and summarised in Table 3.3.

Table 3.3: Strata Encountered During Phase 1 Intrusive Works

Stratum Description	Depth to Top (m bgl)	Depth to Base (m bgl)	Thickness (m)
Topsoil – a dark brown, slightly sandy, silty Clay.	0m bgl	0.3m bgl	0.2m to 0.3m
Made Ground – typically comprised dark brown, slightly gravelly, sandy Clay with gravels of fine to medium, sub-angular brick.	0m bgl	0.3m to 1.6m bgl	0.3m to 1.8m
Tidal Flat Deposits – firm to stiff, brown, orange and grey mottled, silty Clay. Bands of grey sandy Silt and silty sandy layers were also noted in numerous window sample boreholes. Occasional decayed rootlets were noted. A thin layer of peat (0.1m thick) was observed in WS9 at 1.8m bgl.	0.3m to 1.6m bgl	Unproven (present at 4m bgl at the base of the boreholes)	Unproven (present at 4m bgl at the base of the boreholes)

4.3.1 Topsoil

Topsoil was noted to be present in WS1, WS2, WS3, WS4 and WS6 and was between 0.2m and 0.3m thick. It was logged as a dark brown, slightly sandy Clay.

4.3.2 Made Ground

Made Ground was present from ground level in six of the window sample boreholes on site (WS5, WS7, WS8, WS9, WS10 and WS11). These boreholes were located within the western portion of the site within the developed piggery area of the site. The Made Ground typically comprised dark brown, slightly gravelly, sandy Clay with gravels of fine to medium, sub-angular brick. The thickness of the Made Ground varied between 0.3m bgl and 1.6m bgl.

In WS6 and WS11, the Made Ground was noted to be 1.6m and 1.5m deep and was logged as a firm brown, slightly sandy Clay. Pig bones were noted to be present between 1.4m and 1.6m bgl in WS6 and 1.3m to 1.5m bgl in WS11.

In WS9, a black, slightly gravelly, sandy Silt was noted with brick gravel and cobbles to 0.4m bgl. In WS10, the Made Ground was 0.5m thick and comprised a 0.1m thick surface concrete layer, overlain by a red to brown, sandy clayey gravel and sandy Clay with brick gravel.

4.3.3 Tidal Flat Deposits

The Tidal Flat Deposits observed were described as firm to stiff, brown, orange and grey mottled, silty Clay. Bands of grey sandy Silt and silty sandy layers were also noted in numerous window sample boreholes. Occasional decayed rootlets were noted. A thin layer of peat (0.1m thick) was observed in WS9 at 1.8m bgl within the deposits. The Tidal Flat Deposits were present to the base of all of the boreholes on site and the depth of the stratum was unproven. The bedrock was not encountered on site.

4.3.4 Borehole Stability

WS1 and WS2 were noted to begin collapsing below 2m bgl. Similarly, WS3 collapsed below 1.7m bgl. In WS4, the window sample borehole collapsed below 3.1m bgl and in WS8 and WS9 below 3.5m bgl. The collapse noted in the boreholes was below the water table.

4.4 Visual and Olfactory Evidence of Contamination

Evidence of pig bones was encountered in WS7 between 1.4m and 1.6m bgl and in WS11 between 1.3m and 1.5m bgl. No further visual or olfactory evidence of contamination was encountered in the shallow soils, this included evidence of hydrocarbon contamination and evidence of potentially asbestos-containing materials.

The visual evidence of asbestos contamination noted on site during the Phase 1 Desk Study and Phase 1 ground investigation (as detailed in Section 2.4 of this report) was noted to remain on site during the Phase 2 ground investigation.

4.5 Groundwater and Ground Gas

4.5.1 Groundwater Strikes

The groundwater strikes encountered during the drilling of the window sample boreholes are summarised in Table 3.4 below. No visual or olfactory evidence of contamination was recorded in the groundwater in any of the boreholes.

Four groundwater samples were taken from WS1, WS4, WS8 and WS9 following the drilling of the boreholes on the 6th March 2018. The samples were sent for laboratory analysis, the results of which are discussed in Section 6.5 of this report.

Table 3.4: Phase 2 Groundwater Strikes

Borehole	Date	Depth to Groundwater (m bgl)	Description
WS1	30.01.2018	2m bgl	Groundwater strike at 2m bgl.
WS2	30.01.2018	1.5m bgl	Slight groundwater strike at 2m bgl. Groundwater at 1.5m bgl after 20 minutes.
WS3	30.01.2018	2.5m bgl	Slight groundwater strike at 2.5m bgl. Groundwater at 1.6m bgl after 20 minutes.
WS7	30.01.2018	1.4m bgl	Slight groundwater strike at 1.4m bgl. Groundwater at 0.5m bgl after 20 minutes.
WS8	30.01.2018	No obvious groundwater strike during drilling	No obvious groundwater strike during drilling
WS9	01.02.2018	No obvious groundwater strike during drilling	No obvious groundwater strike during drilling
WS10	01.02.2018	2.1m bgl	Slight groundwater strike at 2.1m bgl. Groundwater at 1.4m bgl after 20 minutes.
WS11	01.02.2018	1.3m bgl	Slight groundwater strike at 1.3m bgl. Groundwater at 0.4m bgl after 20 minutes.

4.6 Groundwater and Ground Gas Monitoring

Groundwater and ground gas monitoring was carried out immediately following the Phase 2 ground investigation and on a further six occasions (02.02.2018, 09.02.2018, 16.02.2018, 23.02.2018, 02.03.2018, 06.03.2018 and 16.03.2018). The full results are presented in Appendix E and are summarised in Table 3.5 and Table 3.6.

Table 3.5: Groundwater Monitoring Summary

Borehole	Monitoring visits	Depth to Groundwater range (m bgl)	Response Zone (m bgl)	Groundwater observations
WS1	02.02.2018 09.02.2018 16.02.2018 23.02.2018	1.58m to 1.6m bgl	1m to 4m bgl	No visual or olfactory evidence of contamination.
WS4		1.4m to 1.65m bgl	1m to 3m bgl	No visual or olfactory evidence of contamination.

Borehole	Monitoring visits	Depth to Groundwater range (m bgl)	Response Zone (m bgl)	Groundwater observations
WS5	02.03.2018 06.03.2018 16.03.2018	1.35m to 1.54m bgl	0.8m to 2.8m bgl	No visual or olfactory evidence of contamination.
WS6		1.05m to 1.4m bgl	0.9m and 3.9m bgl	No visual or olfactory evidence of contamination.
WS8		0.93m to 1.02m bgl	0.6m and 3.6m bgl	No visual or olfactory evidence of contamination.
WS9		0.72m to 1.10 bgl	1m to 2m bgl	No visual or olfactory evidence of contamination.

The ground gas monitoring was carried out and recorded in accordance with the guidance and protocols presented in CIRIA, Assessing Risks Posed by Hazardous Ground Gases to Buildings (C665) and BS 8576 Guidance on Investigations for Ground Gas. The results were recorded as ppm (isobutylene equivalent).

During each round of gas monitoring, the ground gas concentrations and groundwater level for each borehole were recorded. A portable gas meter was used to measure concentrations of carbon dioxide (CO_2), methane (CH_4) and oxygen (O_2) in percentage volume.

Peak and steady state conditions were recorded. An integral flow meter was used to measure gas flow rates (initial and steady state) in litres per hour. In addition, the atmospheric pressure before and during the monitoring, together with the weather conditions, were noted.

Table 3.6: Ground Gas Monitoring Summary

Borehole	Monitoring visits	Response Zone (m bgl)	Max. flow rate	Steady CO_2 concentration	Max. CH_4 concentration
WS1	09.02.2018 16.02.2018 23.02.2018 02.03.2018 06.03.2018 16.03.2018	1m to 3m bgl	1 l/hr	0.6 % v/v	0.2 % v/v
WS4		0.8m to 2.8m bgl	1.5 l/hr	0.4 % v/v	0.2 % v/v
WS5		0.9m and 3.9m bgl	1.2 l/hr	3.4 % v/v	0.3 % v/v
WS6		0.6m and 3.6m bgl	1.6 l/hr	1.7 % v/v	0.2 % v/v
WS8		1m to 2m bgl	2.6 l/hr	1.4 % v/v	0.2 % v/v
WS9		1m to 3m bgl	2.2 l/hr	2.2 % v/v	0.2 % v/v

The monitoring results are summarised below:

- Methane concentrations recorded ranged between were 0.1% and 0.3% v/v;
- Carbon dioxide concentrations recorded were between 0.2% v/v and 3.4% v/v;
- Oxygen concentrations between 12.4% v/v and 20% v/v;
- Gas flow measurements indicated emission rates of between 0.1 l/hr and 2.6 l/hr;

- Atmospheric pressure was variable throughout the monitoring period and ranged between 987mb and 1023mb. Monitoring was carried out in rising, falling and steady pressure conditions.

4.7 In-situ Testing (SPTs)

Standard Penetrations Tests (SPTs) were undertaken during the advancement of the window sample boreholes on site. The SPT (N values) results are presented in Table 3.7.

Table 3.7: SPT results (N values)

Boreholes	Depth SPT undertaken (m)	SPT (N values) recorded
WS1	1m bgl	8
	2m bgl	5
	3m bgl	14
	4m bgl	1
WS2	1m bgl	11
	2m bgl	6
	3m bgl	8
	4m bgl	11
WS3	1m bgl	8
	2m bgl	5
	3m bgl	4
	4m bgl	8
WS4	1m bgl	9
	2m bgl	4
	3m bgl	6
	4m bgl	5
WS5	1m bgl	7
	2m bgl	4
	3m bgl	0
	4m bgl	8
WS6	1m bgl	9
	2m bgl	2
	3m bgl	3
	4m bgl	2
WS7	1m bgl	5
	2m bgl	3
	3m bgl	4
	4m bgl	12

Boreholes	Depth SPT undertaken (m)	SPT (N values) recorded
WS8	1m bgl	6
	2m bgl	4
	3m bgl	4
	4m bgl	7
WS9	1m bgl	7
	2m bgl	1
	3m bgl	1
	4m bgl	0
WS10	1m bgl	9
	2m bgl	8
	3m bgl	2
	4m bgl	1
WS11	1m bgl	7
	2m bgl	3
	3m bgl	2

5.0 CHEMICAL (CONTAMINATION ANALYSIS) TESTING

5.1 Sampling Strategy

The following samples were taken as part of the Phase 1 ground investigation for the site:

- 4 No. samples from the Topsoil;
- 4 No. samples from the Made Ground; and
- 2 No. samples of groundwater (following the excavation of the trial pits).

The following samples were taken as part of the Phase 2 ground investigation for the site:

- 1 No. sample from the Topsoil;
- 8 No. samples from the Made Ground;
- 2 No. samples from the Tidal Flat Deposits (natural strata); and
- 4 No. samples of groundwater (following the installation of the boreholes).

All of the samples were taken, stored, and transported in general accordance with the British Standard 10175: 2011 Code of Practice for Investigation of Potentially Contaminated sites, and transported by courier to I2 Analytical Services; a UKAS accredited laboratory.

5.1.1 Laboratory Analyses Undertaken

Soils

Arsenic (As), Boron (B) (water soluble), Beryllium (Be), Cadmium (Cd), Hexavalent and Total Chromium (Cr II and VI), Copper (Cu), Lead (Pb), Inorganic Mercury (Hg), Nickel (Ni), Selenium (Se), Vanadium (V), Zinc (Zn), Total Cyanide, pH, Sulphide and Elemental Sulphur, Organic Matter, Sulphate, Ammonium, Nitrogen, Asbestos Screen, Speciated Total Poly-Aromatic Hydrocarbons (PAHs), Speciated Total Petroleum Hydrocarbons TPH-CWG (aliphatic and aromatic fractions) BTEX and total phenols.

Bacterial (microbial) contaminants: Total Coliforms, E.coli, Enterococci, Faecal Streptococci, Clostridia (coliforms), Anthrax and Salmonella.

Anthrax and Salmonella testing was carried out as part of Phase 2 of the ground investigation only.

Groundwater

Silver (Ag), Aluminium (Al), Arsenic (As), Boron (B) (water soluble), Barium (Ba), Cadmium (Cd), Cobalt (Co), Hexavalent and Total Chromium (Cr II and VI), Copper (Cu), Iron (Fe), Mercury (Hg), Magnesium (Mg), Manganese (Mn), Molybdenum (Mo), Sodium (Na), Nickel (Ni), Lead (Pb), Antimony (Sb), Selenium (Se), Tin (Sn), Vanadium (V), Zinc (Zn), Free and

Total Cyanide, pH, Total Phenols, Ammonium, Fluoride, Chloride, Sulphate, Bromate, Nitrate, Nitrite and Speciated Poly-Aromatic Hydrocarbons (PAHs).

6.0 CONTAMINATION RISK ASSESSMENT CRITERIA

A risk-based approach is used for the assessment of contamination. This requires identification of a contaminant source, a receptor, and a realistic pathway via which the contaminant may reach the receptor. The key receptors considered in this assessment are human health (site end users, groundworkers and off-site receptors) and controlled waters.

The Risk Assessment is a two-stage process. The first stage is to perform a Generic Quantitative Risk Assessment (GQRA) - the soil test results have been compared against the relevant Generic Assessment Criteria (GAC). In the absence of a complete regulatory set of screening values, derived using the CLEA Framework, Grange GeoConsulting Limited GAC screening values have been utilised and are based on the following:

- Category 4 Screening Levels (C4SLs) published by DEFRA;
- The 2014 Land Quality Management (LQM) / Chartered Institute of Environmental Health (CIEH) Suitable for Use Levels for Human Health Risk Assessment (S4ULs); and
- Guidance values produced by the Environmental Industries Commission (EIC), the Association of Geotechnical and Geoenvironmental Specialists (AGS), and Contaminated Land: Application in Real Environments (CL:AIRE) in December 2009.

The second stage of the Risk Assessment process is Risk Evaluation, which comprises an authoritative review of the findings with other pertinent information in cases where the GACs are exceeded, to consider if exceedance may be acceptable in the context of the site.

6.1 Human Health Risk Assessment

This is a Tier 2 assessment, using GAC soil screening values, and involves generic human health risk assessment for the CLEA scenario: **Residential with plant uptake.** This scenario is considered appropriate given the proposed use of the site.

The chemical (contamination analysis) testing results from Phase 1 (and later from Phase 2) were screened against Grange GeoConsulting Limited GAC screening values (provided in Appendix F) to carry out an assessment of potential risks associated with contamination at the site. Justification for the criteria adopted for this Risk Assessment is given in Appendix F. In the case where all the samples tested for a given substance were below the GACs, no further consideration is necessary for that substance.

During the two phases of ground investigation, the Soil Organic Matter Content (SOM) of the soils varied between 1.3% and 17%. The average SOM was 7.79% for Phase 1 and 5.32% for Phase 2. Therefore, GACs based on a SOM of 6% were utilised.

As part of the chemical testing undertaken samples were also collected from the trial pits (Phase 1) and the window sample boreholes (Phase 2) and tested for a range of bacterial (microbial) contaminants. This included Anthrax testing in Phase 2 only. GAC screening values for bacterial contaminants are not available, though a qualitative assessment has been undertaken.

6.2 Controlled Waters Risk Assessment

Two groundwater samples were taken from the trial pits immediately following excavation during Phase 1. The water pooled at the base of the pits at approximately 2.2m bgl in TP5 and approximately 1.8m bgl in TP8 was collected and sent for analysis. Four groundwater samples were taken approximately one month following the installation of the window sample boreholes on site during Phase 2. The samples were collected from WS1, WS4, WS8 and WS9 at depths of approximately 1.8m bgl, 2m bgl, 1.3m bgl and 1m bgl.

The risks to groundwater and surface water from contaminants on site were assessed against the Environment Agency (2006) Remedial Targets Methodology (RTM). Pollutants from contaminated land sites are considered as passive inputs under the European Water Framework Directive (2000/60/EC), and as such are regulated under the Agency's 'limit' pollution objective.

Acceptable Water Quality Targets (WQT) are defined for protection of human health (based on UK Drinking Water Standards (DWS)), and for the protection of aquatic ecosystems (Environmental Quality Standards (EQS)).

6.3 Ground Gas

The risks associated with the ground gases methane (CH_4) and carbon dioxide (CO_2) were assessed as part of the Phase 2 ground investigation using BS 8485:2007 (Code of practice for the characterisation and remediation from ground gas in affected developments), and guidelines from CIRIA 665 (Wilson et al 2007), and the National House Building Council (NHBC) (Boyle and Witherington 2007). In accordance with CIRIA 665 (C665):

- 'Situation A' covers all forms of development (residential and industrial / commercial developments), other than those in Situation B; and
- 'Situation B' is defined as the specific development of low-rise (one to three storeys in height) housing with a vented sub-floor void (minimum 150 mm).

The proposed development therefore requires consideration of Situation B.

Consideration has been given to both CH_4 and CO_2 concentrations and flow rates. The Gas Screening Value (GSV) is defined as the product of gas concentration multiplied by flow rate. The GSV is then considered with other parameters to define a Characteristic Situation (CS), which identifies the need for and scope of any necessary gas protection measures.

7.0 CHEMICAL LABORATORY TESTING RESULTS AND RISK ASSESSMENT

The results of the laboratory testing undertaken as part of the Phase 1 and Phase 2 ground investigations are presented in the following sections of this report.

Phase 1

7.1 Risk Evaluation – Human Health

The sample taken from TP8 at 1.8m bgl in the Made Ground during Phase 1 of the intrusive works recorded a concentration of benzo(a)pyrene of 3.2 mg /kg marginally exceeding the GAC of 3 mg / kg.

No GACs for nitrogen or ammonium for the residential with plant uptake scenario are available, though it was noted that high concentrations of nitrogen (including 450 mg / kg in TP4, 3,500 mg / kg in TP6 and 2,800 mg /kg in TP8) were recorded. Similarly, very high ammonium concentrations (including 55 mg / kg in TP4 and 40 mg /kg in TP8) were recorded.

One sample, taken from TP7 at 0.2m bgl was found to contain asbestos. Loose chrysotile (white asbestos) was detected at concentrations of <0.001% in the Made Ground. No further samples were found to contain asbestos.

A summary of the concentrations of bacterial contaminants recorded in the soil samples collected at the site is provided in Table 6.1.

Table 6.1: Bacterial contaminant concentrations in soils

Contaminant	Concentration recorded in TP4	Concentration recorded in TP6	Concentration recorded in TP8
Total Coliforms	> 242,000 mpn / gram	> 242,000 mpn / gram	> 242,000 mpn / gram
E. Coli	600 mpn / gram	600 mpn / gram	1,000 mpn / gram
Faecal Streptococci	> 8,000 mpn / gram	> 8,000 mpn / gram	> 8,000 mpn / gram
Clostridia	> 8,000 mpn / gram	> 8,000 mpn / gram	> 8,000 mpn / gram

High concentrations of all four of the bacterial contaminants were recorded in the samples taken at the site during Phase 1. A discussion with the biological laboratory confirmed that the concentrations recorded are high and indicated the presence of soils rich in faecal content and bacteria. The concentrations of Faecal Streptococci and Clostridia were noted to be particularly high. The laboratory advised that the concentrations of bacteria within these samples were so high that they exceeded the upper limits of detection of the laboratory apparatus were exceeded.

Based on these results, the laboratory recommended that additional testing be undertaken to determine the extent of this contamination across the site. The laboratory also advised that based on the biological results obtained to date, there is the potential for salmonella and anthrax to impact the site and that further testing should be undertaken. This additional recommended testing was undertaken as part of the Phase 2 ground investigation.

The presence of high concentrations of total coliforms (which refers to a large group of bacteria typically associated with faecal origin), Clostridia and Faecal Streptococci (both evidence of faecal contamination) indicate that the activities at the piggery have had an impact on the underlying soils (with high levels of bacterial contamination observed to a depth of 1.8m bgl in TP8) and that they are impacted by animal waste (and slurry) and the historical burial of animals at the site.

No further contaminants were found to exceed the relevant GACs.

7.2 Risk Evaluation – Controlled Waters

The samples of groundwater taken from TP5 and TP8 during Phase 1 were not found to contain any contaminant concentrations exceeding the Environmental Quality Stands (EQS), except for a marginally elevated concentration of copper in TP8 of 15 µg/kg. This concentration exceeded the threshold of 5 ug/kg. Copper is an essential nutrient at low concentrations but is toxic to aquatic organisms at higher concentrations. This concentration in groundwater is not considered to pose a risk to human health.

Seven contaminants were recorded in groundwater at concentrations above the UK Drinking Water Standards (DWS) in one or more samples. Significant exceedances of the UK DWS were recorded for some contaminants. These exceedances are summarised in Table 6.2. It should be noted that the use of drinking water standards to undertake a risk assessment for the site is a very conservative approach, particularly as the water within the trial pits will not be used as a potable water supply.

Table 6.2: Groundwater exceedances of UK drinking water standards

Contaminant	Exceedance recorded in TP5 groundwater sample	Exceedance recorded in TP8 groundwater sample	UK drinking water standard
Sulphate as SO4	330 mg / litre	640 mg / litre	250 mg / litre
Nitrate as NO3	74.3 mg / litre	354 mg / litre	0.5 mg / litre
Nitrite as NO2	0.87 mg / litre	3 mg / litre	0.5 mg / litre
Manganese	0.25 mg / litre	0.09 mg / litre	0.05 mg / litre
Ammonium as NH4	No exceedance	9000 mg / litre	0.5 mg / litre
Sodium	No exceedance	260 mg / litre	200 mg / litre

A slightly elevated concentration of sulphate (as SO_4) of 330 mg / kg was recorded in TP5. A concentration of sulphate over twice the UK DWS of 640 mg / litre was recorded in TP8. High concentrations of nitrite as NO_2 were also recorded, up to six times the UK DWS. Slightly elevated concentrations of manganese were recorded in TP5 and TP8. TP8 also recorded a slightly raised concentration of sodium.

Significantly elevated concentrations of ammonium (as NH_4) some 18,000 times the UK DWS were recorded in TP8. Nitrate as NO_3 concentrations recorded in TP5 and TP8 were some 150 and 700 times the UK DWS for this component.

These extremely elevated concentrations of ammonium and nitrate are associated with the use of the site for agricultural purposes and the presence of large concentrations of animal waste (and slurry), the historical burial of animals and the potential use of fertilisers and pesticides etc. The soils impacted by these activities will therefore that a high organic and nutrient content.

7.3 Phase 1 Risk Evaluation Conclusions

Elevated concentrations of contaminants (particularly biological and nutrient-rich contaminants) were observed in the soils and the groundwater at the site. Asbestos was also observed in one location.

Based on the intrusive works undertaken as part of Phase 1, it was recommended that additional intrusive works were carried out at the site to confirm and define the ground and groundwater conditions. It was concluded that the second phase of ground investigation should include both targeted and non-targeted window sample boreholes. It was concluded based on the findings that a programme of gas and groundwater monitoring should be undertaken to support the intrusive works. Due to the findings, which indicated a high nutrient content of the site soils and the presence of large quantities of bacterial contaminants it was concluded that there was a high probability that the soils on site are producing methane and carbon monoxide (and potentially carbon dioxide) due to the anaerobic conditions associated with high the presence of soils rich in faecal content and bacteria.

The report indicated the need for testing for salmonella and anthrax and the supplementary biological testing.

This advice was adopted, and the recommended works undertaken as part of the Phase 2 works which are detailed in Section 3 of this report and outlined in the following sections of this report.

Phase 2

7.4 Risk Evaluation – Human Health

Four of the eleven soil samples tested as part of the Phase 2 ground investigation were found to contain asbestos. Loose chrysotile fibres (white asbestos) were detected in the Made Ground in WS7 (0.4m bgl), WS8 (0.2m bgl), WS9 (0.3m bgl) and WS11 (1.4m bgl). No further samples were found to contain asbestos.

Some slightly elevated concentrations of benzo(a)pyrene were recorded, however all concentrations were below the GAC of 3 mg / kg. No PAH exceedances were recorded in the soil samples taken.

No GACs for nitrogen or ammonium for the residential with plant uptake scenario are available, though it was noted that extremely high concentrations of nitrogen (including 2,400 mg / kg in WS9 and 2,600 mg / kg in WS7) were recorded. Similarly, very high ammonium concentrations (including 41 mg / kg in WS9) were recorded.

While WS7 contained a high concentration of nitrogen, the ammonium content was below the detection limit of the analysing equipment; < 0.5 mg/kg.

A summary of the concentrations of bacterial contaminants recorded in the soil samples collected at the site is provided in Table 6.2.

Table 6.2: Bacterial contaminant concentrations in soils

Contaminant	Concentration recorded in WS9	Concentration recorded in WS10
Total Coliforms	130,000 mpn / gram	38,700 mpn / gram
E. Coli	100 mpn / gram	100 mpn / gram
Enterococci	2,700 cfu/g	4,500 cfu/g
Clostridium Perfringens	> 8,000 mpn / gram	> 8,000 mpn / gram
Faecal Coliforms	4,900 mpn / gram	7,200 mpn / gram

Further testing was undertaken on five soil samples for Bacillus anthracis, the causative agent of anthrax at depths ranging between 0.5m and 1.5m bgl from three of the window sample boreholes (WS6, WS7 and WS11). These locations were within the area where historical burying of animals was known to have taken place and where evidence of animal bone had been discovered during the investigation. No evidence of Bacillus anthracis was found in the samples sent for analysis, either by real-time PCR assay or supportive culture-based analysis. The full results are presented in Appendix G.

Testing was undertaken on four samples of soil, taken from three of the window sample boreholes (WS6, WS7 and two samples from WS11) at depths ranging between 0.5m bgl and 1.4m bgl for salmonella testing. As detailed above, these locations were within the area where historical burying of animals was known to have taken place. No evidence of salmonella was recorded in the samples taken. The full results are presented in Appendix G.

7.5 Risk Evaluation – Controlled Waters

The samples of groundwater taken from WS1, WS4, WS8 and WS9 as part of the investigation.

All four of the samples were found to contain concentrations of copper exceeding the Environmental Quality Stand (EQS) of 5 µg/L. Concentrations between 6.2 µg and 25 µg were recorded which were not highly elevated. All copper concentrations recorded were well below the UK Drinking Water Standard (DWS) for copper of 2 mg/L.

The EQS for zinc of 50 µg (based on average water hardness) was exceeded in two samples, taken from WS8 and WS9 where concentrations of 1,300 µg/L and 210 µg/L were recorded.

Copper and zinc are essential nutrient sat low concentrations but is toxic to aquatic organisms at higher concentrations. Therefore, these concentrations in groundwater are not considered to pose a risk to human health. No further exceedances of the EQS were recorded in the samples taken.

Two contaminants were recorded in groundwater at concentrations above the UK Drinking Water Standards (DWS) in two or more samples. These exceedances are summarised in

Table 6.3. It should be noted that the use of drinking water standards to undertake a risk assessment for the site is a very conservative approach, particularly as the water within the boreholes will not be used as a potable water supply.

Table 6.3: Groundwater exceedances of UK drinking water standards

Contaminant	Exceedance recorded in WS8 groundwater sample	Exceedance recorded in TWS9groundwater sample	UK drinking water standard
Manganese	500 µg / litre	110 µg / litre	50 µg / litre
Ammonium as NH4	6.9 mg / litre	3.6 mg / litre	0.5 mg / litre

Elevated concentrations of manganese were recorded in WS8 and WS9. The concentration recorded in WS8 was ten times the UK DWS. Elevated concentrations of ammonium (as NH_4) up to 13 times the UK DWS were recorded in WS8.

7.6 Risk Evaluation – Ground Gas

The site is regarded as having a low potential for ground gas generation (proposed development Situation B). The ground gas regime is considered to meet Characteristic Situation 1 (CS1). The following conclusions resulting from the interpretation of the ground gas data have been used to assist in the classification of the ground gas regime as CS1:

- The Gas Screening Value (GSV) for CH4 is calculated based on the worse-case initial flow rate (2.6 l/hr) and worse-case initial gas concentration (0.3% v/v). The GSV for CH4 was calculated as 0.0078;
- The GSV for CO2 is calculated based on the worse-case steady flow rate (2.6 l/hr) and worse-case steady gas concentration (3.4 % v/v). The GSV for CO2 was calculated as 0.089;
- The monitoring wells were screened within the natural strata which was the potential source of ground gas, due to the limited thickness of Made Ground and the absence of extensive thicknesses of organic material or animal waste encountered during the ground investigation;
- The maximum recorded concentrations of CO_2 (3.4 %) and CH_4 (0.3 %) do not exceed the typical maximum for CS1 (which are 5% and 1% respectively);
- The monitoring data is considered appropriately representative given the ground conditions encountered at the site (limited thickness of Made Ground and no significant quantities of organic material or animal waste found on site).

The full results of the gas monitoring are to be found in Appendix F. The monitoring strategy reported in Appendix F is considered suitable for assessment of ground gas risk.

The site is classified as Green Amber 1 in accordance with the NHBC Traffic Light Classification and as Characteristic Situation 1 in accordance with CIRIA C655. Based on these classifications, no mitigation against ground gas is required at the site.

8.0 GEOTECHNICAL LABORATORY TESTING RESULTS

Geotechnical testing was only undertaken as part of Phase 2 of the ground investigation at the site. The results of the testing undertaken are summarised in this section of the report.

8.1 Liquid and Plastic Limits, Plasticity Index and % passing through a 425µm BS Test Sieve

Three samples were tested to confirm their liquid and plastic limits and plasticity indexes. The percentages of material passing through a 425µm BS Test Sieve was also recorded. The samples were taken from the Tidal Flat Deposits natural strata within the window sample boreholes. The results of which are summarised in Table 7.1 and included in Appendix G.

Table 7.1: Liquid and plastic limits, plasticity index and % of material passing through a 425um BS Test Sieve

Stratum	Sample and Depth (m bgl)	Sample Description	Liquid Limit	Plastic Limit	Plasticity Index	% material passing 425µm BS Test Sieve
Tidal Flat Deposits	WS2 (0.6m bgl)	Brown Clay	66%	30%	36%	100%
	WS6 (1m bgl)	Brown Clay	71%	28%	43%	100%
	WS9 (1m bgl)	Brown Clay	88%	44%	44%	100%

8.2 Particle Size Distribution

Three Particle Size Distribution (PSD) tests of the Northampton Sand Formation natural strata was undertaken. The results of which are presented in Table 7.2.

Table 7.2: Particle Size Distribution Test Results

Stratum	Sample Depth	Sample Proportions (dry mass %)	Grading Analysis
Tidal Flat Deposits	WS1 (1.2m bgl)	54.9% Sand 31.3% Silt 13.8% Clay	D100mm: 2 D60mm: 0.0799 D30mm: 0.041
	WS1 (3.5m bgl)	91.6% Sand 8.4% Fines (<0.063mm)	D100mm: 2 D60mm: 0.123 D30mm: 0.0833 D10mm: 0.0643 Uniformity Coefficient: 1.9 Curvature Coefficient: 0.88
	WS8 (1.5m bgl)	65.9% Sand 28.1% Silt 6% Clay	D100mm: 2 D60mm: 0.0895 D30mm: 0.0605 D10mm: 0.00886 Uniformity Coefficient: 10 Curvature Coefficient: 4.6

8.3 California Bearing Ratio

The results of the two California Bearing Ratio (CBR) tests undertaken are presented in Table 7.3. The soils used to perform the CBR test were described as brown, slightly sandy Clay (WS3) and mottled brown sandy Clay (WS4).

Table 7.3: California Bearing Ratio Test Results

Stratum	Sample Depth	Curve correction applied	CBR Values %			
			2.5mm	5mm	Highest	Average
Tidal Flat Deposits	WS3 (0.5m to 1m bgl)	No	2.8% top 3.3% base	2.8% top 3.4% base	2.8% top 3.4% base	3.1%
	WS4 (0.5m to 1m bgl)	No	0.8% top 0.8% base	1% top 1.1% base	1% top 1.1% base	1%

8.4 Moisture Content

Moisture content tests were undertaken on seven samples of the Tidal Flat Deposits natural strata. Eleven further samples of the Topsoil, Made Ground and the natural strata were tested for moisture content as part of the chemical testing for contamination purposes. The results of which are presented in Table 7.4.

Table 7.4: Moisture Content Test Results

Stratum	Sample Depth	Type of Sample	Natural Moisture Content
Topsoil	WS3 (0.2m bgl)	Chemical testing sample	14%
Made Ground	WS5 (0.1m bgl)	Chemical testing sample	25%
	WS7 (0.4m bgl)	Chemical testing sample	20%
	WS7 (1.5m bgl)	Chemical testing sample	31%
	WS8 (0.2m bgl)	Chemical testing sample	38%
	WS9 (0.3m bgl)	Chemical testing sample	22%
	WS10 (0.4m bgl)	Chemical testing sample	22%
	WS11 (0.5m bgl)	Chemical testing sample	26%
	WS11 (1.4m bgl)	Chemical testing sample	30%
Tidal Flat Deposits	WS1 (0.5m bgl)	Chemical testing sample	25%
	WS1 (1.2m bgl)	Geotechnical testing sample	21%
	WS1 (3.5m bgl)	Geotechnical testing sample	19%
	WS2 (0.6m bgl)	Geotechnical testing sample	21% to 31%
	WS3 (0.5m to 1m bgl)	Geotechnical testing sample	34%
	WS4 (0.5m to 1m bgl)	Geotechnical testing sample	37%
	WS6 (0.5m bgl)	Chemical testing sample	22%

Stratum	Sample Depth	Type of Sample	Natural Moisture Content
	WS6 (1m bgl)	Geotechnical testing sample	37%
	WS9 (1m bgl)	Geotechnical testing sample	34% to 57%

8.5 pH Value

The pH values of the samples were recorded as part of the chemical (contamination analysis) testing during both phases of the ground investigation. pH testing was also undertaken on four samples as part of the geotechnical analysis on site. The pH ranged between 6.3 and 8.6 and the average pH on site was 7.67.

The pH of the samples taken represented near neutral to slightly alkaline soil conditions.

8.6 Sulphate Content

The results of the sulphate analysis undertaken on four samples of the natural strata are presented in Table 7.5.

Table 7.5: Sulphate Content (chemical testing for geotechnical purposes)

Stratum	Sample Depth (m bgl)	Total Sulphate as SO4	Water Soluble Sulphate as SO4	Total Sulphur %
Tidal Flat Deposits	WS1 (1.2m bgl)	0.032 %	0.14 g/L	0.016 %
	WS1 (3.5m bgl)	0.043 %	0.038 g/L	0.034 %
	WS2 (0.6m bgl)	0.063 %	0.023 g/L	0.027 %
	WS9 (1m bgl)	0.123 %	0.15 g/L	0.121 %

8.7 Chloride Content

The four samples detailed in Section 7.6 were also scheduled for chloride analysis. The results are presented in Table 7.6.

Table 7.6: Chloride Content (chemical testing for geotechnical purposes)

Stratum	Sample Depth (m bgl)	Water Soluble Chloride
Tidal Flat Deposits	WS1 (1.2m bgl)	2.1 mg /L
	WS1 (3.5m bgl)	2.6 mg/L
	WS2 (0.6m bgl)	2.8 mg/L
	WS9 (1m bgl)	56 mg/L

8.8 Nitrate Content

The four samples detailed in Section 7.6 and 7.7 were also scheduled for nitrate analysis. All samples recorded concentrations of water soluble nitrate below the detection limit of 2 mg/L.

8.9 Magnesium Content

The four samples were also scheduled for magnesium analysis. The results are presented in Table 7.7.

Table 7.7: Magnesium Content (chemical testing for geotechnical purposes)

Stratum	Sample Depth (m bgl)	Water Soluble Magnesium	Magnesium (leachate equivalent)
Tidal Flat Deposits	WS1 (1.2m bgl)	25 mg/kg	13 mg/L
	WS1 (3.5m bgl)	< 5 mg/kg	< 2.5 mg/L
	WS2 (0.6m bgl)	23 mg/kg	12 mg/L
	WS9 (1m bgl)	< 5 mg/kg	< 2.5 mg/L

9.0 GEOENVIRONMENTAL CONCLUSIONS AND RECOMMENDATIONS

9.1 Human Health

During the Desk Study it was noted several of the pig sty units on site have sheeted cement asbestos roofing. Piles of asbestos sheeting were also present on site. Asbestos containing materials within the existing fabric of the site buildings (roofing materials and possibly pipe lagging) could also be present. Heaps of construction rubble, which could also potentially contain asbestos-containing materials were noted on site. While it has been recommended that an asbestos survey be undertaken prior to the demolition of the buildings on site, the sources within the buildings and the construction rubble will be removed off-site as part of the redevelopment scheme. At present, these sources remain on site and remain a source of contamination with the potential to impact the site soils and site receptors.

Evidence of asbestos was recorded in the soils on site. One sample in Phase 1, taken from TP7 at 0.2m bgl during Phase 1 was found to contain asbestos. Loose chrysotile was detected at concentrations of <0.001% in the Made Ground. Four of the eleven soil samples tested as part of the Phase 2 ground investigation were also found to contain asbestos. Loose chrysotile fibres were detected in the Made Ground.

No evidence of hydrocarbon contamination (staining, fuel or oil spillages) was observed during both phases of the ground investigation and all concentrations of PAHs were below the relevant assessment criteria.

The sample taken from TP8 at 1.8m bgl during Phase 1 from within the Made Ground recorded a concentration of benzo(a)pyrene of 3.2 mg /kg marginally exceeding the GAC of 3 mg / kg. Due to the depth of this concentration below ground level and the scale of the exceedance it is not considered to pose a significant risk to site users, with residents very unlikely to dig to this depth within their gardens. However, if changes are made to proposals to reduce ground levels on site, leaving this concentration at a shallower depth, the removal of soils from this location may need to be undertaken.

No GACs for nitrogen or ammonium for the residential with plant uptake scenario are available, though it was noted that extremely high concentrations of nitrogen were recorded during Phase 1 and Phase 2. Similarly, very high ammonium concentrations were recorded.

High concentrations of bacterial contaminants were also recorded in the samples taken at the site during Phase 1 indicating the presence of soils rich in faecal content and bacteria. The concentrations of Faecal Streptococci and Clostridia were noted to be particularly high.

The presence of high concentrations of total coliforms, Clostridia and Faecal Streptococci (both evidence of faecal contamination) indicate that the activities at the piggery have had a huge impact on the underlying soils (with high levels of bacterial contamination observed to a depth of 1.8m bgl in TP8) and that they are impacted by animal waste (and slurry) and the historical burial of animals at the site. The laboratory indicated that the levels of bacterial spores in the soils are at a level where they are likely to require removal to ensure safe occupation of the site for use as residential properties in the future.

No evidence of anthrax or salmonella was recorded in the samples scheduled for testing.

9.2 Controlled Waters

Elevated concentrations of sulphate, sodium, nitrite, ammonia, nitrate and manganese were recorded above the UK DWS on site in numerous locations. The concentration of ammonium recorded in one sample, TP8 from Phase 1, recorded a concentration of ammonium some 18,000 times the UK DWS.

The highly elevated concentrations of contaminants are associated with the use of the site for agricultural purposes and the presence of large concentrations of animal waste (and slurry), the historical burial of animals and the potential use of fertilisers and pesticides etc. The soils impacted by these activities will therefore that a high organic and nutrient content and the shallow groundwater beneath the site is impacted. Surface water and shallow groundwater at the site feeds into the large network of culverts, streams and field drains that are present in the vicinity of the site. It is considered that the site may be having a detrimental impact on the nearby surface water network, particularly with ammonium, nitrate and nitrite impacting the nearby water courses.

9.3 Ground Gas

The site is regarded as having a low potential for ground gas generation (proposed development Situation B). The ground gas regime is considered to meet Characteristic Situation 1 (CS1). Based on these classifications, no mitigation against ground gas is required at the site.

9.4 Remedial Measures

Former Pig Farm Area

No soil samples were found to contain contaminant concentrations that exceeded the Residential with Plant Uptake GACs. Four samples of the Made Ground were found to contain Chrysotile asbestos. One of these samples was scheduled for asbestos quantification and recorded an asbestos by hand picking percentage and total asbestos in the sample of <0.001%.

Given the proposed development at the site (residential with gardens) there is the potential for site end users and ground workers to encounter site soils, with the potential to uncover previously unidentified contamination on site.

Given the presence of asbestos fibres in the soil on site the contractor should make adequate safety provisions during the works to protect works and surround sites and people from the risks of exposure from asbestos and should comply with the CAR2012 regulations.

Given the proposed development at the site (residential properties with garden) there is the potential for site end users and groundworkers to come into contact with the bacteria rich soils in the shallow Made Ground in soft landscaping areas.

There are currently no GACs for Bacteria levels within soil however we would recommend placement of a sufficient thickness and quality of clean topsoil layer in all areas of soft landscaping and residential gardens will be required to provide a barrier between the site end

users and the residual contamination in the shallow site soils. This clean imported topsoil should be a minimum of 600mm thick and underlain by a geo-textile marker layer within the former Pig Farm area.

Testing of soils within the Pig Farm area have tested negative for Salmonella and Anthrax.

Current Grass Paddock Area

No visual or olfactory evidence of contamination was encountered in any of the boreholes or trial pits on in the grass paddock in soils or groundwater.

None of the samples taken were found to contain asbestos and all of the samples recorded concentrations of any inorganic or organic contaminants below the relevant residential with plant uptake screening criteria.

The proposed development will be occupied by residential properties with gardens and associated infrastructure including access and parking facilities. Therefore, there is the potential for exposure to unforeseen contamination at the site, though based on the results of the ground investigation this is considered unlikely. It is considered that the risks to ground workers from potentially unidentified substances will be mitigated through appropriate Health & Safety precautions, regular dust control during the demolition and construction works (particularly to minimise the generation of potential airborne asbestos fibres) and the use of personal protective equipment (PPE) are adopted during the site works and that a watching brief for contamination is maintained during the earthworks. Good practice should always be adopted during works on site (during construction and during any future maintenance works).

The site has a low potential for ground gas generation relating to carbon dioxide and methane ground gases (proposed development Situation B). The ground gas regime on site is classified as Green Amber 1 in accordance with the NHBC Traffic Light Classification and as Characteristic Situation 1 in accordance with CIRIA C655. Based on these classifications, no mitigation against carbon dioxide and methane ground gases is required at the site.

No further remediation measures are considered necessary for the proposed end use within the current grass paddock section of the site.

10.0 GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

10.1 Foundations

The proposed development is to construct a number of detached residential dwellings.

The allowable bearing pressure / design bearing pressure for foundations takes into consideration an acceptable load to take into account the risk of shear failure of the ground (ultimate limit state) and also acceptable limits of settlement (serviceability limit state).

The exploratory holes encountered Topsoil or Made Ground to depths of between 0.3 and 1.8mbgl over Tidal Flat Deposits to a depth of between 0.3 and 4.0mbgl.

The Made Ground is an unsuitable bearing strata. The Tidal Flat Deposits may be adequate to support the proposed development using strip, trench fill or piled foundations.

Groundwater levels have been recorded between 0.72 and 1.65m bgl.

10.1.1 Shallow and Trenchfill Foundations

Shallow foundations should be placed within Tidal Flat Deposits. Within these materials an allowable bearing pressure of 50kN/m2 can be assumed which includes a factor of safety of 3.0 against general shear failure and will limit total foundation settlement to less than 25mm for foundation widths up to 1m bearing at a minimum 1m depth.

However, given the variability of composition of the Tidal Flat Deposits, the shallow groundwater conditions, the presence of thick Made Ground in some areas and the presence of very soft ground at depth it may be more suitable to consider pile foundations.

10.1.2 Piled Foundations

In the light of the presence of the depth of the Made Ground, shallow groundwater and the presence of soft ground at depth the underlying West Walton Formation Formation is likely to be a suitable as support to pile foundations.

Piles should be designed to penetrate into the West Walton Formation, gaining support from shaft adhesion and end bearing.

Additional deep boreholes should be undertaken to confirm the depth and strength of the West Walton Formation to assist design optioning.

A specialist piling contractor should be consulted to optimize pile design with regard to pile capacity, types, depths and sizes for the support of new structures.

10.2 Ground Floor Slabs

Given the presence of variable, weak, compressible tidal flat deposits at the site, it is recommended that suspended floor slabs should be adopted, in accordance with NHBC Standards.

10.3 Roads and Pavements

Based on the test results, it is considered likely a CBR of 1% will be achievable over the majority of the site and can be used for preliminary design, subject to in situ testing during construction.

Proof rolling of the formation level will be required and any loose or soft spots to be removed and replaced with an engineered fill, in accordance with a suitable Specification. The formation level will also need to be protected during inclement weather from deterioration.

10.4 Groundwater

Groundwater levels have been recorded between 0.72m bgl and 1.65m bgl across the site.

Therefore, any below ground excavations greater than 0.70m should expect to encounter groundwater and design of basement walls, floor slabs and below ground structures should allow for presence of high groundwater levels.

10.5 Buried Concrete

Based on guidelines provided in BRE Special Digest 1, the soils can be classified as Design Sulfate Class DS-1 and ACEC Class AC-1.

This equates to a Designated Concrete Class DC-1 for a 50 year design life (see BS 8500-1 for details).

11.0 REFERENCES

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APPENDICES

Appendix A DRAWINGS

Appendix B PHOTOGRAPHS

Appendix C PHASE 1 GROUND INVESTIGATION PLAN AND EXPLORATORY LOGS

Appendix D PHASE 2 GROUND INVESTIGATION PLAN AND EXPLORATORY LOGS

Appendix E PHASE 2 MONITORING DATA

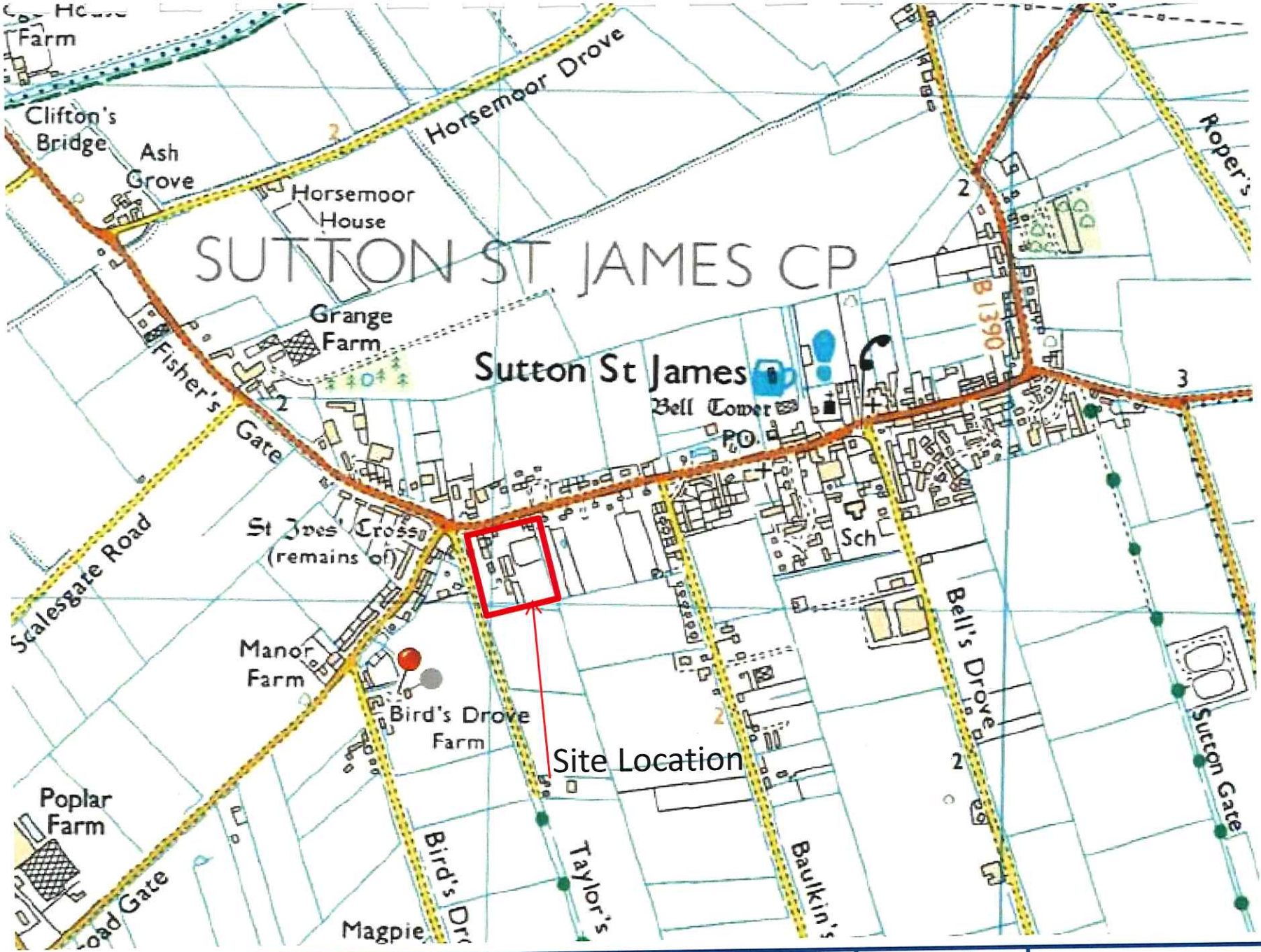
Appendix F GRANGE GEOCONSULTING LIMITED METHODOLOGY

Appendix G CONTAMINATION TESTING RESULTS AND CONTAMINATION PLAN

Appendix H GEOTECHNICAL TESTING RESULTS

Appendix A

DRAWINGS



Grange Geo	Sutton St James Site location plan	Client- Kirk Homes Ltd Date- July 2017	North	Drawing- R17053-DWG1

Appendix B

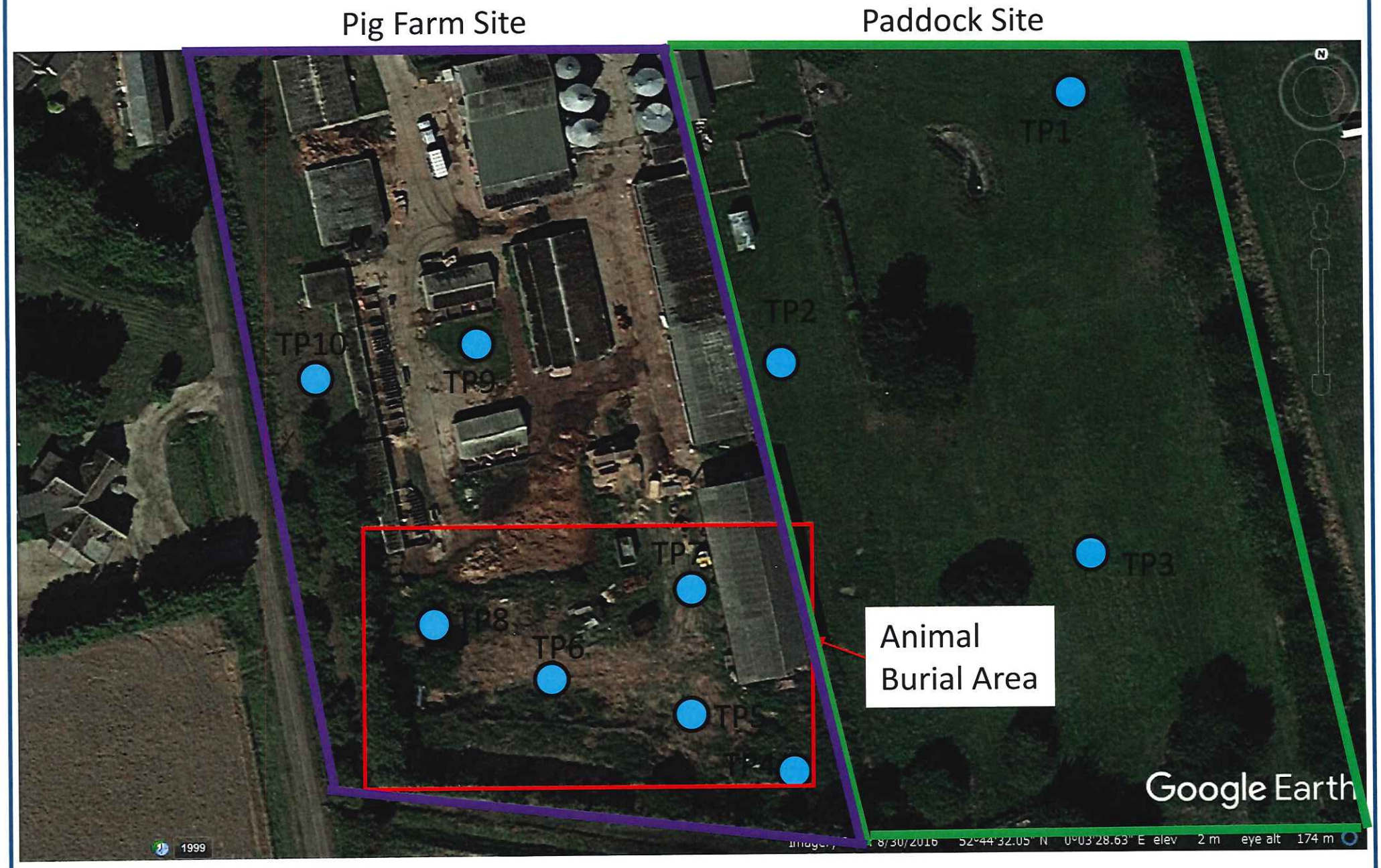
INTRUSIVE WORKS PHOTOGRAPHS



Figure 1: Drilling WS1

Appendix C

PHASE 1 INTRUSIVE WORKS PLAN AND EXPLORATORY LOGS



Grange Geo	Trial Hole Locations Phase 1	Client- Mr James Kirk Date- April 2018	North	Drawing- R17053-DWG3

Trial Pit Log

TP No: 1

Client: Kirk Homes ltd

Sheet: 1 of 1

Project: Sutton St James

Method: 7t tracked excavator

Grange Geo

Sample Depth (m)	Sample Type	S. Vane kN/m^2	Description	Depth mBGL	Legend
			Topsoil, dark brown, slightly sandy, silty CLAY. Live roots to 0.40m.		
			Stiff, brown and grey mottled, silty CLAY. (Tidal Flat Deposits)		
0.50				0.50	
1.00			Light brown and grey mottled, silty, fine SAND. (Tidal Flat Deposits)	1.00	
1.50				1.50	
2.00			End of trial hole.	2.00	

General Comments:

1. Pit walls stable
2. No groundwater encountered.
3. No visible or olfactory evidence of contamination

Date: 23/06/2017
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd, 43 Winchilsea Avenue, Newark, NG24 4AD
Tel: 07773529385

Trial Pit Log

TP No: 2

Client: Kirk Homes ltd

Sheet: 1 of 1

Project: Sutton St James

Method: 7t tracked excavator

Grange Geo

Sample Depth (m)	Sample Type	S. Vane kN/m²	Description	Depth mBGL	Legend
			Topsoil, dark brown, slightly sandy, silty CLAY. Live roots to 0.40m.		
0.50			Stiff, brown and grey mottled, silty CLAY. (Tidal Flat Deposits)	0.50	
1.00			Orange brown and grey mottled, silty SAND. (Tidal Flat Deposits)	1.00	
1.50				1.50	
2.00			End of trial hole.	2.00	

General Comments:

1. Pit walls stable
2. No groundwater encountered
3. No visible or olfactory evidence of contamination

Date: 23/06/2017
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd, 43 Winchilsea Avenue, Newark, NG24 4AD
Tel: 07773529385

Trial Pit Log

TP No: 3

Client: Kirk Homes ltd

Sheet: 1 of 1

Project: Sutton St James

Method: 7t tracked excavator

Grange Geo

Sample Depth (m)	Sample Type	S. Vane kN/m^2	Description	Depth mBGL	Legend
			Topsoil, dark brown, slightly sandy, silty CLAY. Live roots to 0.40m.		
0.50			Light brown, sandy, silty CLAY. (Tidal Flat Deposits)	0.50	
			Light brown and grey mottled, silty, fine SAND. (Tidal Flat Deposits)	1.00	
1.00					
1.50				1.50	
			End of trial hole.	2.00	
2.00					

General Comments:

1. Pit walls stable
2. Slight groundwater seepage below 1.70m.
3. No visible or olfactory evidence of contamination

Date: 23/06/2017
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd, 43 Winchilsea Avenue, Newark, NG24 4AD
Tel: 07773529385

Trial Pit Log

TP No: 4

Client: Kirk Homes ltd

Sheet: 1 of 1

Project: Sutton St James

Method: 7t tracked excavator

Sample Depth (m)	Sample Type	S. Vane kN/m^2	Description	Depth mBGL	Legend
			Made Ground, dark brown, slightly sandy, silty CLAY. Abundant live roots.		
0.50			Made Ground, brown, silty CLAY.	0.50	
1.00			Made Ground, dark brown, silty CLAY with abundant plastic bags and occasional pig bones.	1.00	
1.50			Grey, silty fine SAND. (Tidal Flat Deposits)	1.50	
2.00			End of trial hole.	2.00	

General Comments:

1. Pit walls collapsing from 0.30 to 1.60mbgl.
2. No groundwater encountered
3. Evidence of plastic and animal bone from 0.60 to 1.20mbgl

Date: 23/06/2017
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd, 43 Winchilsea Avenue, Newark, NG24 4AD
Tel: 07773529385

Trial Pit Log

TP No: 5

Client: Kirk Homes ltd
Project: Sutton St James

Sheet: 1 of 1
Method: 7t tracked excavator

Grange Geo

Sample Depth (m)	Sample Type	S. Vane kN/m²	Description	Depth mBGL	Legend
			Topsoil, stiff, dark brown, slightly gravelly, CLAY. Gravel of fine to medium, sub angular flint. Live roots to 0.50m.		
0.50	HSV	70Kpa	Brown, stiff, silty CLAY. (Tidal Flat Deposits)	0.50	
1.00	HSV	85Kpa		1.00	
1.20	HSV	55Kpa			
			Light brown, silty, fine SAND. (Tidal Flat Deposits)		
1.50				1.50	
2.00				2.00	
			End of trial hole.		

General Comments:

1. Pit walls stable
2. Slight groundwater seepage below 1.80m.
3. No visible or olfactory evidence of contamination

Date: 23/06/2017
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd, 43 Winchilsea Avenue, Newark, NG24 4AD
Tel: 07773529385

Trial Pit Log

TP No: 6

Client: Kirk Homes ltd
Project: Sutton St James

Sheet: 1 of 1
Method: 7t tracked excavator

Grange Geo

Sample Depth (m)	Sample Type	S. Vane kN/m²	Description	Depth mBGL	Legend
			Made Ground, dark brown, slightly sandy, silty CLAY with fragments of plastic, iron, brick, string.		
0.50				0.50	
1.00			Soft, to firm, grey and brown mottled, silty CLAY. (Tidal Flat Deposits)	1.00	
1.20	HSV	48Kpa			
1.50				1.50	
2.00			End of trial hole.	2.00	

General Comments:

1. Pit walls stable
2. Slight groundwater seepage below 1.90mbgl.
3. Evidence of contamination from ground level to 0.90mbgl.

Date: 23/06/2017
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd, 43 Winchilsea Avenue, Newark, NG24 4AD
Tel: 07773529385

Trial Pit Log

TP No: 7

Client: Kirk Homes ltd
Project: Sutton St James

Sheet: 1 of 1
Method: 7t tracked excavator

Grange Geo

Sample Depth (m)	Sample Type	S. Vane kN/m²	Description	Depth mBGL	Legend
			Made Ground, dark brown, slightly gravelly, CLAY. Gravels of fine to medium, sub angular flint.		
0.50			Firm, brown, silty CLAY. (Tidal Flat Deposits)	0.50	
1.00			Dark grey with some brown mottling, silty CLAY. (Tidal Flat Deposits)	1.00	
1.50			Brown and orange brown mottled, silty, fine SAND. (Tidal Flat Deposits)	1.50	
2.00			End of trial hole.	2.00	

General Comments:

1. Pit walls stable
2. Groundwater seepage below 1.80mbgl.
3. No visible or olfactory evidence of contamination

Date: 23/06/2017
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd, 43 Winchilsea Avenue, Newark, NG24 4AD
Tel: 07773529385

Trial Pit Log

TP No: 8

Client: Kirk Homes ltd
Project: Sutton St James

Sheet: 1 of 1
Method: 7t tracked excavator

Grange Geo

Sample Depth (m)	Sample Type	S. Vane kN/m^2	Description	Depth mBGL	Legend
			Made Ground, brown and grey mottled, slightly gravelly, silty CLAY. Gravel of fine to coarse, sub angular flint and brick.		
0.50				0.50	
			Made Ground, brown and grey mottled CLAY, with fragments of string, brick, plastic, bone and pockets of black organic matter.		
1.00				1.00	
1.50				1.50	
			Soft, brown and grey silty CLAY. (Tidal Flat Deposits)	2.00	
2.00			End of trial hole.		

General Comments:

1. Pit walls stable
2. Strong groundwater inflow from 1.50 to 1.80mbgl.
3. Evidence of contamination between 0.60 and 1.80mbgl.

Date: 23/06/2017
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd, 43 Winchilsea Avenue, Newark, NG24 4AD
Tel: 07773529385

Trial Pit Log

TP No: 9

Client: Kirk Homes ltd
Project: Sutton St James

Sheet: 1 of 1
Method: 7t tracked excavator

Grange Geo

Sample Depth (m)	Sample Type	S. Vane kN/m^2	Description	Depth mBGL	Legend
			Made Ground, brown, slightly gravelly, CLAY. Gravels of fine to course, angular to sub rounded brick, concrete and rare plastic.		
0.50				0.50	
			Firm, becoming soft, blue grey and brown mottled, silty CLAY. Occasional shell fragments. (Tidal Flat Deposits)		
1.00				1.00	
1.50				1.50	
			End of trial hole.		

General Comments:

1. Pit walls stable
2. Slight groundwater seepage below 1.60mbgl.
3. Evidence of plastci fragments from 0.00 to 0.60mbgl.

Date: 23/06/2017
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd, 43 Winchilsea Avenue, Newark, NG24 4AD
Tel: 07773529385

Trial Pit Log

TP No: 10

Client: Kirk Homes ltd

Sheet: 1 of 1

Project: Sutton St James

Method: 7t tracked excavator

Sample Depth (m)	Sample Type	S. Vane kN/m²	Description	Depth mBGL	Legend
			Topsoil, dark brown, slightly sandy, silty CLAY. Live roots to 0.40m.		
0.50	HSV	100Kpa	Stiff, brown and grey mottled, silty CLAY. (Tidal Flat Deposits)	0.50	
1.00	HSV	50Kpa		1.00	
1.50	HSV	35Kpa		1.50	
			PEAT		W W W W
2.00	HSV	15Kpa	Blue grey, very soft, silty CLAY. (Tidal Flat Deposits)	2.00	
			End of trial hole.		

General Comments:

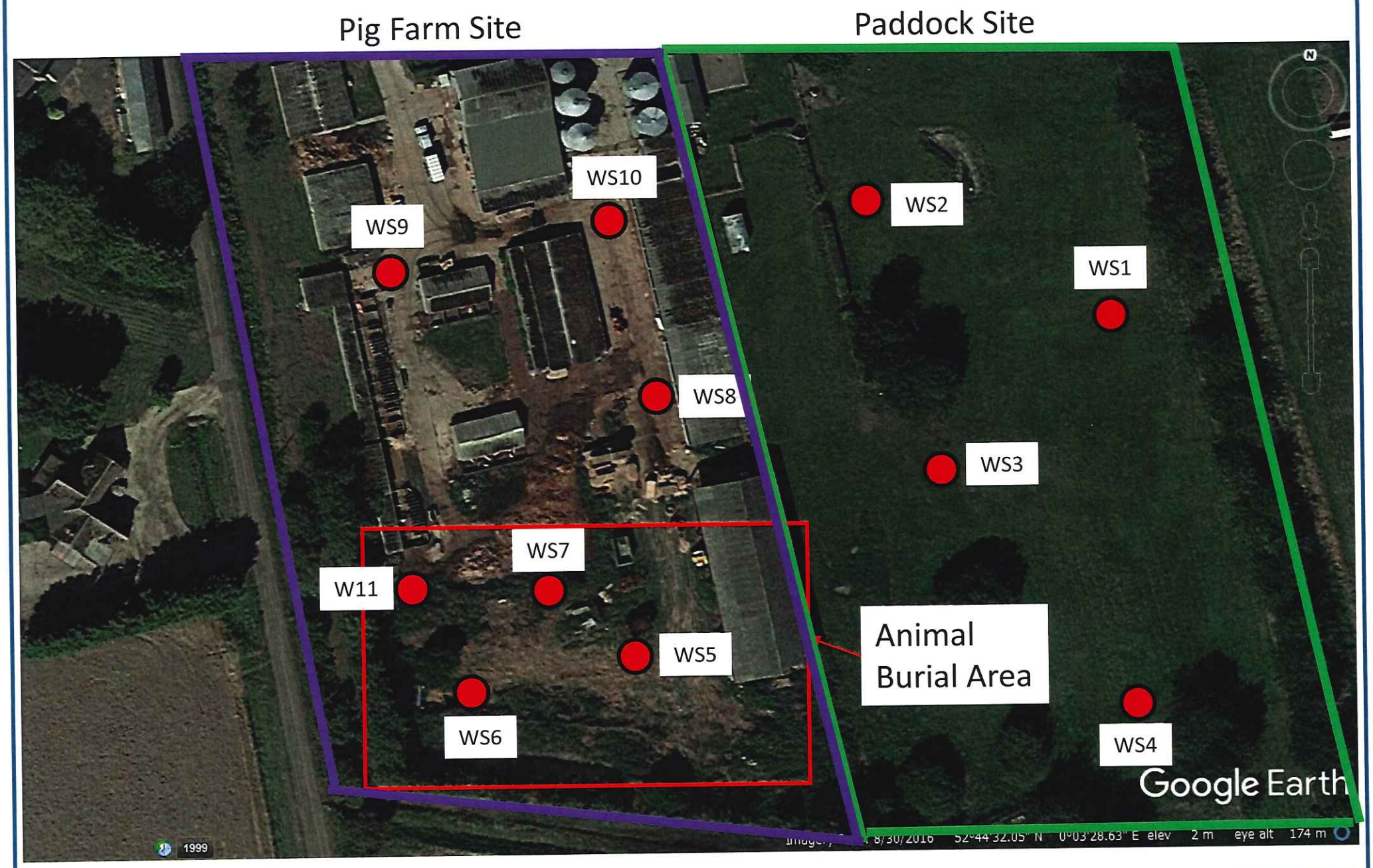
1. Pit walls stable
2. No groundwater encountered
3. No visible or olfactory evidence of contamination

Date: 23/06/2017
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd, 43 Winchilsea Avenue, Newark, NG24 4AD
Tel: 07773529385

Appendix D

PHASE 2 INTRUSIVE WORKS PLAN AND EXPLORATORY LOGS



Grange Geo	Trial Hole Locations Phase 2	Client- Mr James Kirk Date- April 2018	North	Drawing- R17053-DWG4

Window sample Log

WS No: **1**

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Topsoil, dark brown, slightly sandy, CLAY.		
0.5	ES		Grey and brown mottled, firm to stiff, CLAY. (Tidal Flat Deposits)	0.5	
1	SPT	SPT N = 8	Loose, Grey and brown, silty, fine SAND. (Tidal Flat Deposits)	1	
1.2	ES				
1.5				1.5	
1.8	ES				
2	SPT	SPT N = 5		2	
			Firm to stiff, grey, sandy, SILT. (Tidal Flat Deposits)		
2.5				2.5	
3	SPT	SPT N = 14		3	
3.5	ES			3.5	
4	SPT	SPT N = 1		4	
			End of borehole		

General Comments:

1. Hole collapsing below 2.0m. Groundwater strike at 2.0m
2. Gas Monitoring well installed to 4.0m (0.0m to 1.0m Plain pipe with bentonite seal, 1.0 to 4.0m slotted pipe with gravel)
3. No visual or olfactory evidence of contamination.

Scale:
Date: 30/01/18
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd

Window sample Log

WS No: 2

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Grange Geo

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Topsoil, dark brown, slightly sandy, CLAY.		
0.5			Firm to stiff, brown and grey mottled, slightly sandy, CLAY. (Tidal Flat Deposits)	0.5	
1	SPT	SPT N = 11		1	
1.5			Firm to stiff, grey and browm mottled, sandy, SILT. (Tidal Flat Deposits)	1.5	
2	SPT	SPT N = 6	-becoming grey.	2	
2.5				2.5	
3	SPT	SPT N = 8		3	
4	SPT	SPT N = 11	End of borehole.		

General Comments:

1. Slight groundwater strike at 2.0m. Groundwater at 1.50m after 20 minutes. Borehole collapsed below 2.0m
2. No installation.
3. No visual or olfactory evidence of contamination.

Scale:
Date: 30/01/18
Logged by: AH
Checked: AH
Job No: R17053

Window sample Log

WS No: **3**

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Grange Geo

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
0.2	ES		Topsoil, dark brown, slightly sandy, CLAY.		
0.5			Firm to stiff, grey and brown, mottled, silty CLAY. (Tidal Flat Deposits)	0.5	
1	SPT	SPT N = 8		1	
1.5			Firm, grey and brown mottled, sandy, SILT. (Tidal Flat Deposits)	1.5	
2	SPT	SPT N = 5		2	
2.5				2.5	
3	SPT	SPT N = 4	-becoming grey.	3	
4	SPT	SPT N = 8			
			End of borehole.		

General Comments:

1. Slight groundwater strike at 2.50m.Groundwater at 1.60m after 20 minutes. Borehole collapsed below 1.70m
2. No installation.
3. No visual or olfactory evidence of contamination.

Scale:
Date: 30/01/18
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd

Window sample Log

WS No: 4

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Grange Geo

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Topsoil, dark brown, slightly sandy, CLAY.		
0.5			Firm, grey and brown, sandy, CLAY. (Tidal Flat Deposits)	0.5	
1	SPT	SPT N = 9	Grey and brown mottled, silty, fine to medium SAND. (Tidal Flat Deposits)	1	
1.5			Firm, brown, sandy, SILT. (Tidal Flat Deposits)	1.5	
2	SPT ES	SPT N = 4		2	
2.5			-becoming grey.	2.5	
3	SPT	SPT N = 6		3	
4	SPT	SPT N = 5	End of borehole.		

General Comments:

1. Borehole collapsing below 3.10m.
2. Installation to 3.0m. 1m plain pipe at surface, 2m slotted at base.
3. No visual or olfactory evidence of contamination.

Scale:
Date: 30/01/18
Logged by: AH
Checked: AH
Job No: R17053

Window sample Log

WS No: **5**

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
0.1	ES		Made Ground, dark brown, slightly gravelly, sandy CLAY. Gravels of fine to medium, sub angular brick.		
0.5			Firm to stiff brown and grey mottled, slightly sandy, CLAY. (Tidal Flat Deposits)	0.5	
1	SPT	SPT N = 7		1	
			Loose, light brown, silty, fine to medium, SAND. (Tidal Flat Deposits)		
1.5				1.5	
2	SPT	SPT N = 4		2	
			Very soft to firm, grey, sandy, SILT. (Tidal Flat Deposits)		
2.5				2.5	
3	SPT	SPT N = 0		3	
				3.5	
4	SPT	SPT N = 8		4	
			End of borehole.		

General Comments:

1. No groundwater strike.
2. Installation to 2.8m. 0.8m plain pipe at surface, 2m slotted at base.
3. No visual or olfactory evidence of contamination.

Scale:
Date: 30/01/18
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd

Window sample Log

WS No: 6

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Grange Geo

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Topsoil, brown, slightly sandy CLAY.		
0.5	ES		Firm to stiff, grey and brown mottled, CLAY. Occasional decayed rootlets below 1.20m. (Tidal Flat Deposits)	0.5	
1	SPT	SPT N = 9		1	
1.5				1.5	
2	SPT	SPT N = 2		2	
2.5				2.5	
3	SPT	SPT N = 3	Soft, grey, sandy SILT. (Tidal Flat Deposits)	3	
3.5				3.5	
4	SPT	SPT N = 2	End of borehole.	4	

General Comments:

1. No groundwater strike.
2. Installation to 3.9m. 0.9m plain pipe at surface, 3m slotted at base.
3. No visual or olfactory evidence of contamination.

Scale:
Date: 30/01/18
Logged by: AH
Checked: AH
Job No: R17053

Window sample Log

WS No: 7

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Made Ground (re-worked Natural), firm brown, slightly sandy CLAY.		
0.4	ES				
0.5				0.5	
1	SPT	SPT N = 5		1	
1.5	ES		Made Ground, dark brown, slightly gravelly, CLAY with fragment of pig bone.	1.5	
			Soft, brown and grey, mottled CLAY. (Tidal Flat Deposits)		
2	SPT	SPT N = 3		2	
2.5				2.5	
			Firm to stiff, grey, sandy, SILT. (Tidal Flat Deposits)		
3	SPT	SPT N = 4		3	
3.5				3.5	
4	SPT	SPT N = 12		4	
			End of borehole.		

General Comments:

1. Slight groundwater strike at 1.40m.Groundwater at 0.5m after 20 minutes.
2. No installation.
3. Evidence of pig bones between 1.4m to 1.6m bgl.

Scale:
Date: 30/01/18
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd

Window sample Log

WS No: 8

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Grange Geo

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
0.2	ES		Made Ground, black, slightly gravelly, sandy, SILT. Gravels of fine to medium, angular brick.		
0.5			Firm, brown, slightly sandy, CLAY. (Tidal Flat Deposits)	0.5	
1	SPT	SPT N = 6	Firm, brown and orange brown, sandy, SILT. (Tidal Flat Deposits)	1	
1.3	ES				
1.5				1.5	
2	SPT	SPT N = 4		2	
2.5				2.5	
3	SPT	SPT N = 4	-becoming grey below 3.0m bgl.	3	
4	SPT	SPT N = 7	End of borehole.		

General Comments:

1. Borehole collapsing below 3.50m
2. Installation to 3.6m. 0.6m plain pipe at surface, 3m slotted at base.
3. No visual or olfactory evidence of contamination.

Scale:
Date: 30/01/18
Logged by: AH
Checked: AH
Job No: R17053

Window sample Log

WS No: 9

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
0.3	ES		Made Groud, black, slightly gravelly, sandy, SILT. Gravels of fine to medium, angular brick. Brick cobble at 0.30m.		
0.5			Soft to firm, grey, silty CLAY. (Tidal Flat Deposits)	0.5	
1	SPT ES	SPT N = 7		1	
1.5			Very Soft, grey, CLAY with occasional decayed rootlets. (Tidal Flat Deposits)	1.5	
			-1.80m thin peat layer.		
2	SPT	SPT N = 1		2	
2.5			Very soft, grey, sandy, silty, CLAY with occasional decayed rootlets. (Tidal Flat Deposits)	2.5	
3	SPT	SPT N = 1		3	
			Very soft, grey, sandy, SILT. (Tidal Flat Deposits)	3.5	
4	SPT	SPT N = 0		4	
			End of borehole.		

General Comments:

1. Borehole collapsing below 3.50m
2. Installation to 3.6m. 0.6m plain pipe at surface, 3m slotted at base.
3. No visual or olfactory evidence of contamination.

Scale:
Date: 01/02/18
Logged by: AH
Checked: AH
Job No: R17053

Window sample Log

WS No: **10**

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Made Ground, concrete.		
			Made Ground, red brown, clayey, GRAVEL. Gravels of medium to coarse, angular brick.		
0.4	ES		Made Ground, brown, sandy CLAY with rare brick gravel.	0.5	
0.5			Grey and brown mottled, sandy CLAY. (Tidal Flat Deposits)		
1	SPT	SPT N = 9	Firm to stiff, grey and brown mottled, sandy SILT. (Tidal Flat Deposits)	1	
1.5				1.5	
2	SPT	SPT N = 8		2	
2.5				2.5	
3	SPT	SPT N = 2	Very soft, grey, sandy, SILT. (Tidal Flat Deposits)	3	
3.5				3.5	
4	SPT	SPT N = 1		4	
			End of borehole.		

General Comments:

1. Slight groundwater strike at 2.10m. Groundwater at 1.40m after 20 minutes.
2. No installation.
3. No visual or olfactory evidence of contamination.

Scale:
Date: 01/02/18
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd

Window sample Log

WS No: **11**

Client: Kirk Homes Ltd
Project: Sutton St James

Sheet: 1 of 1
Method: Window Sample

Sample Depth (m)	Sample Type	Testing result	Description	Depth mBGL	Legend
			Made Ground (re-worked natural), firm, brown and grey mottled, slightly sandy CLAY.		
0.5	ES			0.5	
1	SPT	SPT N = 7		1	
1.4	ES		Made Ground, dark grey, silty CLAY with rare fragments of pig bones.		
1.5				1.5	
			Soft, orange brown and brown, mottled CLAY.		
2	SPT	SPT N = 3		2	
2.5				2.5	
			Very soft, grey, sandy SILT.		
3	SPT	SPT N = 2		3	
			End of borehole.		

General Comments:

1. Slight groundwater strike at 1.30m. Groundwater at 0.40m after 20 minutes.
2. No installation.
3. Evidence of pig bones between 1.3 to 1.5m bgl.

Scale:
Date: 01/02/18
Logged by: AH
Checked: AH
Job No: R17053

Grange Geo Consulting Ltd

Appendix E

PHASE 2 Monitoring Data

Grange Geo GAS AND GROUNDWATER MONITORING

Site:		Sutton St James
Client:		
Job No.:		R17053
Date:		02/02/2018
Start / End Time:		12
Engineer:		Andy Hare
Monitoring Equipment:	**Gas Meter ID**	**GG001**
	PID ID	
	Dip Tape	**In-Situ 30m**
	Other	

NR = Not Recorded
Dry = No Groundwater

Weather Conditions	**Start**	**End**
(Dry / Raining)	dry	dry
Cloud Cover (Oktas)	4/8	4/8
Wind Strength (mph)	8.0	8.0
Wind Direction (from)	sw	sw
Temperature (°C)	12.0	12.0
Barometric Pressure (mb)	1021	1019
(Rising/ Falling)	Falling	
PID - Air	0	
PID - Calibration Gas	100	

Location Reference	**Relative Pressure (mbar)**	**Flow (l/hr)**		**Methane (%v/v)**		**Carbon Dioxide (%v/v)**		**Oxygen (%v/v)**		**Hydrogen Sulphide (ppm)**	**Carbon Monoxide (ppm)**		**Depth to water (m)**	**Base of Response Zone (m)**	**Free-Phase Product Level Top (m)**	**Groundwater Elevation (m AOD)**	**Notes**
		Peak	**Steady**	**Peak**	**Steady**	**Peak**	**Steady**	**Min**	**Steady**								
Ambient Air Start (Calibration)																	
Ambient Air Finish (Calibration)																	
WS9		0.2	0.2	0.2	0.2	0.7	0.7	17.6	17.6				1.10				
WS6		1.0	1.0	0.2	0.2	1.7	1.7	17.0	17.0				1.40				
WS5		1.2	1.2	0.3	0.3	3.6	3.4	15.7	15.7				1.50				
WS8		2.6	2.6	0.2	0.2	1.4	1.4	17.2	17.2				1.02				
WS4		1.1	1.0	0.2	0.2	0.4	0.3	19.6	19.6				1.65				
WS1		0.8	0.8	0.2	0.2	0.6	0.6	18.6	18.6				1.60				

Grange Geo GAS AND GROUNDWATER MONITORING

Site:		Sutton St James
Client:		
Job No.:		R17053
Date:		09/02/2018
Start / End Time:		10am
Engineer:		AH
Monitoring Equipment:	Gas Meter ID	GG001
	PID ID	
	Dip Tape	30 m
	Other	

NR = Not Recorded
Dry = No Groundwater

Weather Conditions	Start	End
(Dry / Raining)	dry	dry
Cloud Cover (Oktas)	8/8	8/8
Wind Strength (mph)	18.0	18.0
Wind Direction (from)	NW	NW
Temperature (°C)	4.0	4.0
Barometric Pressure (mb)	1008	1009
(Rising/ Falling)		
PID - Air	0	
PID - Calibration Gas		

Location Reference	Relative Pressure (mbar)	Flow (l/hr)		Methane (%v/v)		Carbon Dioxide (%v/v)		Oxygen (%v/v)		Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	PID (ppm)	Depth to water (m)	Base of Response Zone (m)	Free-Phase Product Level Top (m)	Groundwater Elevation (m AOD)	Notes
		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady								
Ambient Air Start (Calibration)																	
Ambient Air Finish (Calibration)																	
WS9		0.2	0.2	0.2	0.2	0.8	0.8	17.4	17.4				0.94				
WS6		0.5	0.5	0.2	0.2	1.5	1.5	16.0	16.0				1.30				
WS5		0.4	0.4	0.3	0.3	3.4	3.2	15.5	15.5				1.54				
WS8		2.0	2.0	0.2	0.2	0.7	0.7	18.2	18.2				0.93				
WS4		1.0	1.0	0.2	0.2	0.3	0.2	19.7	19.7				1.55				
WS1		1.0	1.0	0.2	0.2	0.4	0.4	19.0	19.0				1.55				

Grange Geo GAS AND GROUNDWATER MONITORING

Site:		Sutton St James
Client:		
Job No.:		R17053
Date:		16/02/2018
Start / End Time:		3pm
Engineer:		AH
Monitoring Equipment:	**Gas Meter ID**	**GG001**
	PID ID	
	Dip Tape	**In-Situ 30m**
	Other	

NR = Not Recorded
Dry = No Groundwater

Weather Conditions	Start	End
(Dry / Raining)	dry	dry
Cloud Cover (Oktas)	1/8	1/8
Wind Strength (mph)	7.0	8.0
Wind Direction (from)	sw	sw
Temperature (°C)	7.0	7.0
Barometric Pressure (mb)	1023	1022
(Rising/ Falling)		
PID - Air		
PID - Calibration Gas		

Location Reference	Relative Pressure (mbar)	Flow (l/hr)		Methane (%v/v)		Carbon Dioxide (%v/v)		Oxygen (%v/v)		Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	PID (ppm)	Depth to water (m)	Base of Response Zone (m)	Free-Phase Product Level Top (m)	Groundwater Elevation (m AOD)	Notes
		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady								
Ambient Air Start (Calibration)																	
Ambient Air Finish (Calibration)																	
WS9		0.4	0.4	0.1	0.1	1.0	1.0	17.0	17.0				0.90				
WS6		0.7	0.7	0.2	0.2	1.7	1.7	15.6	15.6				1.25				
WS5		0.3	0.2	0.3	0.3	3.2	3.1	15.6	15.7				1.48				
WS8		2.6	2.5	0.2	0.2	0.5	0.5	20.0	20.0				0.95				
WS4		1.4	1.3	0.2	0.2	0.3	0.2	19.0	19.0				1.50				
WS1		0.8	0.7	0.2	0.2	0.5	0.4	19.2	19.2				1.58				

Site:		Sutton St James
Client:		
Job No.:		R17053
Date:		23/02/2018
Start / End Time:		9am
Engineer:		AH
Monitoring Equipment:	**Gas Meter ID**	**GG001**
	PID ID	
	Dip Tape	**30 m**
	Other	

NR = Not Recorded
Dry = No Groundwater

Weather Conditions	**Start**	**End**
(Dry / Raining)	raining	raining
Cloud Cover (Oktas)	8/8	8/8
Wind Strength (mph)	20.0	20.0
Wind Direction (from)	NW	NW
Temperature (°C)	2.0	2.0
Barometric Pressure (mb)	996	996
(Rising/ Falling)		
PID - Air	0	
PID - Calibration Gas	100	

Location Reference	**Relative Pressure (mbar)**	**Flow (l/hr)**		**Methane (%v/v)**		**Carbon Dioxide (%v/v)**		**Oxygen (%v/v)**		**Hydrogen Sulphide (ppm)**	**Carbon Monoxide (ppm)**	**PID (ppm)**	**Depth to water (m)**	**Base of Response Zone (m)**	**Free-Phase Product Level Top (m)**	**Groundwater Elevation (m AOD)**	**Notes**
		Peak	**Steady**	**Peak**	**Steady**	**Peak**	**Steady**	**Min**	**Steady**								
WS9		1.0	1.0	0.2	0.2	1.9	1.7	14.0	14.0				0.80				
WS6		1.5	1.5	0.2	0.2	1.3	1.3	17.5	17.5				1.20				
WS5		0.2	0.2	0.2	0.2	2.2	2.2	17.2	17.2				1.45				
WS8		0.3	0.3	0.2	0.2	0.6	0.5	19.0	19.0				0.99				
WS4		1.5	1.5	0.2	0.2	0.4	0.4	17.7	17.8				1.40				
WS1		0.5	0.5	0.2	0.2	0.3	0.3	19.4	19.4				1.60				

GAS AND GROUNDWATER MONITORING

Site:		Sutton St James
Client:		
Job No.:		R17053
Date:		02/03/2018
Start / End Time:		1pm
Engineer:		AH
Monitoring Equipment:	**Gas Meter ID**	**GG01**
	PID ID	
	Dip Tape	
	Other	

NR = Not Recorded
Dry = No Groundwater

Weather Conditions	Start	End
(Dry / Raining)	snow showers	snow showers
Cloud Cover (Oktas)	2/8	2/8
Wind Strength (m/s)	25.0	30.0
Wind Direction (from)	e	End
Temperature (°C)	-2.0	-2.0
Barometric Pressure (mb)	998	998
(Rising/ Falling)	falling	
PID - Air		
PID - Calibration Gas		

Location Reference	Relative Pressure (mbar)	Flow (l/hr)		Methane (%v/v)		Carbon Dioxide (%v/v)		Oxygen (%v/v)		Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	PID (ppm)	Depth to water (m)	Base of Response Zone (m)	Free-Phase Product Level Top (m)	Groundwater Elevation (m AOD)	Notes
		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady								
Ambient Air Start (Calibration)																	
Ambient Air Finish (Calibration)																	
WS9		1.2	1.2	0.2	0.2	1.3	1.3	13.8	13.8				0.72				
WS6		1.2	1.3	0.2	0.2	1.1	1.1	17.8	17.8				1.05				
WS5		0.2	0.2	0.2	0.2	2.2	2.2	17.0	17.0				1.35				
WS8		0.5	0.5	0.2	0.2	0.4	0.4	18.9	18.9				0.95			-0.95	
WS4		1.0	1.0	0.2	0.2	0.3	0.2	18.1	18.1				1.42			-1.42	
WS1		0.6	0.6	0.2	0.2	0.3	0.3	19.5	19.5				1.53			-1.53	

GAS AND GROUNDWATER MONITORING

Site:		Sutton St James
Client:		
Job No.:		R17053
Date:		06/03/2018
Start / End Time:		11am
Engineer:		AH
Monitoring Equipment:	**Gas Meter ID**	**GG01**
	PID ID	
	Dip Tape	
	Other	

NR = Not Recorded
Dry = No Groundwater

Weather Conditions	Start	End
(Dry / Raining)	Dry	Dry
Cloud Cover (Oktas)	8/8	8/8
Wind Strength (m/s)	10.0	10.0
Wind Direction (from)	sw	sw
Temperature (°C)	7.0	7.0
Barometric Pressure (mb)	988	987
(Rising/ Falling)		
PID - Air		
PID - Calibration Gas		

Location Reference	Relative Pressure (mbar)	Flow (l/hr)		Methane (%v/v)		Carbon Dioxide (%v/v)		Oxygen (%v/v)		Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	PID (ppm)	Depth to water (m)	Base of Response Zone (m)	Free-Phase Product Level Top (m)	Groundwater Elevation (m AOD)	Notes
		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady								
Ambient Air Start (Calibration)																	
Ambient Air Finish (Calibration)																	
WS9		2.2	2.1	0.2	0.2	2.2	2.2	12.4	12.4				0.75				
WS6		1.6	1.5	0.2	0.2	1.4	1.4	17.2	17.2				1.08				
WS5		0.2	0.2	0.2	0.2	2.5	2.5	16.5	16.5				1.30				
WS8		0.7	0.7	0.2	0.2	0.5	0.5	18.5	18.5				0.90				
WS4		1.4	1.3	0.2	0.2	0.3	0.2	19.0	19.0				1.40				
WS1		0.8	0.7	0.2	0.2	0.5	0.4	19.2	19.2				1.50				

BWB GAS AND GROUNDWATER MONITORING

Site:		Sutton St James
Client:		
Job No.:		R17053
Date:		16/03/2018
Start / End Time:		11am
Engineer:		AH
Monitoring Equipment:	**Gas Meter ID**	**GG01**
	PID ID	
	Dip Tape	
	Other	

NR = Not Recorded
Dry = No Groundwater

Weather Conditions	Start	End
(Dry / Raining)	showers	showers
Cloud Cover (Oktas)	4/8	4/8
Wind Strength (m/s)	6.0	7.0
Wind Direction (from)	sw	sw
Temperature (°C)	11.0	11.0
Barometric Pressure (mb)	1000	1000
(Rising/ Falling)		
PID - Air		
PID - Calibration Gas		

Location Reference	Relative Pressure (mbar)	Flow (l/hr)		Methane (%v/v)		Carbon Dioxide (%v/v)		Oxygen (%v/v)		Hydrogen Sulphide (ppm)	Carbon Monoxide (ppm)	PID (ppm)	Depth to water (m)	Base of Response Zone (m)	Free-Phase Product Level Top (m)	Groundwater Elevation (m AOD)	Notes
		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady								
Ambient Air Start (Calibration)																	
Ambient Air Finish (Calibration)																	
WS9		0.1	0.1	0.1	0.1	0.8	0.8	17.7	17.7				0.78				
WS6		0.7	0.7	0.2	0.2	1.7	1.7	15.6	15.6				1.10				
WS5		0.3	0.2	0.3	0.3	3.2	3.1	15.6	15.7				1.33				
WS8		2.6	2.5	0.2	0.2	0.5	0.5	20.0	20.0				0.88				
WS4		1.4	1.3	0.2	0.2	0.3	0.2	19.0	19.0				1.44				
WS1		0.8	0.7	0.2	0.2	0.5	0.4	19.2	19.2				1.46				
WS1																	

Appendix F

GRANGE GEOCONSULTING LIMITED METHODOLOGY

RISK ASSESSMENT RATIONALE

The work presented in this report has been carried out in general accordance with recognised best practice as detailed in guidance documents such as in BS5930:1999 and BS10175:2001. Important aspects of the risk assessment process are transparency and justification. The rationale behind the risk assessments presented is given in this appendix.

A preliminary risk assessment is made of both geotechnical and geo-environmental hazards identified at the desk study stage and confirmed (or amended) at the ground investigation stage. This is based on a simple matrix of probability of occurrence versus the consequence, as explained below. In the case of geo-environmental hazards, the risk assessment process proceeds to the next level, the generic risk assessment, in which actual contaminant concentrations are considered.

Preliminary Risk Assessment (Geotechnical Risk Register)

The preliminary geotechnical risk register is compiled in accordance with the Highways Agency Design Manual for Roads and Bridges HD/02. This requires an estimation of the *probability* of an event happening multiplied by the *impact* or consequences of that event. Five levels of probability and impact are given scores and these are multiplied to give a risk rating and a qualitative risk level is assigned as in Table A based on the terminology of Clayton (2001).

Table A: Geotechnical Risk Rating

Assessment of Geotechnical Risks (Risk Register)				
Probability (P)	**Impact (I)**	**Impact in terms of cost or time (% of construction cost or time)**	**Risk Rating (R = P x I)**	**Risk Level**
Very likely (5)	Very High (5)	>25%	17 to 25	Intolerable
Likely (4)	High (4)	10 to 25%	13 to 16	Intolerable
Probable (3)	Medium (3)	4 to 10%	9 to 12	Substantial
Unlikely (2)	Low (2)	1 to 4%	5 to 8	Tolerable
Negligible (1)	Very Low (1)	<1%	1 to 4	Trivial

Preliminary Risk Assessment (Geoenvironmental Consequences and Probability)

The Preliminary Risk Assessment includes a geo-environmental Hazard Identification, which seeks to list all the suspected contaminant **sources**, the **receptors** that might be harmed by those sources and the **pathways** via which the sources might reach the receptors to cause the harm. The source-pathway-receptor concept is known as a pollution linkage, and only when a linkage is complete is there any possibility of risk of harm arising.

The Hazard Identification evaluates all the **possible** pollution linkages in tabular form. Professional judgement is then used to evaluate which of these pollution linkages may be considered as **plausible**. Plausible pollution linkages are unacceptable risks in terms of the current contaminated land regime legal framework and require either remediation or further assessment. These are normally addressed via intrusive ground investigation and the chemical analysis of soil and water samples.

Where no plausible linkage identified, the linkage is classed as 'no linkage' in the summary table and no further action is required. If a linkage is plausible, a comparison is made of consequence against probability in general accordance with the guidance given in CIRIA Report C552 (Rudland *et al* 2001). Classification of consequences and probability are given in CIRIA C552 Tables 6.3 and 6.4, respectively, but there are

several inconsistencies in the original Table 6.3, in particular relating to 'significant harm or significant possibility of significant harm' (SH/SPOSH). Consequently, the table has been updated by Grange Geo in line with current practice and is given in Table B. Also added are scores from 1 to 4 for each category.

The basis of the classification is that 'severe' and 'major' are likely to result in SH/SPOSH as defined by the EPA 1990, Part 2A, with 'severe' resulting in acute harm. 'Moderate' lies below the level of SH/SPOSH but above the level of 'no harm' as implied by the relevant Generic assessment criterion (GAC, see below). Minor lies below the 'no harm' level.

Table B: Classification of Consequences of Geoenvironmental Risks

Classification of Consequences for Geoenvironmental Risks		
Classification	**Definition**	**Examples**
Severe (4 points)	Concentration of contaminants is likely to (or is known from previous data to) exceed that indicative of unacceptable intake or contact. I.e. >>SH/SPOSH, concentrations are high enough to cause acute (short-term) effects.	Human health: short-term (acute) effects likely to result in significant harm. E.g. high conc. of cyanide at the surface of an informal recreational area. Planting: complete and rapid die-back of landscaped areas. Controlled waters: short-term pollution, e.g. major spillage into controlled water. Buildings etc.: catastrophic damage, e.g. explosion causing collapse. Ecosystems: short-term risk to an ecosystem or organism forming part of that ecosystem in a designated protected area, e.g. by contamination spillage. Site workers: risk assessment required to determine PPE and this may involve USEPA Level A, B or C protection.
Major (3 points)	Concentration of contaminants is likely to (or is known from previous data to) exceed that indicative of unacceptable intake or contact. I.e. >SH/SPOSH.	Human health: long-term (chronic) effects likely to result in significant harm. E.g. high conc. of contaminants close to the surface of a development site. Planting: stressed or dead plants in landscaped areas. Controlled waters: pollution of sensitive water resources, e.g. leaching into major or minor aquifers or rivers. Buildings etc.: damage renders unsafe to occupy. Ecosystems: death of species in an ecosystem in a designated protected area, e.g. by contamination spillage. Site workers: risk assessment required to determine PPE and this may involve USEPA Level B, C or D protection.

Classification of Consequences for Geoenvironmental Risks		
Classification	**Definition**	**Examples**
Moderate (2 points)	Concentration of contaminants is likely to (or is known from previous data to) exceed that indicative of no harm but not unacceptable intake or contact. I.e. >SVG/GAC but <SH/SPOSH.	Human health: harm but probably not significant harm unless particularly sensitive individual within the receptor group. May be aesthetic/olfactory impacts. Planting: damage to plants in landscaped areas, e.g. stunted growth, discoloration. Controlled waters: pollution of non-sensitive water bodies e.g. leaching into non-classified groundwater or minor ditches. Buildings etc.: damage to sensitive buildings etc. Ecosystems: minor change in an ecosystem in a designated protected area, but not significant harm. Site workers: risk assessment required to determine PPE and this may involve USEPA Level C or D protection.
Minor (1 point)	Concentration of contaminants is likely to (or is known from previous data to) be less than that indicative of no harm. I.e. <SGV/GAC.	No measurable effects, but simple PPE required (USEPA Level D protection, i.e. overalls, boots, goggles, hard hat).

CIRIA Table 6.4 is reproduced as Table C below, but also with the addition of scores from 1 to 4. This provides an estimate of the probability that the event described by the pollution linkage will occur. For example, the likelihood that pollution of groundwater will occur by leaching of metals into the aquifer.

Table C: Classification of Probability of Geoenvironmental Risks

Classification of Probability of Geoenvironmental Risks	
Classification	**Definition**
High (4 points)	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Medium (3 points)	There is a pollution linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event in not inevitable, but possible in the short term and likely over the long term.
Low (2 points)	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is no means certain that even over a longer period such event could take place, and is less likely in the shorter term.
Unlikely (1 point)	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

The perceived level of risk for each pathway is then derived from the probability versus consequences matrix, modified after CIRIA C552 Table 6.5, given in Table D. The scores are summed accordingly and the result assigned a risk level by dividing the range between the minimum score of 1 and the maximum score of 16 equally into 5 categories i.e. 1 to <4 is very low risk, 4 to <7 is low risk, 7 to <10 is moderate risk, 10 to <13 is high risk and 13 to 16 is very high risk.

Table D: Qualitative Risk Level from Consequence and Probability

		Consequence			
Probability	*product*	**Severe (4)**	**Major (3)**	**Moderate (2)**	**Minor (1)**
	High (4)	16 = Very high risk	12 = High risk	8 = Moderate risk	4 = Low risk
	Medium (3)	12 = High risk	9 = Moderate risk	6 = Low risk	3 = Very low risk
	Low (2)	8 = Moderate risk	6 = Low risk	4 = Low risk	2 = Very low risk
	Unlikely (1)	4 = Low risk	3 = Very low risk	2 = Very low risk	1 = Very low risk

This approach assumes an equivalence between probability and consequences and ignores the difficulty that can arise where to probability of occurrence appears to be almost negligible but the consequences are very severe. In such conditions, there is a degree of subjectivity in assessing the level of risk and it could be low, moderate or high. Such risks may require specialist consideration beyond the scope of this standard report.

A description of the classified risks and the likely action required can be determined from Table E.

Table E: Description of the Classified Risks and Likely Action Required

Description of Classified Risks and Likely Action Required	
Very High Risk	A significant pollution linkage, including actual evidence of significant harm or significant possibility and significant harm, is clearly identifiable at the site (e.g. from visual or documentary evidence) under current conditions, with potential for legal and/or financial consequences for the site owner or other Responsible Person. Remediation advisable based on acute impacts being likely. Immediate action should be considered.
High Risk	A pollution linkage is identifiable at the site under current and future use conditions. Although likely, there is no obvious actual evidence of significant harm or significant possibility and significant harm under current conditions. Extent of risk is therefore subject to confirmation by investigation and risk assessment and most likely to be deemed significant. Remediation required for redevelopment and may also be required under Part 2A for existing receptors.
Moderate Risk	A pollution linkage is identifiable at the site under current and future use conditions. However, it is not likely to be a significant linkage under current conditions. Actual extent of risk subject to confirmation by additional investigation and risk assessment and most likely to lie between no possibility of harm (under current conditions) and significant possibility of significant harm (under conditions created by new use). Remediation may be required for redevelopment.
Low risk	Potential pathways and receptors exist but history of contaminative use or site conditions indicates that contamination is likely to be of limited extent and below the level of no possibility of harm. Precautionary investigations and risk assessment advisable on change of use.
Very Low Risk	No pollution linkage likely to exist under current or future conditions. Site not capable of being determined under Part 2A (in accordance with PPS23) where the Local Authority inspects the site. No further action recommended.

Contaminant Analysis of Samples

CLR 8 (Environment Agency 2002b), the DoE Industry Profile documents and ISO10381-5 provide good summaries of priority pollutants for UK sites. Additionally, the Environment Agency has produced a list of priority pollutants for ecological risk assessment in a consultation document (Environment Agency 2003a). These documents have been used, with the findings of the Phase 1 investigation, to scope the analyses of chemicals of potential concern.

Grange Geo considers there to be a minimum requirement for soil chemical analysis, even for Greenfield sites, to satisfy the 'suitable for use' criterion of the planning regime. The GACs adopted by Grange Geo for the Site are given in the following table. Grange Geo considers there to be a minimum requirement for soil chemical analysis, even for Greenfield sites, to satisfy the 'suitable for use' criterion of the planning regime. The Generic Assessment Criteria (GACs) adopted by Grange Geo for the Site are based on a **RESIDENTIAL WITH PLANT UPTAKE** Standard Land Use and are presented in the table below.

Table F: Generic Assessment Criteria (GAC) for Residential with Plant Uptake

Based on a 6% Soil Organic Matter Content

Based on C4SL and S4UL values. Some contaminants revert to the GAC in the absence of a C4SL or a S4UL value.

Heavy Metals	
Cyanide	4.6
Arsenic	37
Beryllium	1.7
Boron	290
Cadmium	11
Chromium	910
Chromium VI	4.3
Copper	2400
Lead	200
Mercury (elemental)	1.2
Mercury (inorganic)	40
Nickel	130
Selenium	250
Vanadium	410
Zinc	3700
BTEX	
Benzene	0.087
Toluene	130
Ethyl Benzene	47
m/p Xylenes	56
o Xylenes	60
Xylenes	56
Speciated PAHs	
Naphthalene	1.5

Acenaphthylene	170
Acenaphthene	210
Fluorene	160
Phenanthrene	92
Anthracene	2300
Fluoranthene	260
Pyrene	560
Benzo[a]anthracene	3.1
Chrysene	6
Benzo[b]fluoranthene	2.6
Benzo[k]fluoranthene	8.5
Benzo[a]pyrene	2.2
Indeno[123-cd]pyrene	3.2
Dibenzo[ah]anthracene	0.24
Benzo[ghi]perylene	44
Asbestos	
Asbestos	Non-detected
Speciated TPH	
Aliphatic C5 - C6	30
Aliphatic C6 - C8	73
Aliphatic C8 - C10	19
Aliphatic C10 - C12	93
Aliphatic C12 - C16	740
Aliphatic C16 - C21	45000
Aliphatic C21 - C35	45000
Aromatic C5 - C7	65
Aromatic C7 - 8	120
Aromatic C8 - C10	27
Aromatic C10 - 12	69
Aromatic C12 - C16	140
Aromatic C16 - C21	250
Aromatic C21 - C35	890

Appendix G

CONTAMINATION TESTING RESULTS

Stansted Laboratories LTD
Unit 9-10, Riverside Industrial Estate
27 Thames Road
Barking, Essex
IG11 0ND

Tel: +44 (0)20 8594 5104
Fax: +44 (0)20 8591 8762
sales@stanstedlabs.co.uk
www.stanstedlabs.co.uk

Directors: B. Patel, K.Patel

2266

Client: i2 Analytical LTD
Address: 7 Woodshots Meadow
Croxley Green Business Park
Croxley Green
Hertfordshire
WD18 8YS
Site: 18-74778 (Sutton St James)
FAO: Trevor Hill
Order No: 9628, 18-74778

Job Number: M/182/54364
Report No.: 57901.1
Date Taken: Thu, 1st Feb 2018 00:00
Date Rec'd: Tue, 6th Feb 2018

Items Marked ¤ are not included in the UKAS Schedule

Sample ID	Description & Temperatures	Analysis	Result	Tested	Notes / Species
SL246458 *Soil*	900446 (WS9@0.30) Init Temp ¤ Temp > 1 Min ¤ Temp > 2 Min ¤	Coliforms ¤	130000 MPN/g	06/02/2018	
		E.Coli ¤	100 MPN/g	06/02/2018	
		Enterococci ¤	2700 cfu/g	06/02/2018	
		Clostridium perfringens ¤	>8000 cfu/g	06/02/2018	
		Faecal Coliforms ¤	4900 MPN/g	06/02/2018	
SL246459 *Soil*	900447 (WS10@0.40) Init Temp ¤ Temp > 1 Min ¤ Temp > 2 Min ¤	Coliforms ¤	38700 MPN/g	06/02/2018	
		E.Coli ¤	100 MPN/g	06/02/2018	
		Enterococci ¤	4500 cfu/g	06/02/2018	
		Clostridium perfringens ¤	>8000 cfu/g	06/02/2018	
		Faecal Coliforms ¤	7200 MPN/g	06/02/2018	

Method Codes
SLM/B312/M - Coliforms and Escherichia coli
SLM/B316/M - Clostridium perfringens
SLM/B370/M - Enterococci

Legend & Footnotes
cfu = Colony Forming Units
mpn = Most Probable Number
TNTC = Too Numerous to Count

Sampling is not included in our UKAS Schedule.
All Samples Analysed as received.

Test report authorised by :
B.Patel

Director
Date: 09/02/2018 13:23:53

Test Report checked by : Gabor Pokornyi
09/02/2018 13:12:59

Disclaimer
Results relate to water samples tested and should not be reproduced except in full, without the written approval of the laboratory. Interpretations and opinions are not included in our UKAS schedule.
00:00 means time not declared.

------- END OF REPORT -------

Andrew Hare
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i2 Analytical Ltd.
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Croxley Green
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Watford,
Herts,
WD18 8YS

t: 01923 225404
f: 01923 237404
e: reception@i2analytical.com

Analytical Report Number : 18-74778

Project / Site name:	Sutton St James	**Samples received on:**	01/02/2018
Your job number:	R17053	**Samples instructed on:**	01/02/2018
Your order number:		**Analysis completed by:**	12/02/2018
Report Issue Number:	1	**Report issued on:**	12/02/2018
Samples Analysed:	11 soil samples		

Signed:

Jordan Hill
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

This certificate should not be reproduced, except in full, without the express permission of the laboratory.
The results included within the report are representative of the samples submitted for analysis.

UKAS TESTING 4041

mCERTS

Analytical i2 Environmental Science

Analytical Report Number: 18-74778

Project / Site name: Sutton St James

Lab Sample Number				900443	900444	900445	900446	900447
Sample Reference				WS1	WS3	WS8	WS9	WS10
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.20	0.20	0.30	0.40
Date Sampled				30/01/2018	30/01/2018	30/01/2018	01/02/2018	01/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	25	14	38	22	22
Total mass of sample received	kg	0.001	NONE	0.39	0.34	0.36	1.4	1.6
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	-	Chrysotile- Loose Fibrous Debris	Chrysotile- Loose Fibres	-
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Detected	Detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.5	7.7	7.7	7.5	7.8
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Ammonium as NH_4	mg/kg	0.5	MCERTS	-	-	-	41	< 0.5
Total Nitrogen (Kjeldahl)	mg/kg	5	NONE	-	-	-	2400	700
Organic Matter	%	0.1	MCERTS	1.9	3.9	13	3.9	1.3
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	< 0.80	< 0.80	< 0.80	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	32	21	15	17	26
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	41	36	15	37	30
Copper (aqua regia extractable)	mg/kg	1	MCERTS	14	26	32	18	13
Lead (aqua regia extractable)	mg/kg	1	MCERTS	17	25	14	24	13
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	0.4	0.5	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	34	33	21	30	25
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	3.7	< 1.0	< 1.0
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	58	51	28	51	41
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	61	85	120	76	42

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Analytical Report Number: 18-74778

Project / Site name: Sutton St James

Lab Sample Number				900443	900444	900445	900446	900447
Sample Reference				WS1	WS3	WS8	WS9	WS10
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.20	0.20	0.30	0.40
Date Sampled				30/01/2018	30/01/2018	30/01/2018	01/02/2018	01/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	-	-	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	-	-	< 8.0	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	< 10	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	-	-	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	-	-	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	-	-	< 2.0	< 2.0
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	-	-	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	-	-	< 10	< 10
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	-	-	< 10	< 10
Microbiological (Subcontracted)								
Total Coliforms	mpn/g	N/A	NONE	-	-	-	130000	38700
Faecal Coliforms	mpn/g	N/A	NONE	-	-	-	4900	7200
E. Coli	mpn/g	1	NONE	-	-	-	100	100
Faecal Streptococci	cfu/g	N/A	NONE	-	-	-	2700	4500
Clostridia	cfu/g	N/A	NONE	-	-	-	> 8000	> 8000

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UKAS TESTING 4041 MCERTS

Analytical i2 Environmental Science

Analytical Report Number: 18-74778

Project / Site name: Sutton St James

Lab Sample Number				900448	900449	900450	900451	900452
Sample Reference				WS6	WS7	WS7	WS5	WS11
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.40	1.50	0.10	0.50
Date Sampled				01/02/2018	01/02/2018	01/02/2018	01/02/2018	01/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	22	20	31	26	26
Total mass of sample received	kg	0.001	NONE	0.37	0.43	0.39	0.35	0.38
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	-	Chrysotile- Loose Fibres	-	-	-
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.7	7.1	7.4	7.4	7.7
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Ammonium as NH_4	mg/kg	0.5	MCERTS	-	-	< 0.5	-	-
Total Nitrogen (Kjeldahl)	mg/kg	5	NONE	-	-	2600	-	-
Organic Matter	%	0.1	MCERTS	2.3	3.4	4.3	11	7.9
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.23	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.29	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	< 0.05	0.17	4.5	0.37	< 0.05
Anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.2	< 0.05	< 0.05
Fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.46	7.0	1.1	< 0.05
Pyrene	mg/kg	0.05	MCERTS	< 0.05	0.37	5.5	0.98	< 0.05
Benzo(a)anthracene	mg/kg	0.05	MCERTS	< 0.05	0.22	3.0	0.53	< 0.05
Chrysene	mg/kg	0.05	MCERTS	< 0.05	0.22	2.9	0.56	< 0.05
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.26	3.5	0.83	< 0.05
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	< 0.05	0.12	1.3	0.36	< 0.05
Benzo(a)pyrene	mg/kg	0.05	MCERTS	< 0.05	0.20	2.9	0.63	< 0.05
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.2	0.30	< 0.05
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.31	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	1.4	0.35	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	< 0.80	2.02	35.2	6.03	< 0.80
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	18	16	14	13	12
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	40	31	29	36	24
Copper (aqua regia extractable)	mg/kg	1	MCERTS	12	36	28	27	22
Lead (aqua regia extractable)	mg/kg	1	MCERTS	19	18	28	36	15
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	0.4	0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	39	28	27	21	22
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	1.0	< 1.0	< 1.0	1.4
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	57	41	41	33	33
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	77	86	120	120	64

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Analytical Report Number: 18-74778

Project / Site name: Sutton St James

Lab Sample Number				900448	900449	900450	900451	900452
Sample Reference				WS6	WS7	WS7	WS5	WS11
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.50	0.40	1.50	0.10	0.50
Date Sampled				01/02/2018	01/02/2018	01/02/2018	01/02/2018	01/02/2018
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
Toluene	µg/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
Ethylbenzene	µg/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
p & m-xylene	µg/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
o-xylene	µg/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-	< 0.001	-	< 0.001	-
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-	< 0.001	-	< 0.001	-
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	< 0.001	-	< 0.001	-
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-	< 2.0	-	< 2.0	-
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-	< 8.0	-	< 8.0	-
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-	< 8.0	-	66	-
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-	< 10	-	72	-
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-	< 0.001	-	< 0.001	-
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-	< 0.001	-	< 0.001	-
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-	< 0.001	-	< 0.001	-
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-	< 1.0	-	< 1.0	-
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-	< 2.0	-	2.9	-
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-	< 10	-	13	-
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-	< 10	-	78	-
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-	< 10	-	94	-
Microbiological (Subcontracted)								
Total Coliforms	mpn/g	N/A	NONE	-	-	-	-	-
Faecal Coliforms	mpn/g	N/A	NONE	-	-	-	-	-
E. Coli	mpn/g	1	NONE	-	-	-	-	-
Faecal Streptococci	cfu/g	N/A	NONE	-	-	-	-	-
Clostridia	cfu/g	N/A	NONE	-	-	-	-	-

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UKAS TESTING 4041

MCERTS

Analytical i2 Environmental Science

Analytical Report Number: 18-74778

Project / Site name: Sutton St James

Lab Sample Number				900453				
Sample Reference				WS11				
Sample Number				None Supplied				
Depth (m)				1.40				
Date Sampled				01/02/2018				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1				
Moisture Content	%	N/A	NONE	30				
Total mass of sample received	kg	0.001	NONE	0.34				
Asbestos in Soil Screen / Identification Name	Type	N/A	ISO 17025	Chrysotile- Loose Fibres				
Asbestos in Soil	Type	N/A	ISO 17025	Detected				
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.0				
Total Cyanide	mg/kg	1	MCERTS	< 1				
Ammonium as NH_4	mg/kg	0.5	MCERTS	-				
Total Nitrogen (Kjeldahl)	mg/kg	5	NONE	-				
Organic Matter	%	0.1	MCERTS	5.6				
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthene	mg/kg	0.05	MCERTS	0.12				
Fluorene	mg/kg	0.05	MCERTS	0.17				
Phenanthrene	mg/kg	0.05	MCERTS	2.6				
Anthracene	mg/kg	0.05	MCERTS	0.76				
Fluoranthene	mg/kg	0.05	MCERTS	4.3				
Pyrene	mg/kg	0.05	MCERTS	3.4				
Benzo(a)anthracene	mg/kg	0.05	MCERTS	1.5				
Chrysene	mg/kg	0.05	MCERTS	1.7				
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	1.4				
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	0.86				
Benzo(a)pyrene	mg/kg	0.05	MCERTS	1.3				
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	0.48				
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	< 0.05				
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	0.72				
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	19.3				
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	14				
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2				
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0				
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	26				
Copper (aqua regia extractable)	mg/kg	1	MCERTS	36				
Lead (aqua regia extractable)	mg/kg	1	MCERTS	22				
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	0.4				
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	25				
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0				
Vanadium (aqua regia extractable)	mg/kg	1	MCERTS	35				
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	110				

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Analytical Report Number: 18-74778

Project / Site name: Sutton St James

Lab Sample Number				900453				
Sample Reference				WS11				
Sample Number				None Supplied				
Depth (m)				1.40				
Date Sampled				01/02/2018				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Monoaromatics								
Benzene	ug/kg	1	MCERTS	-				
Toluene	µg/kg	1	MCERTS	-				
Ethylbenzene	µg/kg	1	MCERTS	-				
p & m-xylene	µg/kg	1	MCERTS	-				
o-xylene	µg/kg	1	MCERTS	-				
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	-				
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	-				
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	-				
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	-				
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	-				
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	-				
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	-				
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	-				
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	-				
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	-				
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	-				
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	-				
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	-				
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	-				
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	-				
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	-				
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	-				
Microbiological (Subcontracted)								
Total Coliforms	mpn/g	N/A	NONE	-				
Faecal Coliforms	mpn/g	N/A	NONE	-				
E. Coli	mpn/g	1	NONE	-				
Faecal Streptococci	cfu/g	N/A	NONE	-				
Clostridia	cfu/g	N/A	NONE	-				

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Analytical Report Number : 18-74778

Project / Site name: Sutton St James

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
900443	WS1	None Supplied	0.50	Brown clay with vegetation.
900444	WS3	None Supplied	0.20	Brown clay and loam with vegetation.
900445	WS8	None Supplied	0.20	Brown loam and clay with vegetation.
900446	WS9	None Supplied	0.30	Grey clay.
900447	WS10	None Supplied	0.40	Brown clay.
900448	WS6	None Supplied	0.50	Brown clay.
900449	WS7	None Supplied	0.40	Brown clay.
900450	WS7	None Supplied	1.50	Brown clay with vegetation.
900451	WS5	None Supplied	0.10	Brown loam and clay with vegetation.
900452	WS11	None Supplied	0.50	Brown clay and loam.
900453	WS11	None Supplied	1.40	Brown clay.

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Analytical Report Number : 18-74778

Project / Site name: Sutton St James

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Ammonium as NH4 in soil	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method, 10:1 water extraction.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	MCERTS
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Clostridia in soil Subcon to Stanstead Labs	Clostridia in Soils - Subcontracted Analysis	Subcontracted Analysis - See Attached Subcon Report.		D	NONE
E. Coli in soil Subcon	E.Coli in Soil - Subcontracted Analysis	Subcontracted Analysis - See Attached Subcon Report.		W	NONE
Faecal Coliforms in soil Subcon	Faecal Coliforms in Soil - Subcontracted Analysis	Subcontracted Analysis - See Attached Subcon Report.		W	NONE
Faecal Streptococci in soil Subcon	Faecal Streptococci in Soil - Subcontracted Analysis	Subcontracted Analysis - See Attached Subcon Report.		W	NONE
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Kjeldahl nitrogen in soil	Determination of total nitrogen using the Kjeldahl-digestion method and colorimetric determination.	In house method based on BS 7755-3.7:1995 &	L087-PL	D	NONE
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Total Coliforms Biology in soil Subcon	Total Coliforms in Soil - Subcontracted Analysis	Subcontracted Analysis - See Attached Subcon Report.		W	NONE
Total cyanide in soil	Determination of total cyanide by distillation followed by colorimetry.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	MCERTS

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Analytical Report Number : 18-74778

Project / Site name: Sutton St James

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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The results included within the report are representative of the samples submitted for analysis.

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Analytical Report Number : 18-74907

Project / Site name:	Sutton St James	**Samples received on:**	01/02/2018
Your job number:	R17053	**Samples instructed on:**	01/02/2018
Your order number:		**Analysis completed by:**	15/02/2018
Report Issue Number:	1	**Report issued on:**	15/02/2018
Samples Analysed:	4 soil samples		

Signed:

Jordan Hill
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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UKAS TESTING 4041

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Analytical i2 Environmental Science

Analytical Report Number: 18-74907

Project / Site name: Sutton St James

Lab Sample Number				901156	901157	901158	901159	
Sample Reference				WS1	WS1	WS2	WS9	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				1.20	3.50	0.60	1.00	
Date Sampled				30/01/2018	30/01/2018	30/01/2018	01/02/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	
Moisture Content	%	N/A	NONE	21	19	21	34	
Total mass of sample received	kg	0.001	NONE	0.79	0.61	0.47	0.54	
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.6	7.6	7.7	7.2	
Total Sulphate as SO_4	%	0.005	MCERTS	0.032	0.043	0.063	0.123	
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.014	0.038	0.023	0.15	
Water Soluble Chloride (2:1) (leachate equivalent)	mg/l	0.5	MCERTS	2.1	2.6	2.8	56	
Total Sulphur	%	0.005	MCERTS	0.016	0.034	0.027	0.121	
Water Soluble Nitrate (2:1) as N (leachate equivalent)	mg/l	2	NONE	< 2.0	< 2.0	< 2.0	< 2.0	
Heavy Metals / Metalloids								
Magnesium (water soluble)	mg/kg	5	NONE	12	18	15	25	
Magnesium (leachate equivalent)	mg/l	2.5	NONE	5.7	8.9	7.3	12	

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Analytical Report Number : 18-74907

Project / Site name: Sutton St James

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
901156	WS1	None Supplied	1.20	Brown sandy clay.
901157	WS1	None Supplied	3.50	Brown sandy clay.
901158	WS2	None Supplied	0.60	Brown clay with vegetation.
901159	WS9	None Supplied	1.00	Brown clay.

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Analytical Report Number : 18-74907

Project / Site name: Sutton St James

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Chloride, water soluble, in soil	Determination of Chloride colorimetrically by discrete analyser.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests. 2:1 extraction.	L082-PL	D	MCERTS
Magnesium, water soluble, in soil	Determination of water soluble magnesium by extraction with water followed by ICP-OES.	In-house method based on TRL 447	L038-PL	D	NONE
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
Total Sulphate in soil as %	Determination of total sulphate in soil by extraction with 10% HCl followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L038	D	MCERTS
Total Sulphur in soil as %	Determination of total sulphur in soil by extraction with aqua-regia, potassium bromide/bromate followed by ICP-OES.	In-house method based on BS1377 Part 3, 1990, and MEWAM 2006 Methods for the Determination of Metals in Soil	L038	W	MCERTS
Water Soluble Nitrate (2:1) as N in soil	Determination of nitrate by reaction with sodium salicylate and colorimetry.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08, 2:1 extraction.	L078-PL	W	NONE

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Environmental Science

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Analytical Report Number : 18-78298

Project / Site name:	Sutton St James	**Samples received on:**	07/03/2018
Your job number:	R17053	**Samples instructed on:**	07/03/2018
Your order number:		**Analysis completed by:**	16/03/2018
Report Issue Number:	1	**Report issued on:**	16/03/2018
Samples Analysed:	4 water samples		

Signed:

Nicole Fay
Quality Assistant
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Analytical i2 Environmental Science

Analytical Report Number: 18-78298

Project / Site name: Sutton St James

Lab Sample Number				920995	920996	920997	920998	
Sample Reference				WS1	WS4	WS8	WS9	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				1.80	2.00	1.30	1.00	
Date Sampled				06/03/2018	06/03/2018	06/03/2018	06/03/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
General Inorganics								
pH	pH Units	N/A	ISO 17025	7.7	7.6	7.4	7.3	
Total Cyanide	µg/l	10	ISO 17025	< 10	< 10	< 10	< 10	
Free Cyanide	µg/l	10	ISO 17025	< 10	< 10	< 10	< 10	
Sulphate as SO_4	µg/l	45	ISO 17025	7490	8030	104000	17000	
Sulphate as SO_4	mg/l	0.045	ISO 17025	7.5	8.0	104	17.0	
Chloride	mg/l	0.15	ISO 17025	32	32	45	25	
Fluoride	µg/l	50	ISO 17025	190	190	240	380	
Ammonium as NH_4	µg/l	15	ISO 17025	34	240	6900	3600	
Nitrate as N	mg/l	0.01	ISO 17025	< 0.01	0.01	0.04	0.75	
Nitrate as NO_3	mg/l	0.05	ISO 17025	< 0.05	0.05	0.16	3.34	
Nitrite as N	µg/l	1	ISO 17025	38	40	18	33	
Nitrite as NO_2	µg/l	5	ISO 17025	120	130	60	110	
Hardness - Total	mgCaCO3/l	1	ISO 17025	148	141	314	269	
Bromate by IC	mg/l	0.002	ISO 17025	< 0.002	< 0.002	< 0.002	< 0.002	
Total Phenols								
Total Phenols (monohydric)	µg/l	10	ISO 17025	< 10	< 10	< 10	< 10	
Speciated PAHs								
Naphthalene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Acenaphthylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Acenaphthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Fluorene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Phenanthrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Benzo(a)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Chrysene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Benzo(b)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Benzo(k)fluoranthene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Benzo(a)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Indeno(1,2,3-cd)pyrene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Dibenz(a,h)anthracene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Benzo(ghi)perylene	µg/l	0.01	ISO 17025	< 0.01	< 0.01	< 0.01	< 0.01	
Total PAH								
Total EPA-16 PAHs	µg/l	0.16	ISO 17025	< 0.16	< 0.16	< 0.16	< 0.16	

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Analytical i2
Environmental Science

Analytical Report Number: 18-78298

Project / Site name: Sutton St James

Lab Sample Number				920995	920996	920997	920998	
Sample Reference				WS1	WS4	WS8	WS9	
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	
Depth (m)				1.80	2.00	1.30	1.00	
Date Sampled				06/03/2018	06/03/2018	06/03/2018	06/03/2018	
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	
Analytical Parameter (Water Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Zinc (total)	µg/l	0.5	ISO 17025	14	18	1300	210	
Aluminium (dissolved)	ug/l	1	ISO 17025	43	110	140	43	
Antimony (dissolved)	µg/l	0.4	ISO 17025	0.9	0.5	0.7	1.1	
Arsenic (dissolved)	µg/l	0.15	ISO 17025	1.43	1.61	5.87	5.87	
Barium (dissolved)	µg/l	0.06	ISO 17025	53	59	17	25	
Boron (dissolved)	µg/l	10	ISO 17025	17	16	72	71	
Cadmium (dissolved)	µg/l	0.02	ISO 17025	0.04	< 0.02	0.04	0.03	
Calcium (dissolved)	mg/l	0.012	ISO 17025	50	48	100	85	
Chromium (hexavalent)	µg/l	5	ISO 17025	< 5.0	< 5.0	< 5.0	< 5.0	
Chromium (III)	µg/l	1	NONE	< 1.0	< 1.0	< 1.0	< 1.0	
Chromium (dissolved)	µg/l	0.2	ISO 17025	0.2	0.2	0.4	0.3	
Cobalt (dissolved)	µg/l	0.2	ISO 17025	0.3	0.3	2.1	0.6	
Copper (dissolved)	µg/l	0.5	ISO 17025	8.4	6.2	7.3	25	
Iron (dissolved)	mg/l	0.004	ISO 17025	0.50	0.20	0.11	0.19	
Lead (dissolved)	µg/l	0.2	ISO 17025	1.0	1.5	0.7	0.4	
Magnesium (dissolved)	mg/l	0.005	ISO 17025	5.5	5.5	15	14	
Manganese (dissolved)	µg/l	0.05	ISO 17025	38	20	500	110	
Mercury (dissolved)	µg/l	0.05	ISO 17025	< 0.05	< 0.05	< 0.05	< 0.05	
Molybdenum (dissolved)	µg/l	0.05	ISO 17025	1.7	1.4	5.9	7.2	
Nickel (dissolved)	µg/l	0.5	ISO 17025	1.9	1.7	4.0	7.1	
Selenium (dissolved)	µg/l	0.6	ISO 17025	1.2	1.1	1.5	1.6	
Silver (dissolved)	µg/l	0.05	NONE	0.12	0.11	< 0.05	< 0.05	
Sodium (dissolved)	mg/l	0.01	ISO 17025	13	12	31	17	
Tin (dissolved)	µg/l	0.2	ISO 17025	0.31	< 0.20	< 0.20	< 0.20	
Vanadium (dissolved)	µg/l	0.2	ISO 17025	1.1	1.5	3.2	7.1	
Zinc (dissolved)	µg/l	0.5	ISO 17025	12	11	10	12	

U/S = Unsuitable Sample I/S = Insufficient Sample

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Analytical i2
Environmental Science

Analytical Report Number : 18-78298

Project / Site name: Sutton St James

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Ammonium as NH4 in water	Determination of Ammonium/Ammonia/ Ammoniacal Nitrogen by the colorimetric salicylate/nitroprusside method. Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Boron in water	Determination of boron in water by acidification followed by ICP-OES. Accredited matrices: SW PW GW	In-house method based on MEWAM	L039-PL	W	ISO 17025
Bromate in Water	Determination of bromate in waters based on ion chromatography. Accredited matrices GW, PW, SW.	In house method based on Standard Methods for the Analysis of Water and Waste Water, method 4500	L008-PL	W	ISO 17025
Chloride in water	Determination of Chloride colorimetrically by discrete analyser.	In house based on MEWAM Method ISBN 0117516260. Accredited matrices: SW, PW, GW.	L082-PL	W	ISO 17025
Cr (III) in water	In-house method by calculation from total Cr and Cr VI.	In-house method by calculation	L080-PL	W	NONE
Fluoride in water	Determination of fluoride in water by 1:1 ratio with a buffer solution followed by Ion Selective Electrode. Accredited matrices: SW, PW, GW.	In-house method based on Use of Total Ionic Strength Adjustment Buffer for Electrode Determination"	L033B-PL	W	ISO 17025
Free cyanide in water	Determination of free cyanide by distillation followed by colorimetry.Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Hexavalent chromium in water	Determination of hexavalent chromium in water by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method by continuous flow analyser. Accredited Matrices SW, GW, PW.	L080-PL	W	ISO 17025
Metals in water by ICP-MS (dissolved)	Determination of metals in water by acidification followed by ICP-MS. Accredited Matrices: SW, GW, PW except B=SW,GW, Hg=SW,PW, Al=SW,PW.	In-house method based on USEPA Method 6020 & 200.8 "for the determination of trace elements in water by ICP-MS.	L012-PL	W	ISO 17025
Metals in water by ICP-OES (dissolved)	Determination of metals in water by acidification followed by ICP-OES. Accredited Matrices SW, GW, PW, PrW.(Al, Cu,Fe,Zn).	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Monohydric phenols in water	Determination of phenols in water by continuous flow analyser. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (skalar)	L080-PL	W	ISO 17025
Nitrate as N in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
Nitrate in water	Determination of nitrate by reaction with sodium salicylate and colorimetry. Accredited matrices SW, GW, PW	In-house method based on Examination of Water and Wastewatern & Polish Standard Method PN-82/C-04579.08,	L078-PL	W	ISO 17025
Nitrite as N in water	Determination of nitrite in water by addition of sulphanilamide and NED followed by discrete analyser (colorimetry). Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
Nitrite in water	Determination of nitrite in water by addition of sulphanilamide and NED followed by discrete analyser (colorimetry).Accredited matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L082-PL	W	ISO 17025
pH at 20oC in water (automated)	Determination of pH in water by electrometric measurement. Accredited matrices: SW PW GW	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	W	ISO 17025

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Analytical i2 Environmental Science

Analytical Report Number : 18-78298

Project / Site name: Sutton St James

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Speciated EPA-16 PAHs in water	Determination of PAH compounds in water by extraction in dichloromethane followed by GC-MS with the use of surrogate and internal standards. Accredited matrices: SW PW GW	In-house method based on USEPA 8270	L102B-PL	W	ISO 17025
Sulphate in water	Determination of sulphate in water by acidification followed by ICP-OES. Accredited matrices: SW PW GW, PrW.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L039-PL	W	ISO 17025
Total cyanide in water	Determination of total cyanide by distillation followed by colorimetry. Accredited matrices: SW PW GW	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton (Skalar)	L080-PL	W	ISO 17025
Total Hardness of water	Determination of hardness in waters by calculation from calcium and magnesium. Accredited Matrices SW, GW, PW.	In-house method based on Examination of Water and Wastewater 20th Edition: Clesceri, Greenberg & Eaton	L045-PL	W	ISO 17025

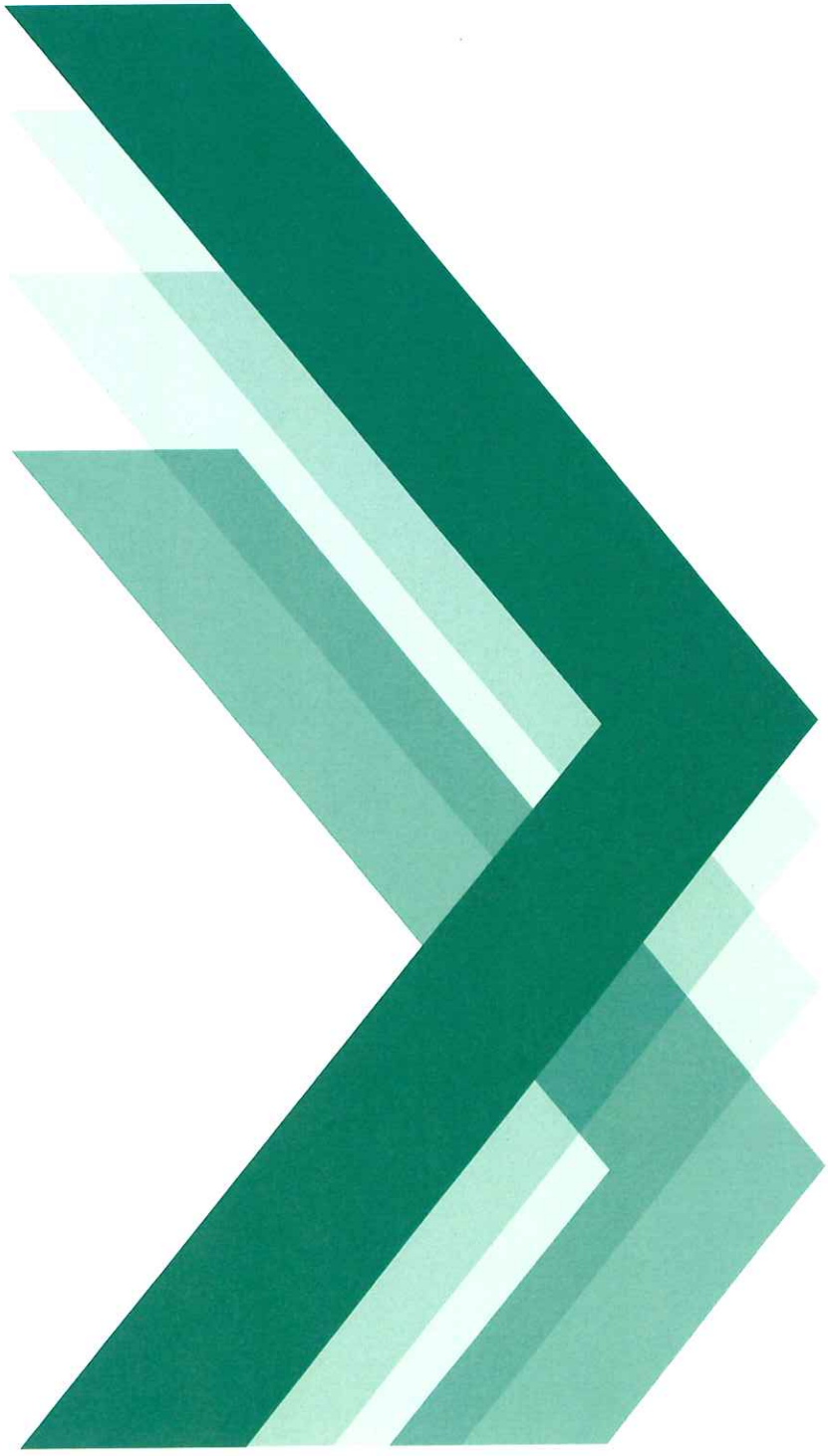
For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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HEALTH & SAFETY LABORATORY

Microbiology Team:

Anthrax Analysis: Sutton St James, Chapel Gate, Sutton St. James, Lincolnshire



Author(s): Steve Stagg

Report Number: 18-3009

HEALTH & SAFETY LABORATORY

Microbiology Team:

Anthrax Analysis: Sutton St James, Chapel Gate, Sutton St. James. Lincolnshire

Reviewed and approved for issue by:	Brian Crook
Date of Issue:	9/2/18
Work carried out by:	Steve Stagg
Customer:	Andrew Hare 43 Winchilsea Avenue Newark NG24 4AD Andrew.hare@grangegeo.co.uk 07773 529385
Project number:	PE11501

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Background

The Health and Safety Laboratory (HSL) received five soil samples on 06/2/18 for microbiological analysis of *Bacillus anthracis*, the causative agent of anthrax. Microbiological work was performed within our Containment Level 3 facility using HSL's standard operating procedure for anthrax detection. This method uses a combined approach of culture-based and DNA-based assessment.

Method

Approximately 10 g of each sample was dispersed in 90 ml sterile distilled water and heat treated at 70°C for 15 minutes to help eliminate non-spore forming background contaminants. An aliquot of each sample was then used to inoculate blood agar plates, which were incubated overnight to allow growth of any *B. anthracis*. Nutrient broth was added to the remainder of each sample and it was incubated overnight to enrich any bacteria present in the sample. Enriched broth and any emerging colonies indicative of *B. anthracis* were analysed separately the following day using molecular tests, to confirm the presence or absence of *B. anthracis*. DNA was extracted from the sample of broth or suspected bacterial colonies, and used in quantitative polymerase chain reaction (qPCR). The method employed is used commonly by HSL, Public Health England (PHE) and is endorsed by the World Health Organisation (WHO). The PCR reaction targets a region of the lethal factor gene located on the pXO1 plasmid and a capsular gene located on the pXO2 plasmid; both are carried by fully virulent strains of anthrax. Presence of any amplified DNA in the test sample was compared against positive and negative PCR controls.

Results

Full test data are as follows:

HSL code	Client sample number	Sample description	Result
1800522	WS-6 0.5	Soil sample from 0.5m	Negative
1800523	WS-7 0.4	Soil sample from 0.4m	Negative
1800524	WS-7 1.5	Soil sample from 1.5m	Negative
1800525	WS-11 0.5	Soil sample from 0.5m	Negative
1800526	WS-11 1.4	Soil sample from 1.4m	Negative

Conclusion

No evidence of *Bacillus anthracis* (causative agent of anthrax) was found in the samples sent for analysis, either by real-time PCR assay or supportive culture-based analysis.

HEALTH & SAFETY LABORATORY

HSL: HSE's Health and Safety Laboratory is one of the world's leading providers of health and safety solutions to industry, government and professional bodies.

The main focus of our work is on understanding and reducing health and safety risks. We provide health and safety expert advice and consultancy, research, specialist training and products.

At HSL, we have been developing health and safety solutions for over 100 years. Our long history means that we're well placed to understand the changing health and safety landscape, and anticipate future issues.

We employ over 450 scientific, medical and technical specialists, including occupational health and risk management experts to help our clients manage a wide range of issues in workplace health and safety.

ISO 9001 ISO 14001 OHSAS 18001

Health and Safety Laboratory
Harpur Hill
Buxton
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SK17 9JN
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www.hsl.gov.uk

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STANSTED LABORATORIES

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27 Thames Road
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Tel: +44 (0)20 8594 5104
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sales@stanstedlabs.co.uk
www.stanstedlabs.co.uk

Directors: B. Patel, K.Patel

Client: Grange Geo
Address: 43 Winchilsea Avenue
NG24 4AD

Site: Kirk Homes, Spalding, PE11 3YR
FAO:
Order No:

Job Number: M/1870/51482
Report No.: 54614.1
Date Taken: Mon, 5th Feb 2018 08:30
Date Rec'd: Tues, 6th Feb 2018

UKAS TESTING
2266

Items Marked ¤ are not included in the UKAS Schedule

Sample ID	Description & Temperatures	Analysis	Result	Tested	Notes / Species
SL234116 *Soil*	WS6 at 0.5m Init Temp ¤ Temp > 1 Min ¤ Temp > 2 Min ¤	Salmonella ¤ §	ND in 25g	6/2/2018	
SL234117 *Soil*	WS7 at 1.5m Init Temp ¤ Temp > 1 Min ¤ Temp > 2 Min ¤	Salmonella ¤ §	ND in 25g	6/2/2018	
SL234118 *Soil*	WS11 at 0.5m Init Temp ¤ Temp > 1 Min ¤ Temp > 2 Min ¤	Salmonella ¤ §	ND in 25g	6/2/2018	
SL234119 *Soil*	WS11 at 1.4m Init Temp ¤ Temp > 1 Min ¤ Temp > 2 Min ¤	Salmonella ¤ §	ND in 25g	6/2/2018	

Method Codes
-

Legend & Footnotes
cfu = Colony Forming Units
mpn = Most Probable Number
TNTC = Too Numerous to Count

§ Subcontracted Test

Sampling is not included in our UKAS Schedule.
All Samples Analysed as received.

Test report authorised by :
B.Patel

Director
Date: 08/02/2018 14:21:42

Test Report checked by : Theepa Supikaran
08/02/2018 09:47:15

Disclaimer
Results relate to water samples tested and should not be reproduced except in full, without the written approval of the laboratory. Interpretations and opinions are not included in our UKAS schedule.
00:00 means time not declared.

------ END OF REPORT ------

Reg. Office: Unit 9-10 Riverside Ind. Estate, 27 Thames Road, Barking, Essex, IG11 0NI
Reg. in England No. 7270283

Appendix H

GEOTECHNICAL TESTING RESULTS

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

Client: Grange Geo Consulting Ltd
Client Address: 43 Winchilsea Avenue
Newark
Notts
NG24 4AD
Contact: Andrew Hare
Site Name: Sutton St James
Site Address: Not Given

Client Reference: R17053
Job Number: 18-74870
Date Sampled: Not Given
Date Received: 01/02/2018
Date Tested: 09/02/2018
Sampled By: Not Given

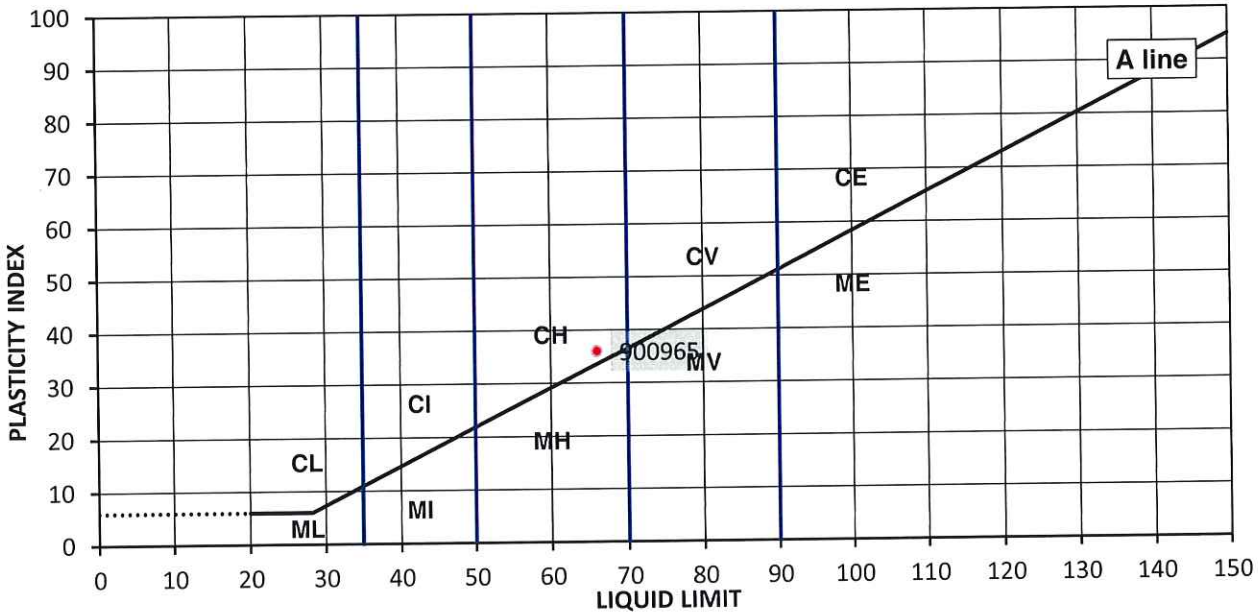
TEST RESULTS

Laboratory Reference: 900965
Sample Reference: Not Given

Description: Brown CLAY
Location: WS2
Sample Preparation: Tested in natural condition

Sample Type: D
Depth Top [m]: 0.60
Depth Base [m]: Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
31	66	30	36	100



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 13/02/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

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The results included within the report are representative of the samples submitted for analysis.
The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland."

GF 105.1

TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

Client:	Grange Geo Consulting Ltd	Client Reference:	R17053
Client Address:	43 Winchilsea Avenue Newark Notts NG24 4AD	Job Number:	18-74870
		Date Sampled:	Not Given
		Date Received:	01/02/2018
Contact:	Andrew Hare	Date Tested:	09/02/2018
Site Name:	Sutton St James	Sampled By:	Not Given
Site Address:	Not Given		

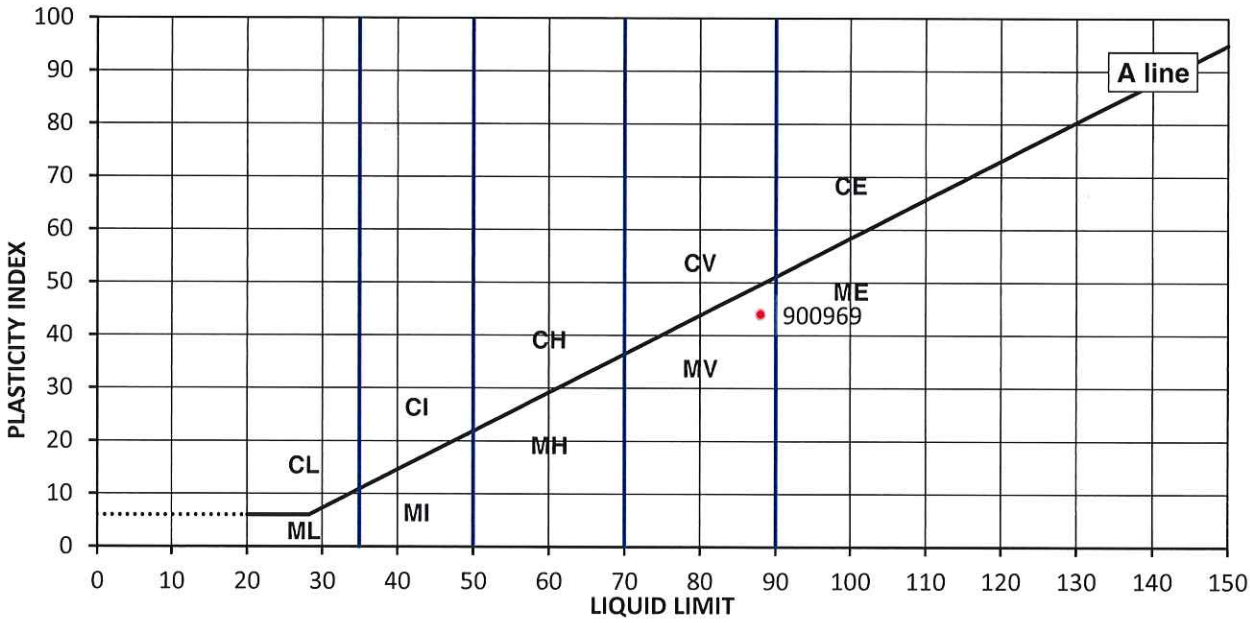
TEST RESULTS

Laboratory Reference: 900969
Sample Reference: Not Given

Description: Black CLAY
Location: WS9
Sample Preparation: Tested in natural condition

Sample Type: D
Depth Top [m]: 1.00
Depth Base [m]: Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
57	88	44	44	100



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 13/02/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Determination of Liquid and Plastic Limits

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377-2: 1990: Clause 4.4 & 5: One Point Method

Client: Grange Geo Consulting Ltd
Client Address: 43 Winchilsea Avenue
Newark
Notts
NG24 4AD
Contact: Andrew Hare
Site Name: Sutton St James
Site Address: Not Given

Client Reference: R17053
Job Number: 18-74870
Date Sampled: Not Given
Date Received: 01/02/2018
Date Tested: 09/02/2018
Sampled By: Not Given

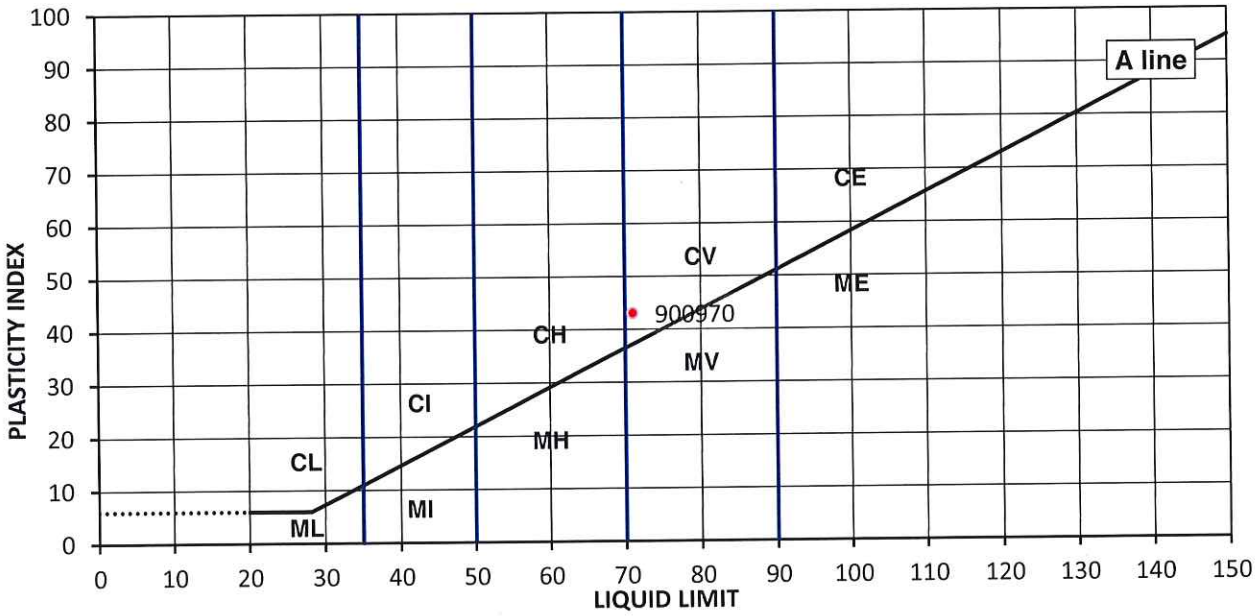
TEST RESULTS

Laboratory Reference: 900970
Sample Reference: Not Given

Description: Brown CLAY
Location: WS6
Sample Preparation: Tested in natural condition

Sample Type: D
Depth Top [m]: 1.00
Depth Base [m]: Not Given

As Received Moisture Content [%]	Liquid Limit [%]	Plastic Limit [%]	Plasticity Index [%]	% Passing 425µm BS Test Sieve
37	71	28	43	100



Legend, based on BS 5930:2015 Code of practice for site investigations

		Plasticity		Liquid Limit
C	Clay	L	Low	below 35
M	Silt	I	Medium	35 to 50
		H	High	50 to 70
		V	Very high	70 to 90
		E	Extremely high	exceeding 90
	Organic	O	append to classification for organic material (eg CHO)	

Remarks

Approved:

Dariusz Piotrowski
PL Laboratory Manager Geotechnical Section
Date Reported: 13/02/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

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GF 105.

TEST CERTIFICATE

Summary of Classification Test Results

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

Environmental Science

Client: Grange Geo Consulting Ltd
Client Address: 43 Winchilsea Avenue
Newark
Notts
NG24 4AD
Contact: Andrew Hare
Site Name: Sutton St James
Site Address: Not Given

Client Reference: R17053
Job Number: 18-74870
Date Sampled: Not Given
Date Received: 01/02/2018
Date Tested: 09/02/2018
Sampled By: Not Given

Test results

Laboratory Reference	Hole No.	Sample				Soil Description	Density		M/C	Atterberg				PD
		Reference	Top depth [m]	Base depth [m]	Type		bulk Mg/m3	dry Mg/m3	%	% Passing 425um %	LL %	PL %	PI %	Mg/m3
900965	WS2	Not Given	0.60	Not Given	D	Brown CLAY			31	100	66	30	36	
900970	WS6	Not Given	1.00	Not Given	D	Brown CLAY			37	100	71	28	43	
900969	WS9	Not Given	1.00	Not Given	D	Black CLAY			57	100	88	44	44	

Comments:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Date Reported: 13/02/2018

Signed:

Darren Berrill
Geotechnical General Manager

for and on behalf of i2 Analytical Ltd

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GF 159

TEST CERTIFICATE

Determination of Particle Size Distribution

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Tested in Accordance with BS1377:Part 2:1990, clauses 9.2 and 9.5

Client:	Grange Geo Consulting Ltd	Client Reference:	R17053
Client Address:	43 Winchilsea Avenue Newark Notts NG24 4AD	Job Number:	18-74870
		Date Sampled:	Not Given
		Date Received:	01/02/2018
Contact:	Andrew Hare	Date Tested:	09/02/2018
Site Name:	Sutton St James	Sampled By:	Not Given
Site Address:	Not Given		

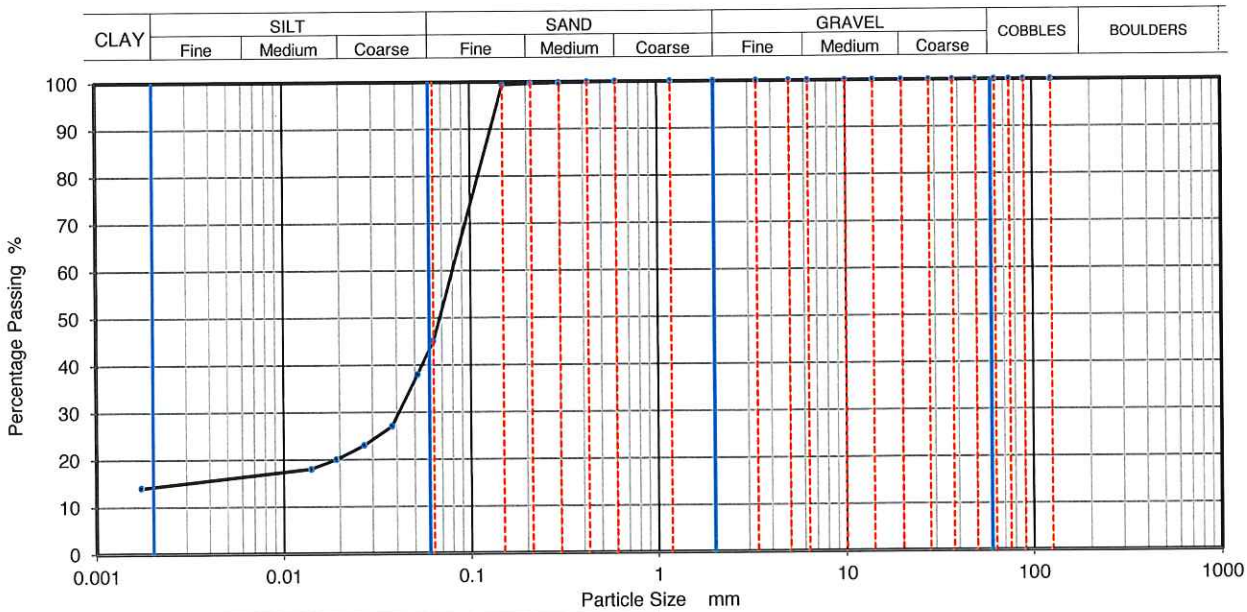
TEST RESULTS Laboratory Reference: 900963

Sample description: Brown clayey very silty SAND

Location: WS1

Supplier: Not Given

Sample Reference: Not Given
Sample Type: B
Depth Top [m]: 1.20
Depth Base [m]: Not Given



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	45
90	100	0.0519	38
75	100	0.0378	27
63	100	0.0270	23
50	100	0.0192	20
37.5	100	0.0141	18
28	100	0.0017	14
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100	Particle density (assumed)	
0.425	100	2.65	Mg/m3
0.3	100		
0.212	100		
0.15	99		
0.063	45		

Dry Mass of sample [g]: 157

Sample Proportions	% dry mass
Very coarse	0.00
Gravel	0.00
Sand	54.90
Silt	31.30
Clay	13.80

Grading Analysis		
D100	mm	2
D60	mm	0.0799
D30	mm	0.041
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Darren Berrill
Geotechnical General Manager

Date Reported: 13/02/2018

for and on behalf of i2 Analytical Ltd

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GF 100.8

TEST CERTIFICATE

Determination of Particle Size Distribution

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

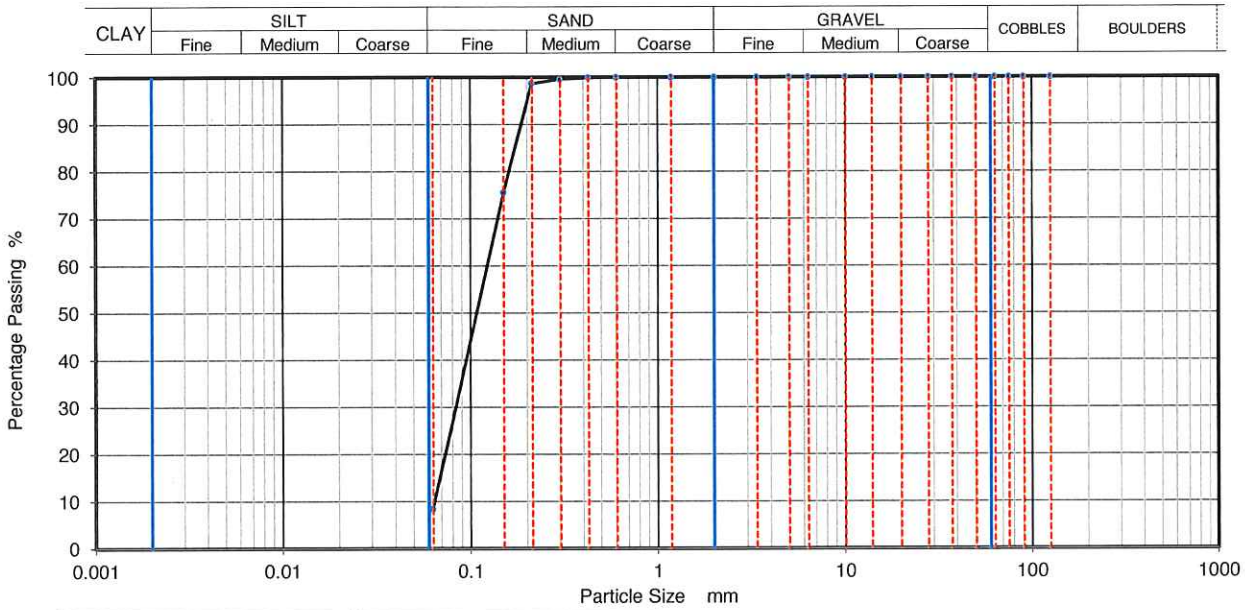
UKAS TESTING 4041

Tested in Accordance with BS1377:Part 2:1990, clause 9.2

Client:	Grange Geo Consulting Ltd	Client Reference:	R17053
Client Address:	43 Winchilsea Avenue Newark Notts NG24 4AD	Job Number:	18-74870
		Date Sampled:	Not Given
		Date Received:	01/02/2018
Contact:	Andrew Hare	Date Tested:	09/02/2018
Site Name:	Sutton St James	Sampled By:	Not Given
Site Address:	Not Given		

TEST RESULTS Laboratory Reference: 900964

Sample description:	Brown clayey SAND	Sample Reference:	Not Given
Location:	WS1	Sample Type:	D
Supplier:	Not Given	Depth Top [m]:	3.50
		Depth Base [m]:	Not Given



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100		
0.425	100		
0.3	100		
0.212	99		
0.15	76		
0.063	8		

Dry Mass of sample [g]: 166

Sample Proportions	% dry mass
Very coarse	0.00
Gravel	0.00
Sand	91.60
Fines <0.063mm	8.40

Grading Analysis		
D100	mm	2
D60	mm	0.123
D30	mm	0.0833
D10	mm	0.0643
Uniformity Coefficient		1.9
Curvature Coefficient		0.88

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Darren Berrill
Geotechnical General Manager

Date Reported: 13/02/2018

for and on behalf of i2 Analytical Ltd

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TEST CERTIFICATE

Determination of Particle Size Distribution

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

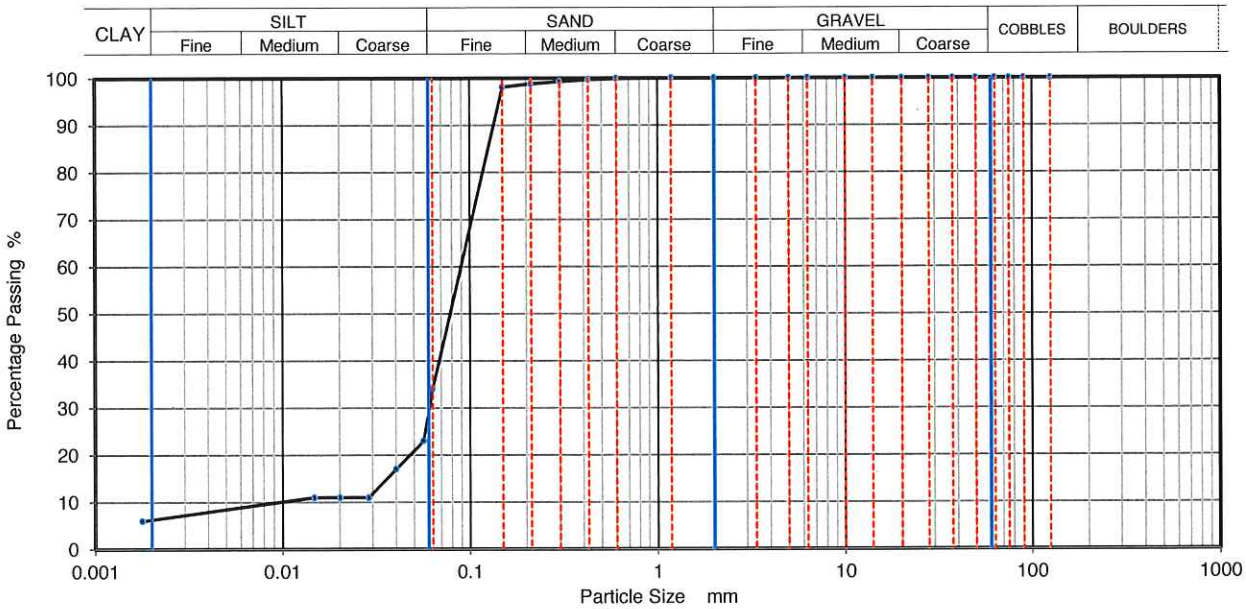
4041

Tested in Accordance with BS1377:Part 2:1990, clauses 9.2 and 9.5

Client:	Grange Geo Consulting Ltd	Client Reference:	R17053
Client Address:	43 Winchilsea Avenue Newark Notts NG24 4AD	Job Number:	18-74870
		Date Sampled:	Not Given
		Date Received:	01/02/2018
Contact:	Andrew Hare	Date Tested:	09/02/2018
Site Name:	Sutton St James	Sampled By:	Not Given
Site Address:	Not Given		

TEST RESULTS Laboratory Reference: 900968

Sample description:	Brown slightly clayey very silty SAND	Sample Reference:	Not Given
Location:	WS8	Sample Type:	D
Supplier:	Not Given	Depth Top [m]:	1.50
		Depth Base [m]:	Not Given



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0630	34
90	100	0.0564	23
75	100	0.0401	17
63	100	0.0285	11
50	100	0.0202	11
37.5	100	0.0147	11
28	100	0.0018	6
20	100		
14	100		
10	100		
6.3	100		
5	100		
3.35	100		
2	100		
1.18	100		
0.6	100	Particle density (assumed)	
0.425	100	2.65	Mg/m3
0.3	99		
0.212	99		
0.15	98		
0.063	34		

Dry Mass of sample [g]: 192

Sample Proportions	% dry mass
Very coarse	0.00
Gravel	0.00
Sand	65.90
Silt	28.10
Clay	6.00

Grading Analysis		
D100	mm	2
D60	mm	0.0895
D30	mm	0.0605
D10	mm	0.00886
Uniformity Coefficient		10
Curvature Coefficient		4.6

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Darren Berrill
Geotechnical General Manager

Date Reported: 13/02/2018

for and on behalf of i2 Analytical Ltd

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GF 100.8

TEST CERTIFICATE

Determination of California Bearing Ratio

Tested in Accordance with BS 1377-4: 1990: Clause 7

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

UKAS TESTING 4041

Client:	Grange Geo Consulting Ltd	Client Reference:	R17053
Client Address:	43 Winchilsea Avenue Newark Notts NG24 4AD	Job Number:	18-74870
		Date Sampled:	Not Given
		Date Received:	01/02/2018
Contact:	Andrew Hare	Date Tested:	09/02/2018
Site Name:	Sutton St James	Sampled By:	Not Given
Site Address:	Not Given		

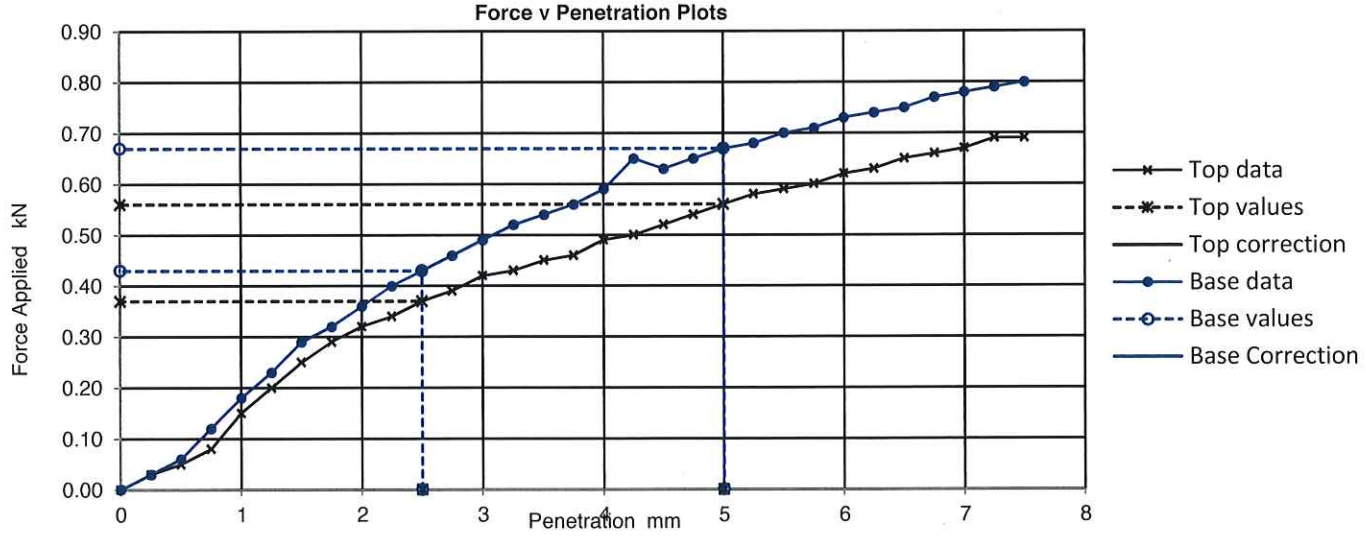
Test Results:

Laboratory Reference:	900966	Depth Top [m]:	0.50
Hole No.:	WS3	Depth Base [m]:	1.00
Sample Reference:	Not Given	Sample Type:	B

Specimen Preparation:

Condition	Remoulded			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
Sample Description:	Brown slightly sandy CLAY			Amount of swell recorded		mm
Material retained on 20mm sieve removed		0	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	1.84	Mg/m3	Surcharge applied	8	kg
	Dry density	1.37	Mg/m3		4.9	kPa
	Moisture content	34	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP	No	2.8	2.8	2.8	3.1	33
BASE	No	3.3	3.4	3.4		32

Remarks:

Test/ Specimen specific remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Darren Berrill
Geotechnical General Manager

Date Reported: 13/02/2018

for and on behalf of i2 Analytical Ltd

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GF 8.

TEST CERTIFICATE

Determination of California Bearing Ratio

Tested in Accordance with BS 1377-4: 1990: Clause 7

UKAS TESTING 4041

i2 Analytical Ltd
7 Woodshots Meadow
Croxley Green Business Park
Watford Herts WD18 8YS

Client:	Grange Geo Consulting Ltd	Client Reference:	R17053
Client Address:	43 Winchilsea Avenue Newark Notts NG24 4AD	Job Number:	18-74870
		Date Sampled:	Not Given
		Date Received:	01/02/2018
Contact:	Andrew Hare	Date Tested:	09/02/2018
Site Name:	Sutton St James	Sampled By:	Not Given
Site Address:	Not Given		

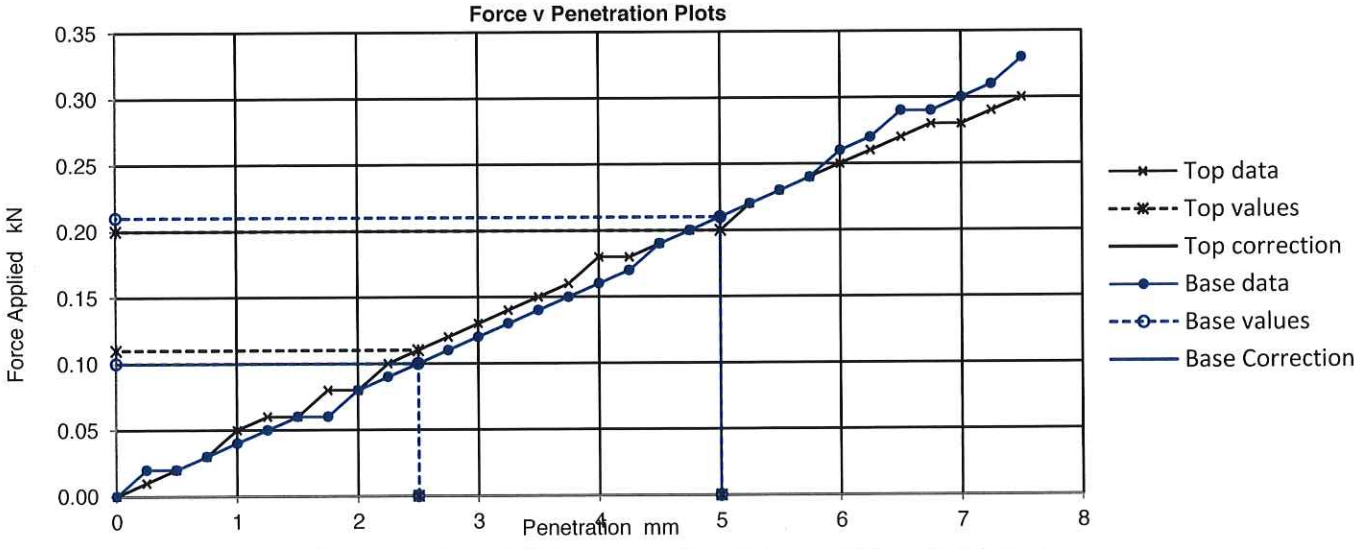
Test Results:

Laboratory Reference:	900967	Depth Top [m]:	0.50
Hole No.:	WS4	Depth Base [m]:	1.00
Sample Reference:	Not Given	Sample Type:	B

Specimen Preparation:

Condition	Remoulded			Soaking details	Not soaked	
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking		days
				Time to surface		days
Sample Description:	Mottled brown sandy CLAY			Amount of swell recorded		mm
Material retained on 20mm sieve removed		0	%	Dry density after soaking		Mg/m3
Initial Specimen details	Bulk density	1.90	Mg/m3	Surcharge applied	8	kg
	Dry density	1.39	Mg/m3		4.8	kPa
	Moisture content	37	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, %				Moisture Content %
		2.5mm	5mm	Highest	Average	
TOP	No	0.8	1.0	1.0	1.0	30
BASE	No	0.8	1.1	1.1		26

Remarks:

Test/ Specimen specific remarks:

Approved:

Dariusz Piotrowski
PL Laboratory Manager
Geotechnical Section

Signed:

Darren Berrill
Geotechnical General Manager

Date Reported: 13/02/2018

for and on behalf of i2 Analytical Ltd

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The results included within the report are representative of the samples submitted for analysis.
The analysis was carried out at i2 Analytical Limited, ul. Pionierow 39, 41-711 Ruda Slaska, Poland."