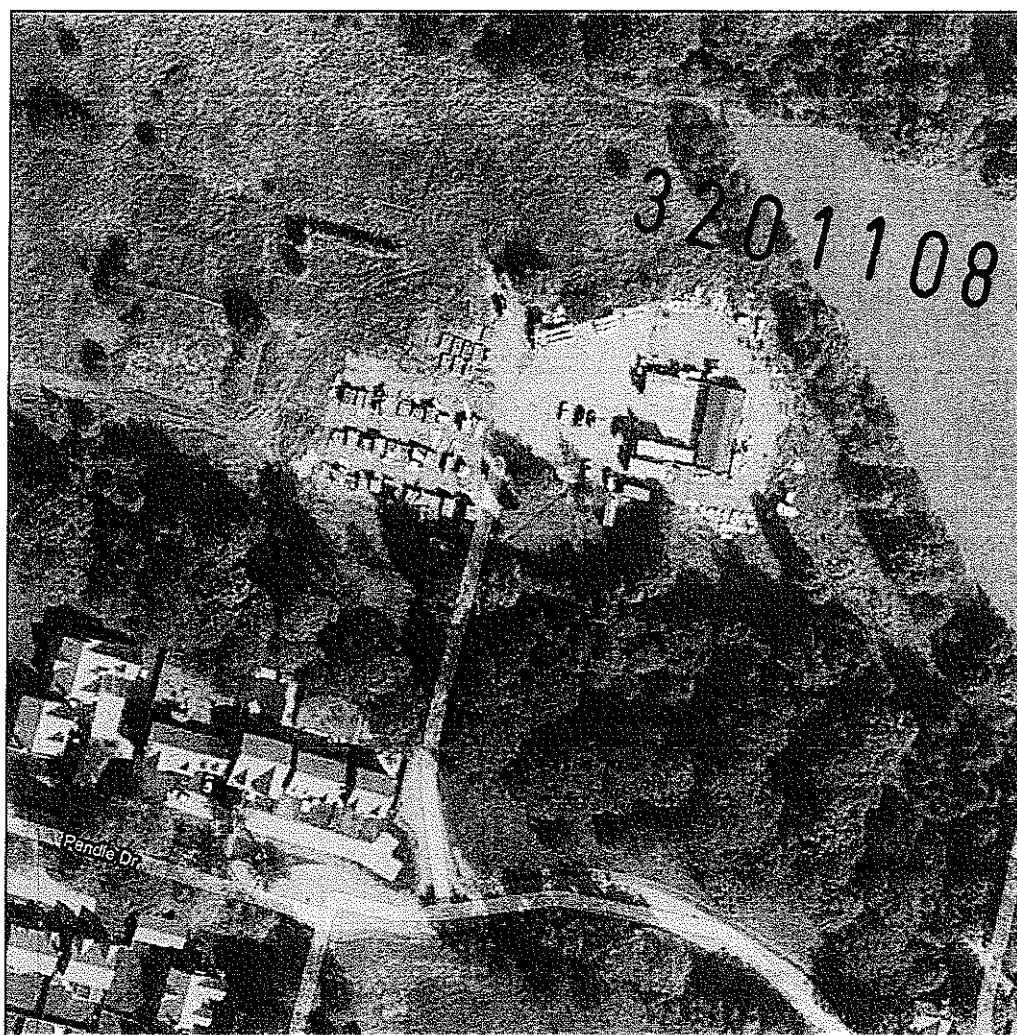


Report No	Date
25608E/R1	February 2011
Project	Preliminary Phase 2 Geoenvironmental Assessment at Phase 3 Calderstones Park, Whalley BB7 9JT
Client	Taylor Wimpey Manchester Limited



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**Taylor
Wimpey**

Report No:	Date:
25608E/R1	February 2011

Project:
Preliminary Phase 2 Geoenvironmental Assessment at Phase 3 Calderstones Park, Whalley BB7 9JT

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Issue Number	Status	Description of Amendments
R1	Draft	

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Approved for issue by:	
Signed: 	Mark Newton Regional Director

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1.0 INTRODUCTION

1.1 Instruction

Clarke Bond North Limited (Clarke Bond) has been commissioned by Dean Harrison of Taylor Wimpey Manchester Limited to undertake a Preliminary Phase 2 Geoenvironmental Assessment of land situated 50m North of Pendle Drive, Whalley BB7 9JT. It is understood that this assessment is part of a pre-acquisition survey and the property is to be developed for residential purposes comprising approximately 50 two-storey houses with associated gardens, car parking, landscaped areas and access roads.

1.2 Background

Previous assessments conducted upon the site comprise the following; which should be read in conjunction with this study.

- Phase 1 and 2 Geoenvironmental Site Investigation Report at Calderstones Park by RSK Group PLC (16372-R1 0) dated 4th of June 2010
- Plot B1 Calderstones Hospital – Borehole Assessment by Strata Surveys Limited (ref NFJ/L13687 17072006 doc) dated 17th of July 2006
- Site Check Data report on land at Calderstones Hospital by Landmark (ref SCPRO-23698251-1-1) dated 29th November 2007
- Plan Search report on land at Calderstones Hospital by Landmark (ref PSC-21960143-1-1) dated 26th June 2007

The RSK Group Phase 1 Geoenvironmental Assessment incorporated a review of public available information; including historic mapping, geological mapping and an environmental database. Based on this review, a Preliminary Conceptual Site Model (PCSM) will be produced for the site, which identified potentially significant source-pathway-receptor pollutant linkages which identified potentially significant source-pathway-receptor pollutant linkages.

Clarkebond have been granted permission by Taylor Wimpey Manchester Limited to utilise the information within the above report so that a suitable preliminary Geoenvironmental risk assessment and conceptual model can be developed for the site; to facilitate the site investigation design.

1.3 Objectives

The objectives of the preliminary site investigation were as follows:

- To provide information on ground conditions to facilitate design of foundations and site infra-structure for the proposed development
- To conduct a semi-quantitative assessment of potential risks from contaminants to human health and/or controlled waters, comprising a Refined Conceptual Model
- Provide preliminary recommendations regarding any remedial measures necessary to mitigate any risks to human health or controlled waters resulting from contamination on the site; or recommendations for any further work

1.4 Scope of Work

The overall scope of the current work included the following:

- Formation of 4no. window sample boreholes to depths circa 5.00m bgl.

- Formation of 1no cable tool boreholes to depth circa 11.00m bgl
- Formation of 9no Trial pits to depth circa 3.00m bgl.
- Formation of 2no soakaway tests in line with BRE 365 Soakaway Design.
- Installation of 4no combined gas and water monitoring wells
- Collection of samples for limited chemical and geotechnical laboratory testing.
- Preparation of a fully interpretative report outlining findings and recommendations

1.5 Report Layout

Section 2 of this report provides a summary of the Phase 1 desk study findings; including the site history, as established from available public record information/previous assessments by others

Section 3 presents a preliminary Conceptual Model for the site and site characterisation attempts to identify potential previous and existing site sources of contamination

Section 4 details the intrusive investigation carried out to validate the conceptual model

Section 5, 6 & 7 details the geotechnical conditions identified by the investigation and makes recommendations for foundation design in respect of the proposed development

Section 8 presents the records of the chemical analyses undertaken and gives the results of the qualitative risk assessment carried out using the results of the chemical analyses and taking account of the proposed end use of the site

Section 9 provides conclusions and recommendations arising from this investigation.

1.6 Limitations

The accuracy of the data supplied by third parties should be considered in the context of any known site conditions for which Clarke Bond cannot be held liable

The comments made in this report are based on the data available at the time of its completion. Any unusual or conflicting evidence discovered during any future site works must be presented to Clarke Bond as soon as possible so that any implications may be considered

This report has been produced by Clarke Bond for the client solely for the purposes of a review of information for the above mentioned site. It may not be used by any person for any other purpose other than that specified without the express written permission of Clarke Bond. Any liability arising out of its use by a third party for purposes not wholly connected with the above shall be the responsibility of that party who shall indemnify Clarke Bond against all claims costs damages and losses arising out of such use

In addition to the above it should be noted that when investigating or developing potentially contaminated sites, sub-surface conditions might vary both spatially and over time. Whilst this investigation and subsequent interpretation has been undertaken to reasonably characterise current sub-surface conditions at the site within the scope of works and agreed budget, the absence of certain ground, contamination or groundwater conditions at the individual locations is not a guarantee that these conditions do not exist elsewhere on the site. Additional information, changes in legislation or revised practices may necessitate re-interpretation of part or all of this report

Unless specifically noted to the contrary, it should be assumed that this report has not been submitted to any regulatory authorities for approval. Redevelopment sites in particular may have planning conditions attached in respect of contaminated land assessment. Where we are made aware of such conditions in advance of scoping the works, we can tailor the report to the regulatory authority requirements. Where we are not made aware of any such requirements

there can be no certainty that our investigation will meet any or all of the regulatory authority requirements

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2.0 PHASE 1 ASSESSMENT

2.1 Site Location

The site is situated within Calderstones Park, Whalley at National Grid Reference (NGR) 372540, 437521 Access to the site is gained via a chain link fence from Pendle Drive to the south

A Site Location Plan and site layout drawing is presented as Figure 01 in Appendix A

2.2 Site Description

The site description has been established from a walkover survey conducted on 24th of January 2011 by Clarkebond Staff The site layout drawing (Figure 2) presented in Appendix A, should be read in conjunction with this site description

The site is triangular shaped, generally level and covers an area of approximately 2.11 hectares The site currently comprises an area of scrub and marsh land with an area of low grade tarmac situated centrally to the site A number of semi-mature trees are located around the site with a larger area of protected mature woodland present in the south.

Overhead telegraph poles are present along the northern and eastern boundaries. Numerous existing and relic services cross the site and the design team should make themselves familiar with the presence Anecdotal evidence suggests that former underground tunnels used as service runs may be present within the area and conversations with the site vendor and local authority are recommended to confirm or discount their presence.

The site is bounded to the east by residential properties, to the north by a public footpath, and existing line of trees; to the west by scrub and marsh land (currently utilised by dog walkers); and to the south by Pendle Drive

The surrounding area comprises a mix of residential properties, agricultural farmland and scrub/marsh land. The residential properties close to the site are positioned along Pendle Drive to the south and Mitton Road to the east The existing Taylor Wimpey construction site is located to the south

No evidence of sources of potential contamination or invasive plant species such as Japanese Knotweed was noted during the site walkover The area of tarmac hardstanding and track leading from Pendle Drive suggests that relic infrastructure once occupied the site; which should be clarified within the historical map review.

2.3 Geology & Coal Authority

The geology of the site is shown on the 1:50,000 scale British Geological Survey maps obtained within the RSK Group Report which are extracted from the British Geological Survey Digital Geological Map of Great Britain at 1:50,000 scale and are summarised as follows:

- Superficial deposits consisting of Devensian Till (Boulder Clay).
- Bedrock comprises the Clitheroe Limestone Formation and Hodder Mudstone Formation (undifferentiated)

No faults are identified within 500m of the site boundary

The site is not indicated to be within an area of known coal mining or brine mining as stipulated by the Coal Authority. The site is not indicated to be within a radon affected area, as less than 1% of homes are above the action level; no radon protective measures are necessary in the construction of new dwellings or extensions

2.4 Hydrogeology & Hydrology

Records indicate the nearest surface water feature to the site is a drain, approximately 300m to the south of the site. Other drains/streams are present between 350m and 600m to the south east of the site. A pond is present approximately 300m to the north west. The River Calder and Barrow Brook are present approximately 800m to the south west and north of the site, respectively

The River Calder, in a reach approximately 800m to the south west, is classified as having River Quality C grade water (fair). The risk to surface water features and/or main rivers is therefore considered low.

There is one surface water abstraction within approximately 600m east of the site listed as an impounded stream for Clitheroe Golf Club.

Guidance from the Environment Agency indicates that the bedrock underlying the site is deemed to be a minor aquifer overlain by soils of a low leaching potential. There are no records of groundwater and/or surface water abstraction licenses within 1000m of the site, and is not listed within an EA defined source protection zone.

As such the site sensitivity to groundwater receptors is deemed to be low to medium.

The site is not within an Environment Agency defined Flood Zone.

2.5 Local Authority & Environment Agency

Lancashire Council has yet to confirm whether or not there are no entries relating to the site in the Contaminated Land Register under s78R(1) of the Environmental Protection Act Part 2a and would be low priority for inspection by the council/EA. It is not known at this time whether the site or any of the surrounding land will be identified as contaminated.

One recorded historic landfill is identified within 500m of the Site. A landfill 100m west licensed for Commercial House Hold Waste.

The Landmark report indicates that the site is not included on the list of sites designated as contaminated land under Part 2A of the Environment Protection Act 1990.

No sites are designated as contaminated land under Part 2A of the Environment Protection Act 1990 within 500m of the site.

No nuisance, Statutory Notices for nuisance pollution incidents have been recorded at the site within the past 12 months.

2.6 Site History

Historical maps of the site area have been obtained from Groundsure. Pertinent information determined from review of these maps is set out in the following table; a full copy of the maps is presented in Appendix C:

Table 2.1: Historic Review of Mapping Coverage

Mapping Date	On-site	Off-site
1848 - 1895	The site occupies one field which is assumed agricultural. A woodland area occupies the south of the site.	The area surrounding the site is predominantly agricultural land, with some areas of woodland and a number of ponds nearby. Mitton road (unlabeled) is approximately 50m to the east of the site, the Blackburn Railway lies approximately 600m to the east. A brick and tile works is approximately 350m to the south east and a tile works approximately 400m to the north west.
1913	A new brick works, with a private railway leading to it, is present along the northern and western borders of the site, with an associated clay pit approximately 200m to the south. The main access route to the brick works forms what will become Pendle Drive.	By 1913 the brick and tile works to the south east and north west are indicated to no longer be operational. Whalley railway station, with its associated goods sheds, is present approximately 1km to the south east. The surrounding area remains predominantly agricultural with residential development in the town of Whalley.
1932 - 1955	An isolation unit of the mental hospital is located on the site. Houses are now present immediately to the east. A sewage works is present approximately 700m to the south west.	The 1932 map indicates the presence of a mental institution (later indicated simply as a hospital) immediately to the west of the site, with a pavilion and football club buildings to the south. Whalley has been further developed.
1970 - 2001	The isolation unit is still shown but is no longer labelled.	The 1970 map indicates a transport depot and cattle breeding centre approximately 100m and 150m to the east respectively.
2006 - 2009	The site is now in its present configuration. No structure is shown on the site, it is assumed to be derelict land with some scars relating to former access ways.	The northern section of the hospital has been redeveloped with residential properties, while the southern section remains in use as a hospital. The area surrounding the site remains largely unchanged to the latest date of mapping (2009).

2.7 Environmental Database

A Groundsure report commissioned for the Site has been used to provide an indication of the site history and surrounding land uses available on the public registers. The report provides data from a number of service providers including the British Geological Survey, Environment Agency and English Nature. A full copy of the Groundsure report is presented in Appendix B.

The table below indicates the risk scoring used on the potential pollutant linkages identified from the historic data search. The degree of risk (R) is calculated by multiplying the likelihood (L) with the effect (E):

Table 2.2 Degree of risk (R) = Likelihood (L) x Effect (E)

Likelihood (L)	Description	Probability	Effect (E)	Description	Increase in cost and time
5	Almost certain	>70%			
4	Probable	50-70%	4	Very high	>10%
3	Likely	30-50%	3	High	4-10%
2	Unlikely	10-30%	2	Low	1-4%
1	Negligible	<10%	1	Very low	<1%
Risk (R)	Risk Level	Action			
1-5	Trivial	None			
6-10	Significant	Undertake appropriate mitigation measures to reduce the risk level by appropriate on-site practice at little additional cost.			
>10	Substantial	Designers should take such risks into account and avoid or reduce risk level to acceptable levels. Additional resources required.			

The following table provides a summary of the data reference points, together with an indication of the hazard, likelihood, severity and degree of risk

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Table 2.3 - Environmental Data Review

Data Type	Distance from site	Hazard	Likelihood	Effect	Degree of risk	Mitigation measures
Current land uses	Onsite +	Migration of contaminants of concern including radioactive substances, inorganic and organic substances from sources offsite to onsite receptors	2	4	8	Phase II site investigation
Discharge consents	None	Discharge of contaminants of concern to the environment near site	1	4	4	Non Required
Landfills	100m	Release of known/unknown contaminants from landfill	2	4	8	Phase II Site Investigation
Groundwater vulnerability	0m	Minor aquifer overlain by strata of a low leaching potential	1	4	4	Non Required
Extreme flooding from rivers or sea without defences within 250m	Not shown within 250m	Flooding of the site	1	4	4	Non Required
Groundwater flooding	Onsite	Flooding due to increase in the level of groundwater in the region of the site	1	4	4	Non Required
Previous Land Uses	Onsite	Migration of contaminants of concern including inorganic and organic substances from sources onsite to offsite receptors	1	4	4	Non Required
Ground stability hazards	Onsite	Total and/or differential settlement	1	4	4	Non required
Historic ground workings	Onsite	Ground stability issues, migration of contamination from on-site sources	2	4	8	Phase II Site Investigation
Mining Affected Areas	Onsite	Ground instability	1	4	4	Non required
Brine Affected Areas	Listed	Ground instability	1	4	4	Non required
Radon Affected Areas	Onsite	Radon Gas migration	1	4	4	Radon protection measures not required

3.0 PRELIMINARY CONCEPTUAL MODEL

The site characterisation attempts to identify potential previous and existing site sources of contamination. The conceptual model links the identified sources likely to cause significant possibility of significant harm via pathways to identified critical receptors. The conceptual model is therefore based on a number of identified source-pathway-receptor scenarios. For land to be classified as contaminated a significant pollutant linkage will need to be identified which will include each component of the conceptual model. The absence or removal of a source or interception of a pathway will 'break' the pollutant linkage.

The conceptual model is characterised by identification of the following:

- On-site sources, which may impact on-site receptors via plausible pathways
- On-site source, which may impact off-site receptors via plausible pathways.
- Off-site sources, which may impact on-site receptors via plausible pathways

The change of land use will require assessment of the new site development layout within the context of introducing new exposure pathways. The planning regime will require assessment of the site to ensure the new development will not be classed as contaminated land under the definition provided by the Part 2A of the Environment Act 1990 as defined in the Environment Protection Act 1995.

The preliminary conceptual model is presented over leaf. The drawing presents the source, pathway and receptors in tabular and graphical form. The first table provides an indication of the potential hazards and consequences. A qualitative score is given to the likelihood and effect to provide an indication of the degree of risk.

3.1 Site Investigation Design

The site investigation was designed to provide further information to help quantify the above risks. Boreholes, trial pits and window samples were positioned to provide geotechnical parameters to facilitate the design of future structures.

4no combined gas and groundwater monitoring wells were installed on site to allow adequate characterisation of risks from ground gas within Made Ground and fill deposits and appropriate mitigation measures, if necessary. Two of the installations were damaged and filled with soil following installation and ground gas monitoring was conducted via the two remaining active wells.

General screening was also conducted on a number of soil samples and tested for heavy metals and inorganic contaminants, sulphate. Visual or olfactory evidence of solvent or hydrocarbon contamination was not recorded during fieldworks and thus not incorporated into the chemical testing suite. A Photo Ionising Detector was utilised to conduct headspace analysis of recovered samples and confirm the above.

On-Site to On-Site Source - Pathway - Receptor Model

Source 1	Source 2	Migration Pathway	L	Exposure Pathway	E	Receptor	R
Made Ground soils	Heavy metals and/or hydrocarbons	Migration of liquids & vapours through unsaturated zone; Migration through saturated zone/groundwater; Preferential flow paths (e.g. drains, service runs etc.)	1	Migration to groundwater	4	Groundwater and/or surface waters, and/or eco-system	3
Made Ground soils	Heavy metals and/or hydrocarbons	Ingestion of soil & household dust; Dermal contact with soil and household dust; Inhalation of indoor vapour and household dust; Inhalation of outdoor vapours and fugitive dust	1	Migration to site users	4	Human beings	3
Made Ground soils	Groundwater	Gas phase migration	1	Outdoor/indoor inhalation	4	Human beings	3
Drill Cuttings	Enriched asbestos	Direct Contact	1	Direct Contact	3	Foundations	3

On-Site to Off-Site Source - Pathway - Receptor Model

Source 1	Source 2	Migration Pathway	L	Exposure Pathway	E	Receptor	R
Made Ground soils	Heavy metals and/or hydrocarbons	Migration of liquids & vapours through unsaturated zone; Migration through saturated zone/groundwater; Preferential flow paths (e.g. drains, service runs etc.)	1	Migration to groundwater	3	Groundwater and/or surface waters, and/or eco-system	3
Made Ground soils	Heavy metals and/or hydrocarbons	Ingestion of soil & household dust; Dermal contact with soil and household dust; Inhalation of indoor vapour and household dust; Inhalation of outdoor vapours and fugitive dust	1	Migration to site users	3	Human beings	3

Off-Site to On-Site Source - Pathway - Receptor Model

Source 1	Source 2	Migration Pathway	L	Exposure Pathway	E	Receptor	R
Made Ground soils	Heavy metals and/or hydrocarbons	Migration of liquids & vapours through unsaturated zone; Migration through saturated zone/groundwater; Preferential flow paths (e.g. drains, service runs etc.)	1	Migration to groundwater	3	Groundwater and/or surface waters, and/or eco-system	3
Made Ground soils	Heavy metals and/or hydrocarbons	Ingestion of soil & household dust; Dermal contact with soil and household dust; Inhalation of indoor vapour and household dust; Inhalation of outdoor vapours and fugitive dust	1	Migration to site users	3	Human beings	3

Likelihood (L)	Description	Probability	Effect (E)	Consequence	Increase in cost and time
5	Almost certain	>10%	4	Very High	>10%
4	Probable	50-100%	3	High	4-10%
3	Unlikely	10-50%	2	Low	1-4%
2	Unlikely	<10%	1	Very Low	<1%
Risk (R)	Risk Level	Action			
1-5	High	None			
6-10	Significant	Undertake appropriate mitigation measures to reduce the risk level by appropriate on-site practices at little additional cost. Mitigation measures should take into account and avoid or reduce the risk level by appropriate on-site practices at little additional cost.			
10-20	Very High	Undertake appropriate mitigation measures to reduce the risk level by appropriate on-site practices at little additional cost. Mitigation measures should take into account and avoid or reduce the risk level by appropriate on-site practices at little additional cost.			

Taylor Wimpey

Preliminary Phase 2
Geoenvironmental
Assessment at
P3 Calderstones Park

clarkebond

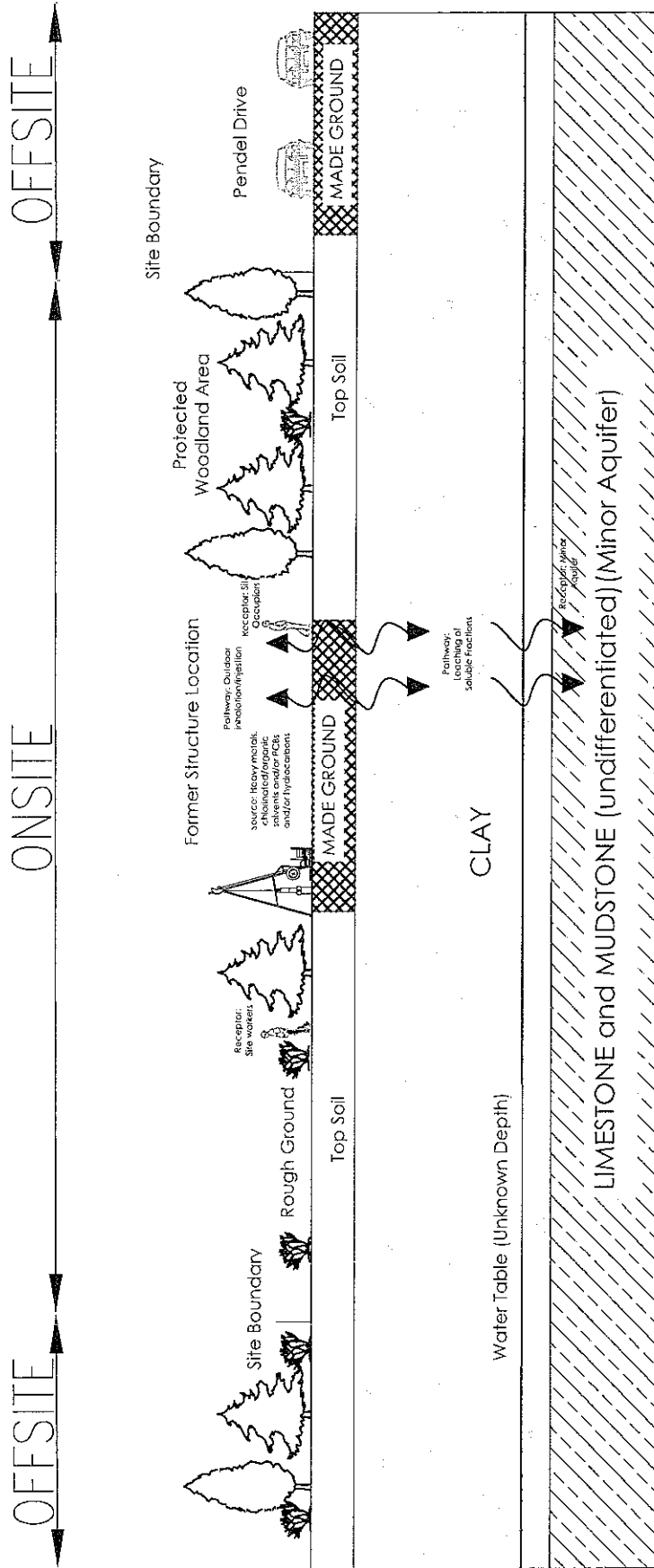
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Preliminary Conceptual Model

Project No.	Drawing No.	Scale	Drawn	Checked	Issue
ZM5608	E 01	NTS	BC	MN	MN
Date	16/02/11	BC	MN	MN	MN

GENERAL NOTES

Do not scale this drawing.
Contractor to check all dimensions and report all errors and omissions to the engineer.



4.0 FIELDWORKS

4.1 General

The intrusive investigation was carried by Geo Site Surveys (GSS) between 24th January 2011 and 25th of January 2011. A plan showing all the exploratory hole locations are presented as Figure 02 in Appendix A. All locations were checked for services against available service plans, scanned with a cable avoidance tool (CAT), and hand dug trial pits formed to a depth of 1.20mbgl prior to the intrusive investigation; in line with Clarke Bond health and safety methodology.

4.2 Cable Tool Percussion Boreholes

During the site investigation a total of 1 no. Cable Tool Percussion Boreholes (BH01) was formed to a depth of 10.30m bgl.

The exploratory hole retrieved continuous soil samples; these were then logged by an onsite engineer and representative samples were taken for geotechnical and chemical analysis.

Detailed Boreholes log sheets are included in Appendix B.

4.3 Window Sample Boreholes

During the site investigation a total of 4no Window Sample Boreholes (WS01 to WS04) were formed to a depth of 3.00 to 5.00m bgl.

Exploratory holes retrieved continuous soil samples from each hole; these were then logged by an onsite engineer and representative samples were taken for geotechnical and chemical analysis.

Detailed window sample borehole log sheets are included in Appendix B.

4.4 Trial Pitting

9 no trial pits (TP01-07, TP09 and TP10) were formed to depths ranging from 1.5mbgl to 3.3m bgl using a JCB 3CX.

Once completed the trial pits were backfilled with arising and re-compacted.

Soakaways were conducted in TP01 and TP02 from ground level to 1.50mbgl and 1.90mbgl respectively in line with BRE Digest 365 – Soakaway design. The permeability tests conducted and calculated permeability soil infiltration rates are shown in appendix E.

Detailed trial pit logs are presented within Appendix B.

4.5 Sample Collection and Analysis

Environmental sample collection was carried out in accordance with Clarke Bond Groups standard operating procedures and BS EN ISO 22475-1:2006. All soil and groundwater samples were collected using either clean stainless steel utensils or clean disposable gloves and placed directly into clean containers provided by the laboratory. Samples obtained during the investigation were subjected to a range of geochemical testing at appropriate UKAS accredited laboratories.

Testing was carried out in accordance with the procedures outlined in BS EN ISO14688-1:2002, 14688-2:2004, and 14689-1:2003.

Geotechnical testing results are included as Appendix C.

Soil and groundwater samples were sent for chemical analysis to SAL Laboratories to be analysed for some or all of the following determinants:

- pH and Sulphate content in accordance with BRE 1 Special Digest on concrete in aggressive ground conditions (2005)
- General indicator suite comprising arsenic, boron (water soluble), cadmium, copper, chromium, lead, mercury, nickel, selenium, silver, zinc, total cyanide, free cyanide, phenols, pH, total sulphur, sulphide, total sulphur, thiocyanate, 2:1 soluble sulphate, magnesium, total organic carbon and nitrate analysis

The results from the chemical analysis are included as Appendix D

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5.0 GROUND CONDITIONS

Ground conditions generally comprise a cover of clayey Topsoil (Made Ground) overlying a layer of soft to firm to firm to stiff reworked clay (Made Ground) possibly associated with site re-profiling and recorded to maximum depths of 3.60mbgl in BH01. The reworked clays possibly resulting from re-profiling of clays resulting from the former Brickworks to the north/northwest of the site. A land drain was recorded at a depth of 1.50m within TP01/SA01

Exploratory holes excavated within areas of the former access routes and Isolation Unit (CP01, TP01, TP02, TP05, TP06, TP07, WS03 and WS04) Made Ground comprising silty clayey ashy gravel of brick, concrete, timber, clinker and slate was recorded to a maximum depth of 2.50m bgl (TP07). Relic infrastructure comprised occasional intact brick/concrete cobbles were recorded and a basement/cellar wall was recorded within TP02/SA02 to a maximum depth of 1.90mbgl

Underlying the Made Ground/Reworked Clay generally firm to stiff dark grey Glacial Boulder Clay was encountered to depth ranging from 0.50mbgl to maximum depths of 10.30mbgl; and was recorded within all the majority of exploratory boreholes with the exception of TP01/SA1

SPT 'N' values ranged from 1.5 to 10 in the Reworked Clay indicating soft to firm to stiff conditions. SPT 'N' values ranged from 4 to 13 within the Glacial Boulder Clay indicating soft to firm to firm to stiff conditions

Hand held shear vane tests conducted within relatively undisturbed samples from the trial pits recorded Cu values ranging from 30 to 51kN/m² in the reworked clays confirming they are generally soft to firm to firm. Cu values ranging from 39 to 126kN/m² were recorded in the Glacial Boulder Clay confirming generally soft to stiff conditions

5.1 Groundwater

Groundwater was encountered during drilling within perched granular Made Ground in BH01 at 2.7mbgl and 8.6mbgl within the granular horizons superficial deposits. In both cases the flow was slow rising to 2.0mbgl and 8.2mbgl respectively after 20mins.

Groundwater was also encountered during the drilling of WS03 and WS04 at 4.00mbgl and 3.00mbgl respectively. No rise was noted.

Groundwater was encountered during the excavation of TP07 at 2.30m bgl within the Made ground and recorded as fast inflowing. It is assumed perched on the underlying natural Glacial Boulder Clay

Four combined groundwater and ground gas monitoring wells were installed on the site and to date 2no. visits have been conducted. It should be noted that two installations located in WS02 and WS03 have been vandalised, WS03 has been partially repaired. Groundwater levels were recorded at the following depths within the Clarke Bond boreholes:

Borehole Number	Range of Depths Recorded (mbgl)	Depth of Response Zone (mbgl)
BH01	1.34	0.50 to 3.50
WS01	0.57	0.50 to 2.00
WS02	Vandalised	0.50 to 2.00
WS03	Vandalised, Repaired	0.50 to 2.00

5.2 Contamination Observations

No visual or olfactory evidence of hydrocarbon or solvent contamination was observed

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5.3 Underground Service Plans

The design team should fully satisfy themselves to the implications of underground services present within the vicinity of the site. Although unlikely and only anecdotal evidence suggests their presence to date, further information should be sought on the presence of former service tunnels beneath the site

5.4 Below ground obstructions

As discussed above, obstructions in the form of relic foundations and basements should be anticipated within the areas of the former Isolation Units

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6.0 GEOTECHNICAL TESTING ANALYSIS

6.1 Laboratory Analysis

A programme of laboratory testing was undertaken in accordance with BS 1377 (1990) "Methods of Test for Soils for Civil Engineering Purposes". The results of which are presented in Appendix C and are summarised below

BS Number	Test	Description
Part 2 3		Moisture Content
Part 2 5		Plasticity index
Part 3 5		Sulphate content
Part 3 9		pH

Moisture Content

Ten samples of the Clay were tested for natural moisture content. The results are summarised below:

Property	Range	Mean
Moisture Content (clay)	27% to 46%	35.00%

Plasticity Index

Ten samples of clay were analysed for plasticity index and hence shrinkage/swelling potential. The results are summarised below:

Property	Range	Mean
Plasticity index (Clay)	42 – 49	45.6
*Amended Plasticity index	14.00 - 21.39	45.21

*Amended for percentage of particles passing a 425mm sieve

The results demonstrate clays of high to very high plasticity with a corresponding high volume change potential.

Sulphate and pH

Six samples were analysed for pH and soluble sulphate as part of a BRE Concrete Suite:

Property	Range
Sulphate as SO ₄ 2:1 (acid soluble) (g/l)	<0.1 (below detectable limit)
pH	7.2 to 8.3

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7.0 GEOTECHNICAL ASSESSMENT

7.1 General

It is understood that the site is to be redeveloped into 2-storey residential housing units, with associated gardens, car parking and landscaped areas. For ease of description and to help in the design of foundations for proposed units, recommendations for foundation design has been grouped and related to George Wimpey Manchester Limited Proposed Development Drawing in appendix A. A copy of the Borehole Location Plan is provided within Appendix A and summarises foundation types, indicative depths and bearing capacities. It is assumed that floor slabs will be of suspended block and beam construction.

Laboratory test results indicate that the grey upper gleyed Glacial Clay is high to very high with a corresponding high volume change potential. Thus the presence of trees and underground services (in particular the location of the currently unknown Calderstones Hospital Rising Water Main) are likely to be the overriding factor between conventional foundations and a piled solution. Where NHBC Chapter 4.2 established that foundations should be taken to depths greater than 2.50mbgl to 3.00mbgl a piled or semi-rigid raft solution should be considered.

To enable pile design, further cable tool boreholes are recommended to depths circa 12.50mbgl; due to the low SPT 'N' values recorded within BH01.

7.2 Foundations

Foundation loads have not been provided, however, it is understood that proposals include forming of approximately No 42 two story units. A foundation risk assessment, options appraisal and costs exercise should be conducted, considering the following options:

- Conventional trench fill and strip foundations (suspended slab)
- Pilled Foundations where trench fill risks extending below 3.0mbgl to conform to current NHBC 'Chapter 4.2 - building near trees' guidelines

Should piled foundations be considered; a specialist piling contractor will need to be approached for advice on their own specialist propriety systems. Vibration and noise being a very important consideration.

Geotechnical testing indicates that site clays are of high to plasticity with a corresponding high shrinkage potential. A number of trees are present which are within possible influencing distance of the site foundations and drainage should be designed in line with NHBC Standards guidance document Chapter 4.2 Building Near Trees.

7.3 Protection of Buried Concrete

Recorded pH values ranged from, 7.2 to 8.3 pH units and 2:1 Sulphate as SO_4 (acid soluble) values below detection limits of the instrument <1%. The results from the chemical laboratory sulphate and pH analysis for the site indicate that a worst case Design Sulphate Class of DS-1 and an Aggressive Chemical Environment for Concrete (ACEC) class of AC-1s.

7.4 Excavations and Groundwater

Spalling and collapse due to loosely backfilled Made Ground was recorded in TP7 (2.50mbgl), which will require support and consideration during foundations and drainage excavations. Groundwater was encountered during drilling in BH01 at 2.7mbgl and 8.6mbgl within the

superficial deposits. Additionally, groundwater was also encountered during the drilling of WS03 and WS04 at 4.00mbgl and 3.00mbgl respectively. Ingress was noted as generally slow to moderate with the exception of TP07 where ground water was encountered at 2.30m bgl in the made ground and recorded as fast inflowing.

It is considered likely that the excavations will not remain fully dry but should be able to be controlled by a screened sump pump techniques and no specialist dewatering techniques (such as well point systems) are envisaged. Localised seepages are likely to be encountered during period of heavy rainfall and within granular inclusions.

Safety precautions should not be neglected especially where personnel are to enter excavations when close support would be required. The stability of the Glacial Till deposits are likely to remain stable in the short term, however, spalling is likely where granular deposits exist. Excavations into sand deposits will require support in order to allow personnel to enter below a depth of 1.20mbgl. All excavations and basement construction should be conducted in line with CIRIA Report 97 – Trenching Practice and BRE 440 Foundations, Basements and External Works 2002.

If excavations are cut at a safe angle of repose or benched a suitably qualified geotechnical engineer should be present to check for potential signs of instability. Where possible all soils should be retained on site to reduce disposal costs.

7.5 Pavement Design

All topsoil, organic matter, soft or disturbed ground should be removed from beneath any exposed area of surfacing and the exposed surface should be proofed rolled to expose any excessively soft or compressible zones, which should be removed.

The formation should always be proof rolled and carefully inspected ensuring that any soft or loose spots are removed and replaced with properly compacted clean granular material.

For design purposes, a conservative CBR value of 1% should be used for pavement construction within the natural superficial deposits.

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8.0 CONTAMINATION ASSESSMENT

8.1 Introduction

The preliminary conceptual site model identified that, the potential for the existence of contamination beneath the site, was low. As such, a number of general screening tests were undertaken during the intrusive investigation to confirm, or otherwise, the site's anticipated low to medium risk status

The following contamination assessment sub-sections will discuss the identified risks associated with individual contaminant groups based on contamination testing results, undertaken on samples from the intrusive investigation

8.2 Rationale

In May of 2008, Contaminated Land: Application in Real Environments (CLAIRE) in conjunction with the Chartered Institute of Environmental Health (CIEH), with support from the Soil and Groundwater Technology Association (SAGTA), released a document entitled 'Guidance on Comparing Soil Contamination Data with a Critical Concentration'⁷

The document provides advice on the use of statistical techniques in the assessment of soil contamination data. It forms part of a package of improved UK guidance highlighted in the Defra discussion paper 'Assessing risks from land contamination – a proportionate approach. Soil Guideline Values: the Way Forward (CLAN 06/2006)'. The overall aim is to increase understanding of the role statistics can play in quantifying the uncertainty attached to estimates of the mean concentration of contaminants thereby creating a more informed basis for regulatory decision-making

The guidance presents a structured approach that can be followed when employing statistical techniques for data assessment

The key question under Planning will usually be "can it confidently be said that the level of contamination on this land is low relative to some appropriate measure of risk?"⁷ In a statistical basis this question is dealt with through the use of formal hypothesis; the null and the alternative, the null being the starting position against which the key question (the alternative hypothesis) can be tested.

Under Planning, the Null hypothesis (H_0) is:

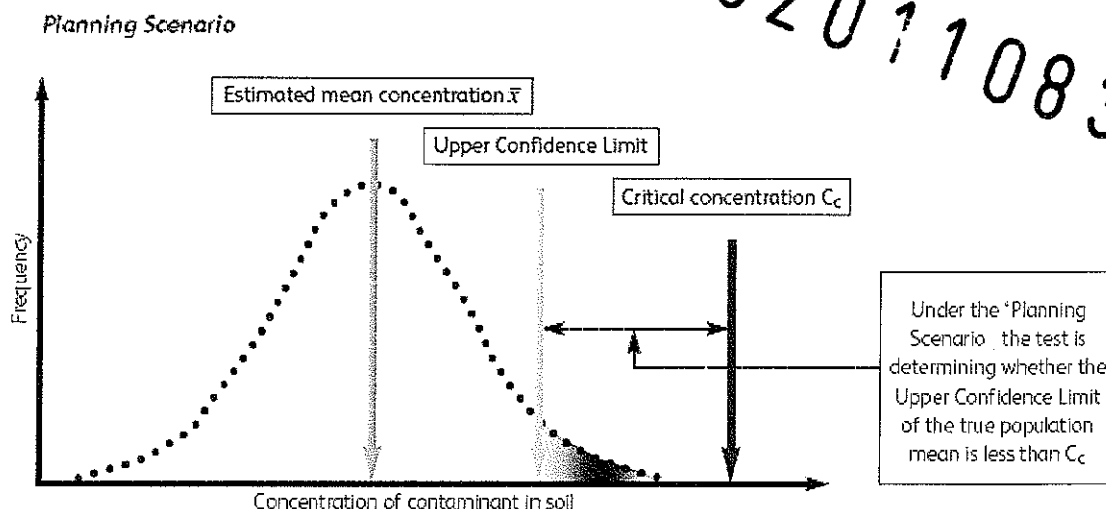
- "that the level of contamination [in the land of interest] is the same as or higher than the critical concentration"

Whilst the alternative hypothesis (H_1) is:

- "that the level of contamination in the land is lower than the critical concentration".

Under the planning process the statistical test must be designed to show that there is a 95% probability that the true population mean falls below the critical concentration and as such the statistical test must involve the comparison of the 95th Upper Confidence Limit (UCL) of the true population mean with the critical concentration as shown in the figure below

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Application of significance tests for the Planning process where data are normally distributed ⁶

A guide to the application of the statistical testing of a dataset for planning purposes, after the CLAIRE and CIEH guidance ⁷, was used for the purposes of this assessment. In general terms the following steps should be followed when applying the statistical test to a dataset under the Planning scenario:

- Calculate sample mean ($\bar{x}$) and sample standard deviation (s)
- Investigate the normality of the data distribution using tests as outlined in Appendix C of the CLAIRE/CIEH guidance
- Investigate statistical outliers and anomalous concentrations as outlined in Appendix B of the CLAIRE/CIEH guidance
- If $\bar{x} > C_c$ (SGV or LQM/CIEH GAC) conclude that the Null Hypothesis (H_0) cannot be rejected. The Developer may then have options on how to proceed including collecting further data and re-running the significance test at the same confidence level, or undertaking remediation on a precautionary basis
- If $\bar{x} < C_c$ apply the one sample t-test if the dataset does NOT deviate significantly from normality (i.e. dataset is normally distributed). The one sample t-test is the same as the mean and maximum value test as outlined in CLR7 ⁸. If the dataset distribution deviates significantly from normality (i.e. dataset is not normally distributed), apply the one-sided Chebychev Theorem

The 95th UCL values for the one sample t-test and the one-sided Chebychev theorem are calculated using the following formulae ⁷:

$$UCL = \bar{x} + (t_{(n-1, 0.95)} \times \frac{s}{\sqrt{n}})$$

LCL for one sample t-test

$$t_0 = \frac{\bar{x} - C_c}{\frac{s}{\sqrt{n}}}$$

Alternative method by calculating t_0 value for comparison with tabulated $t_{(n-1, 0.95)}$ values

$$UCL = \bar{x} + (k_{(0.95)} \times \frac{s}{\sqrt{n}})$$

LCL for one-sided Chebychev Theorem

$$k_0 = \frac{\bar{x} - C_c}{\frac{s}{\sqrt{n}}}$$

Alternative method by calculating k_0 value for comparison with tabulated $k_{(0.95)}$ or k_{crit} values

Where:

$\bar{x}$ = sample mean

$t_{(n-1, 0.95)}$ = Value from Table A.1, Appendix A in CLAIRE/CIEH guidance ⁷ and CLR7 ⁸

$k_{(0.95)}$ = Value from Table A.2, Appendix A in CLAIRE/CIEH guidance ⁷

s = sample standard deviation

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n = sample population

When applying either the one sample t-test or the one-sided Chebychev theorem to the dataset of a determinand where the sample mean is less than the Cc, two alternative techniques are possible for each, as shown by the formulae above and described below:

The 95th UCL value can be calculated for the determinand by inputting values into the formulae above for the separate tests and inputting the $t_{(n-1, 0.95)}$ or $k_{(0.05)}$ values for the one sample t-test and the one-sided Chebychev theorem respectively. These values are tabulated within Appendix A of the CLAIRE/CIEH guidance. The calculated 95th UCL values can then be compared to the Cc and if the 95th UCL < Cc it can be concluded that the Null Hypothesis (H_0) can be rejected.

Alternatively the t_0 (one sample t-test) and the k_0 (one-sided Chebychev theorem) values can be calculated for a determinand where the mean is less than the Cc, using the formulae shown above. The calculated values for t_0 and k_0 are then compared to values for $t_{(n-1, 0.95)}$ and $k_{(0.05)}$ respectively. If the t_0 and k_0 values are less than the respective $t_{(n-1, 0.95)}$ and $k_{(0.05)}$ values then it can be concluded that the Null Hypothesis (H_0) can be rejected.

Within this assessment the 95th UCL values will be used for comparison against critical concentrations (Cc). The Cc with which the sample mean and the 95th UCL will be compared, will be published Soil Guideline Values (SGVs) or, in the absence of published SGVs, LQM/CIEH Generic Assessment Criteria (GAC) ⁹ for a residential end use. This scenario is considered to be a conservative approach given the timeframe and minimum age group of the on-site receptors.

8.3 Soil Guideline values

The Environment Agency's position on CLEA guidance is as follows:

"The CLEA guidance is non-statutory. It does not purport to interpret the policies or procedures of the Environment Agency and shall not operate as a statutory license, waiver, consent or approval from the Environment Agency"⁹

"The CLEA guidance describes the soil concentrations above which, in the opinion of the Environment Agency, there may be concern that warrants further investigation and risk evaluation for both threshold and non-threshold substances. These levels are a guide to help assessors estimate risk. It does not provide a definitive test for telling when risks are significant"⁹

The soil guideline value (SGV) is derived by estimating the concentration of a substance in soil, which will result in an amount of the contaminant entering the human body that is equal to the relevant Health Criteria Value(s). Revised guidance and software has been published for calculation of generic assessment criteria, which will lead to the publication of SGVs based on the new approach. New TOX and SGV reports for priority substances are due to be published after March 2009. The 'old' ten SGV reports will be replaced.

The Environment Agency and DEFRA have produced two new reports - "Human health toxicological assessment of contaminants in soil" and "Updated technical background to the CLEA model". This has led to the withdrawal of CLR7-10, which no longer reflects the current approach and formed the basis of the existing SGVs, as a result all the existing SGV reports have been withdrawn.

The publication of new substance specific TOX reports will lead to the withdrawal of the existing reports. Practitioners are expected to produce their own generic assessment criteria using the CLEA software and handbook.

The following table provides values for comparison on the old CLEA and approach and the new CLEA approach with details of the TOX report status:

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Table 8.1 Soil Guideline Values

Substance	Old CLEA SGV Res. With plant Res. Without plant Allotment Commercial	New CLEA SGV published Res. With plant Allotment Commercial	LQM/CIEH 2 nd Edition GACs Res. With plant Allotment Commercial
Arsenic	20 20 20 500	32 43 640	
Beryllium			51 55 420
Cadmium	1(ph6) 2(ph7) 8(ph8) 30 1(ph6),2(ph7) 8(ph8) 1400	10 1.5 230	3 0.53 348
Chromium	130 200 130 5000		CrIII 3000, CrIV 4.3 CrIII 34600 CrIV 2.1 CrIII 30400 CrIV 35
Copper			2330 524 71700
Lead	450 450 450 750		
Mercury Inorganic	8 15 8 480	170 80 3600	
Nickel	50 75 50 5000	130 230 1800	
Vanadium			75 18 3160
Selenium	35 260 35 8000	350 120 13000	
Zinc			3750 618 665000

The following table presents the published SGV and the newly published LQM/CIEH 2nd Edition 2009 GAC values calculated assuming 1%, 2.5% and 6% Soil Organic Matter (SOM). This provides a basis for correlation with the in-house derived values using the new CLEA model Software Version 1.04 2009.

The following table shows LQM/CIEH GAC values for Polycyclic Aromatic Hydrocarbons of a residential development with plant uptake assume a soil of sandy clay loam, with 1%, 2.5% and 6% SOM.

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Table 8.3 – LQM/CIEH 2nd Edition 2009 PAH GAC values (residential end use)

PAH Designator	Residential land-use LQM/CIEH GAC for Polycyclic Aromatic Hydrocarbons (mg kg ⁻¹ DW) ^{1,2,3,4}		
	1% SOM	2.5% SOM	6% SOM
Acenaphthene	212	480	1000
Acenaphthylene	176	400	856
Anthracene	1300	4900	9200
Ben[a]anthracene	3.1	4.7	5.5
Benzo[a]pyrene	0.83	0.94	1.0
Benzo[b]fluoranthene	6.6	11.5	7.0
Benzo[e]pyrene	44	45	47
Benzo[k]fluoranthene	6.5	9.8	10
Chrysene	6.0	8.0	9.3
Dibenz[a,h]anthracene	0.75	0.88	0.90
Fluoranthene	260	460	670
Indene[1,2,3-cd]pyrene	180	360	790
Indeno[1,2,3-cd]pyrene	3.2	3.9	4.2
Indolene	1.5	3.7	3.7
Phenanthrene	92	200	380
Pyrene	580	1000	1600

¹ Based on a sandy loam soil as defined in BS1: Soil science agency, 2003(1) and 1, 2, 3 and 4% SOM.

² GAC for Polycyclic Aromatic Hydrocarbons not very according to SOM for all land-uses

³ Values are rounded to two significant figures

⁴ Notes assume that four phase characterization is not present

⁵ GACs based on a sub-surface soil to which are correction factor of 1

8.4 Metals

8.4.1 Human Health

Ten soil samples were taken from depths of 0.1m and 2.0m below ground level (bgl) and were sent under chain of custody to undergo laboratory analysis for metals

The majority of the values fell below their respective CLEA/LQM/CIEH GACs for a residential end use

A sample from TP10 at 0.1mbgl recorded a lead concentration of 970mg/kg within Made Ground strata; above the soil guideline value of 450mg/kg. All other concentrations for lead are well below the soil guideline value and this samples is considered to be associated with occasional ash and clinker recorded within the Made Ground

Four samples of topsoil were taken and the calculated 95th Upper Confidence Limit values compared against the Critical concentration concludes that the Null Hypothesis (the true mean concentration is equal to or greater than the critical concentration: $\mu \geq C_c$) cannot be rejected unless TP10 at 0.10m bgl is designated as an outlier

As such the risk from metals to identified receptors post development is considered medium and further analysis is required to confirm the need for capping systems within garden and landscaping areas

8.5 Polycyclic Aromatic Hydrocarbons (PAH)

8.5.1 Human Health

Ten soil samples were taken from Made Ground and superficial deposits and analysed for Speciated PAH by GCMS

The majority of the values fell below their respective LQM/CIEH GACs for a residential end use with plant uptake use using a conservative one percent of soil organic matter content (1% SOM)

Two samples taken from the topsoil from TP01 at 0.1mbgl and TP02 at 0.1mbgl, recorded benzo(a)Pyrene concentrations of 1.6mg/kg and 1.8mg/kg respectively, these are above the soil guideline value of 0.83mg/kg to 1.0mg/kg using a one to six percent of soil organic matter

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content (1-6% SOM). The SOM for the TP01 and TP02 samples is estimated at 9.48% and 4.48% respectively based on the calculation defined in the CLEA model.

In total four samples of topsoil were taken and the calculated 95th Upper Confidence Limit values compared against the Critical concentration concludes that the Null Hypothesis (the true mean concentration is equal to or greater than the critical concentration: $\mu \geq C_c$) cannot be rejected.

Two samples taken in the Made Ground: Gravel from TP01 at 0.4mbgl and TP03 at 0.3mbgl, recorded benzo(a)Pyrene concentrations of 4.9mg/kg and 1.0mg/kg respectively, these are above the soil guideline value of 0.83mg/kg using a one to six percent of soil organic matter content but TP03 is equal to 1.0mg/kg at 6% SOM. The SOM for the TP01 and TP03 samples is estimated at 7.24% and 16.20% respectively based on the calculation defined in the CLEA model. Hence the TP03 sample can be discounted for the purposes of the evaluation.

TP01 at 0.4m bgl recorded values above the SGV's as shown in the table below;

Determinant	Recorded Value mg/kg at 7.24% SOM	LQM/CIEH 2 nd Edition 2009 PAH GAC values at 6% SOM (residential end use)
Benzo(a)anthracene	6.8	5.9
Benzo(a)pyrene	4.9	1.0

In total two samples of the Made Ground: Gravel were taken and the calculated 95th Upper Confidence Limit values compared against the Critical concentration concludes that the Null Hypothesis (the true mean concentration is equal to or greater than the critical concentration: $\mu \geq C_c$) cannot be rejected.

As such the risk from PAH compounds within the Made Ground to identified receptors post development is considered medium and further analysis is required to confirm the need for capping systems within garden and landscaping areas.

8.6 Groundwater

Groundwater was encountered during the excavation of TP07 at 2.30m bgl, BH 01 at 2.7m bgl in the Made Ground. It is assumed perched on the underlying natural Glacial Boulder Clay. Groundwater was also encountered in the Glacial Clay in WS03 at 4.00m bgl, WS04 at 3.00m bgl and BH01 at 8.6m bgl.

Rainfall infiltration and leaching of soluble fractions, within proposed landscaped areas, poses a slight risk to the underground minor Aquifer. However, no records of groundwater and/or surface water abstraction licenses are within 1000m of the site. The site location is also stated to be underlain by superficial deposits of a low leaching potential and this was confirmed by the investigation. The risks to Controlled Water receptors from leaching and groundwater migration are therefore, perceived to be negligible, post construction.

It may be a requirement of the Environment Agency and Lancashire Council to conduct further quantitative analysis to confirm the above. This should be clarified as soon as practically possible.

8.7 Ground Gas Protection Measures

To date 2no ground gas monitoring visits have been conducted from within the installed wells. WS01 recorded a peak CO₂ level of 0.5%v/v, and a peak CH₄ level of 0.1%v/v, flow rates were recorded at maximum of -4.9 litres/hrs. As carbon dioxide does not exceed the 5% threshold value the results (presented in Appendix G) indicate that traffic light classification of GREEN and as such no special protection measures are required for the proposed building, in line with NHBC Guidance on Methane and Carbon Dioxide (Rev4 March 2007).

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It should be noted that this is based on the assessment of the two remaining active wells due to WS02 and WS03 being vandalised

A further 2no ground gas visits are planned over the next 4 weeks and the findings will be forwarded on completion.

8.8 Disposal of Waste Soils from Site

In order to prevent excessive costs and reduce the environmental impact of the development it is recommended that removal of wastes from the site, including waste soils, is kept to a minimum. It is however, envisaged that arisings will be created during the works; in particular within the landscaped mounds.

To evaluate the various on-site soils for potential offsite disposal, soils are classified in accordance with the Hazardous Waste Directive (HWD) that enables the provision of a European Waste Catalogue (EWC) Code for use during offsite disposal and a Hazardous or Non-Hazardous Classification. Non-Hazardous material is suitable for disposal in a Non-Hazardous landfill; however, disposal to an Inert Landfill requires further Waste Acceptance Criteria (WAC) testing in accordance with BS EN 12457-3. Material classed as Hazardous also requires WAC testing to assign a suitable hazardous classification.

Testing conducted to date would indicate that any site materials to be removed off site to landfill; would be classified as stable non-reactive hazardous waste in a non-hazardous landfill.

The Landfill Regulations require that all Hazardous and Non-Hazardous solid waste must be treated prior to offsite disposal to landfill. You can define 'treatment' by using the following 'three-point test'. All three criteria must be satisfied for all of the waste to qualify as being treated:

- 1 It must be a physical, thermal, chemical or biological process including sorting
- 2 It must change the characteristics of the waste
- 3 It must do so in order to:
 - a Reduce its volume; or
 - b Reduce its hazardous nature; or
 - c Facilitate its handling; or
 - d Enhance recovery

Solid chemical analysis indicates that the site soils may be classified as stable non-reactive Hazardous waste. However, Waste Acceptance Criteria (WAC) testing has not been undertaken on any samples to date and as such an Inert or hazardous classification for any site soils can not be given.

It should be noted that a site investigation is unable to identify all below ground conditions at a site and therefore, it should be noted that if during construction works soils that require offsite disposal are identified as being different to what has been preliminarily tested in this report, additional testing will be required prior to disposal or recovery at a licensed offsite facility.

It is also recommended that prior to offsite disposal or recovery of any waste soils; the receiving landfill facility should be sent copies of all relevant chemical analysis and written confirmation of acceptance of soils provided.

All producers of waste have a duty of care to ensure that any waste they produce is handled safely and within the law. They must check that anyone they pass waste on to is authorised to take it. This includes the authorised site earmarked to handle the waste and any haulier (licensed waste carrier) used to transport the waste between the sites.

All waste holders must act to keep waste safe against:

- 1 Corrosion or wear of waste containers;

- 2 Accidental spilling or leaking or inadvertent leaching from waste unprotected from rainfall;
- 3 Accident or weather breaking open contained waste and allowing it to escape;
- 4 Waste blowing away or falling while stored or transported;
- 5 Scavenging of waste by vandals, thieves, children, trespassers or animals

Holders should protect waste against the above risks while it is in their possession and they should also protect it for its future handling requirements. Waste should reach not only its next holder but a licensed facility or other appropriate destination without escape. It is recommended that the container used to transport the waste is suitable not only to prevent solid and liquid residues escaping, but also any potentially dangerous vapours or odours associated with the waste.

Segregation of different categories of waste where they are produced may be necessary to prevent the mixing of incompatible wastes. Segregation may assist the disposal of waste to specialist outlets. Where segregation is practiced on sites, the waste holder should ensure that his employees and anyone else handling waste there are aware of the locations and uses of each segregated waste container.

Waste handed over to another person should be in some sort of container, which might include a skip. The only reasonable exception would be loose material loaded into a vehicle and then covered sufficiently to prevent escape before being moved. Waste containers should suit the material put in them.

A waste transfer note (WTN) is a document which must accompany any transfer of waste between different holders. The purpose of a WTN is to allow other people who handle your waste to know what they are dealing with so that they can manage it safely and properly.

A WTN must be created for each load of waste that leaves the site.

The WTN must contain enough information about the waste to enable anyone coming into contact with it to handle it safely, and either dispose of it or allow it to be recovered within the law. If insufficient information is given on the WTN the responsible party may be liable to be prosecuted.

Records of all waste transferred or received must be kept for at least two years.

8.9 Refined Risk Assessment

The following tables summarise the potential pollutant linkages associated with the proposed development. The degree of risk (R) is calculated by multiplying the likelihood (L) with the effect (E):

On-Site to On-Site Source - Pathway - Receptor Model

Source 1	Source 2	Migration Pathway	L	Exposure Pathway	E	Receptor	R
Made Ground soils	Heavy metals, chlorinated/organic solvents and/or PCBs and/or hydrocarbons	Leaching of soluble fractions	1	Migration to groundwater	4	Groundwater and/or surface waters, and/or eco-system	4
Made Ground soils	Heavy metals, chlorinated/organic solvents and/or PCBs and/or hydrocarbons	Vapour phase and/or soil dust	2	Outdoor/indoor inhalation and/or ingestion	4	Construction workers and/or future site occupiers	3
Made Ground soils	Ground gases	Gas phase migration	1	Outdoor/indoor inhalation and/or ingestion	4	Construction workers and/or future site occupiers	4

On-Site to Off-Site Source - Pathway - Receptor Model

Source 1	Source 2	Migration Pathway	L	Exposure Pathway	E	Receptor	R
Made Ground soils	Heavy metals, chlorinated/organic solvents and/or PCBs and/or hydrocarbons	Leaching of soluble fractions	1	Migration to groundwater	4	Groundwater and/or surface waters, and/or eco-system	4
Made Ground soils	Heavy metals, chlorinated/organic solvents and/or PCBs and/or hydrocarbons	Vapour phase and/or soil dust	1	Indoor and outdoor Inhalation and/or ingestion	3	Adjacent site users	3
Made Ground soils	Ground gases	Gas phase migration	1	Outdoor/indoor inhalation and/or ingestion	4	Construction workers and/or future site occupiers	4

Off-Site to On-Site Source - Pathway - Receptor Model

Source 1	Source 2	Migration Pathway	L	Exposure Pathway	E	Receptor	R
Made Ground soils	Heavy metals, chlorinated/organic solvents and/or PCBs and/or hydrocarbons	Leaching of soluble fractions	1	Migration to groundwater	3	Groundwater and/or surface waters, and/or eco-system	3
Made Ground soils	Heavy metals, chlorinated/organic solvents and/or PCBs and/or hydrocarbons	Vapour phase and/or soil dust	1	Indoor and outdoor Inhalation and/or ingestion	3	Adjacent site users	3
Made Ground soils	Ground gases	Gas phase migration	1	Outdoor/indoor inhalation and/or ingestion	4	Construction workers and/or future site occupiers	4

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Water Table (Unknown Depth)

LIMESTONE and MUDSTONE (undifferentiated) (Minor Aquifer)

On-Site to On-Site Source - Pathway - Receptor Model					
Source 1	Pathway	Receptor	Exposure Pathway	Receptor	Receptor
Mass Ground soils	Heavy metals Chlorinated hydrocarbon solvents and/or PCBs and/or hydrocarbons	Leaching of soluble fractions	Migration to groundwater	Groundwater and/or surface waters and/or no-system	Groundwater and/or surface waters and/or no-system
Mass Ground soils	Heavy metals Chlorinated hydrocarbon solvents and/or PCBs and/or hydrocarbons	Vapour phase and/or soil dust	Outdoor/indoor inhalation and/or ingestion	Consistent workers and/or future site occupants	Consistent workers and/or future site occupants
Mass Ground soils	Ground gases	Gas phase migration	Outdoor/indoor inhalation and/or ingestion	Consistent workers and/or future site occupants	Consistent workers and/or future site occupants
On-Site to Off-Site Source - Pathway - Receptor Model					
Source 1	Pathway	Receptor	Exposure Pathway	Receptor	Receptor
Mass Ground soils	Heavy metals Chlorinated hydrocarbon solvents and/or PCBs and/or hydrocarbons	Leaching of soluble fractions	Migration to groundwater River flood	Groundwater and/or surface waters and/or no-system	Groundwater and/or surface waters and/or no-system
Mass Ground soils	Heavy metals Chlorinated hydrocarbon solvents and/or PCBs and/or hydrocarbons	Vapour phase and/or soil dust	Indoor and outdoor inhalation and/or ingestion	Adjacent site users	Adjacent site users
Mass Ground soils	Ground gases	Gas phase migration	Outdoor/indoor inhalation and/or ingestion	Consistent workers and/or future site occupants	Consistent workers and/or future site occupants
Off-Site to On-Site Source - Pathway - Receptor Model					
Source 2	Pathway	Receptor	Exposure Pathway	Receptor	Receptor
Mass Ground soils	Heavy metals Chlorinated hydrocarbon solvents and/or PCBs and/or hydrocarbons	Leaching of soluble fractions	Migration to groundwater	Groundwater and/or surface waters and/or no-system	Groundwater and/or surface waters and/or no-system
Mass Ground soils	Heavy metals Chlorinated hydrocarbon solvents and/or PCBs and/or hydrocarbons	Vapour phase and/or soil dust	Indoor and outdoor inhalation and/or ingestion	Adjacent site users	Adjacent site users
Mass Ground soils	Ground gases	Gas phase migration	Outdoor/indoor inhalation and/or ingestion	Consistent workers and/or future site occupants	Consistent workers and/or future site occupants

Likelihood (L)	Description	Probability	Effect (E)	Description	Increase in cost and time
5	Almost certain	>70%	4	Very high	>10%
4	Prohibitively likely	50-70%	3	High	4-10%
3	Likely	30-50%	2	Medium	1-4%
2	Unlikely	10-30%	1	Low	<1%
1	Negligible	<10%	0	Very low	<1%
Risk (R)	Hazard Level	Action			
1-5	High	None			
6-10	Significant	Undertake appropriate mitigation measures to reduce the risk level by appropriate on-site practices at little additional cost			
10-20	Unacceptable	Measures should take such risks into account, avoid or reduce			

Taylor Wimpey

Preliminary Phase 2
Geoenvironmental
Assessment at
23 Calderstones Park

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9.0 CONCLUSIONS & RECOMMENDATIONS

Background

Clarke Bond has been commissioned by Dean Harrison of Taylor Wimpey Manchester Limited to undertake a Phase 2 Geoenvironmental Assessment of land situated 50m North of Pendle Drive, Whalley BB7 9JT. It is understood that this assessment is part of a pre-acquisition survey and the property is to be developed for residential purposes.

This report incorporated a previous assessments conducted upon the site by RSK Group PLC (Phase 1 and 2 Geoenvironmental Site Investigation Report at Calderstones Park (16372-R1 0) dated 4th of June 2010); Plot B1 Calderstones Hospital – Borehole Assessment by Strata Surveys Limited (ref NFJ/L13687 17072006 doc) dated 17th of July 2006; Site Check Data report on land at Calderstones Hospital by Landmark (ref SCPRO-23698251-1-1) dated 29th November 2007; and Plan Search report on land at Calderstones Hospital by Landmark (ref PSC-21960143-1-1) dated 26th June 2007 which should be read in conjunction with this study.

Preliminary Conceptual Model

The site is an agricultural field and woodland area until 1913 when brick works, with a private railway leading to it, is present along the northern and western borders of the site. In 1932 to 1970 an Isolation Unit of the Calderstone mental hospital is located on the site. By 2006 the site is in its present configuration. No structure is shown on the site, it is assumed to be derelict land with some scars relating to former access ways and Isolation Unit.

Guidance from the Environment Agency indicates that site is underlain by a minor-aquifer and the nearest surface water feature is a small balancing pond situated approximately 80m to the south of the site.

There are no entries relating to the site in the Contaminated Land Register under s78R(1) of the Environmental Protection Act Part 2a and currently have no intention to inspect the site due to its current commercial end use.

Coal workings and Brine Mining are unlikely to impact the site.

The preliminary conceptual model identified a low contamination potential associated with former end use and a low potential risk to identified receptors. Further site investigation works were recommended to establish risks associated with foundation design and to validate the contamination assessment.

Fieldworks & Ground Conditions

The intrusive investigation was carried by Geo Site Surveys (GSS) between 24th January 2011 and 25th of January 2011. A plan showing all the exploratory hole locations are presented as Figure 02 in Appendix A.

Ground conditions generally comprise a cover of clayey Made Ground and/or Topsoil overlying a layer of soft to firm to firm to stiff reworked clay possibly associated with site re-profiling with the former Brickworks. Made ground comprising Gravel of brick and concrete was also recorded within areas of former structures and/or access routes (2.50m bgl in TP07). Underlying the Made Ground/Reworked Clay generally soft to firm to firm to stiff Glacial Boulder Clay was encountered.

Groundwater was encountered during the excavation of TP07 at 2.30m bgl, BH 01 at 2.7m bgl in the Made Ground. It is assumed that the groundwater is perched on the underlying natural Glacial Boulder Clay and within granular inclusions within the Glacial Till deposits.

Contamination

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The general risk of significant contamination being present within soil and groundwater beneath the site during the Phase 1 desk study was considered to be low to medium

With regards to contaminant risks to end users, construction workers and maintenance staff, Made Ground soils (topsoil and Gravel) are deemed unsuitable for use without capping systems in gardens and landscaped areas. Further testing is required of this strata to delineate the extent of potential capping systems to remove preferential migration pathways. These materials are considered suitable for use beneath areas to be utilised for roads, car parks and hardstanding areas; which will restrict migration pathways for soil contamination to site occupiers.

To date, 2no ground gas monitoring visits (out of a proposed 4) have been conducted from within the installed wells. Results indicate that traffic light classification of GREEN and as such no special protection measures are required for the proposed building, in line with NHBC Guidance on Methane and Carbon Dioxide (Rev4 March 2007). Once the final 2no monitoring visits are conducted an addendum report will be provided to the client which should be submitted immediately to Lancaster Council Director of Planning for comment.

We are of the opinion that based on the findings of the site investigation the site presents a medium risk to end users and maintenance workers from historical industrial activity and a low risk to Controlled Waters post construction.

Although we cannot anticipate the actions of the regulatory authorities, we consider that the risks posed to identified receptors other than those mentioned above are sufficiently low to not warrant extensive remedial activities of the site in its current configuration.

Geotechnical Issues

A foundation risk assessment, options appraisal and costs exercise should be conducted, considering the following options:

- Conventional trench fill and strip foundations (suspended slab)
- Pilled Foundations where trench fill risks extending below 3.0mbgl to conform to current NHBC 'Chapter 4.2 - building near trees' guidelines

Should piled foundations be considered; a specialist piling contractor will need to be approached for advice on their own specialist propriety systems. Vibration, noise and groundwater ingress being a very important consideration.

It is considered likely that the excavations will not remain fully dry but should be able to be controlled by a screened sump pump techniques and no specialist dewatering techniques (such as well point systems) are envisaged. Localised seepages are likely to be encountered during period of heavy rainfall and within granular inclusions.

Pavement design should utilise a CBR value of 1%. Temporary works access routes and hardstanding should be provided with a competent mat of hardcore and good run off drainage maintained.

In order to prevent excessive costs and to reduce the environmental impact of the development it is recommended that removal of wastes from the site, including waste soils, is kept to a minimum.

The results from the chemical laboratory sulphate and pH analyses for the site indicate that a worst case Design Sulphate Class of DS-1 and an Aggressive Chemical Environment for Concrete (ACEC) class of AC-1.

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This report should be provided to Lancaster Council Director of Planning and the Environment Agency as part of any future planning applications to prevent delays in the proposed development

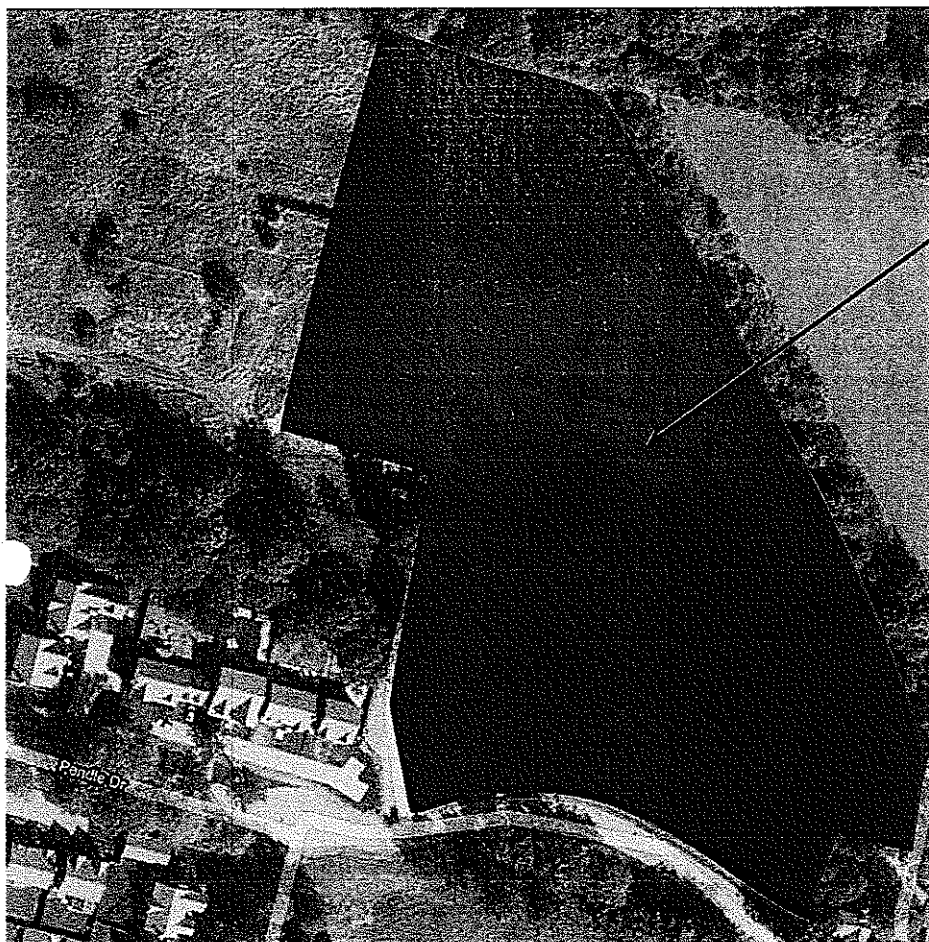
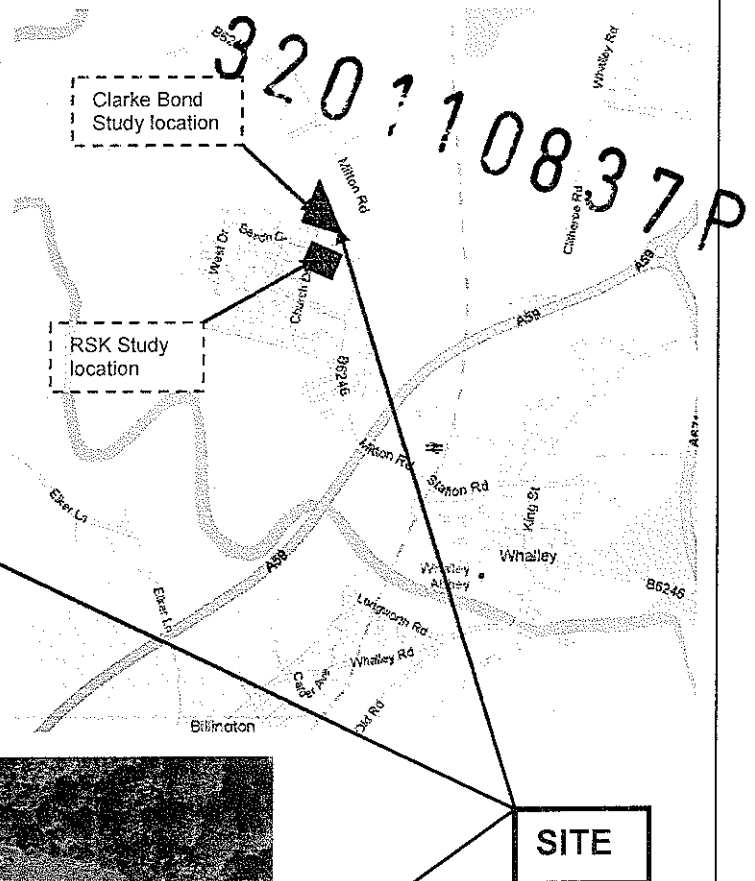
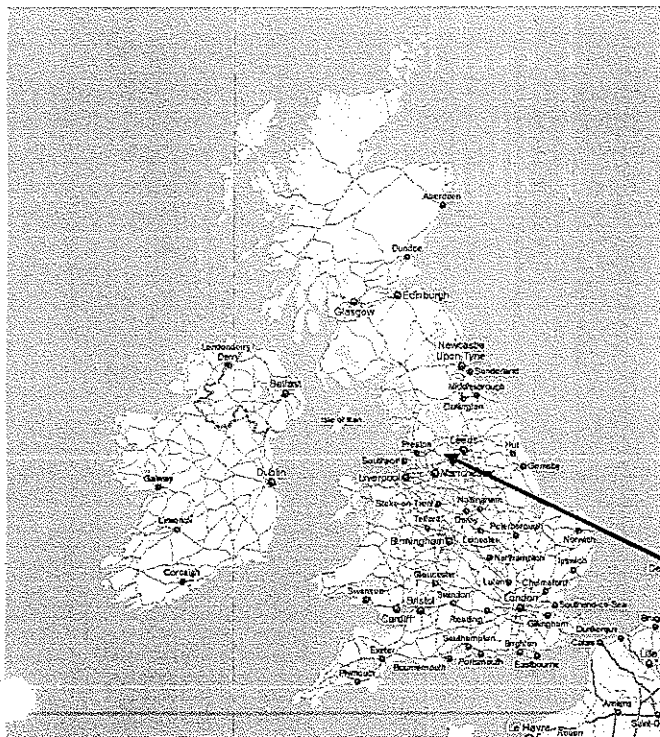
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APPENDICES

- Appendix A - Site Location Plan, Exploratory Hole Location Plan, Proposed Development & Foundation Plan & Site Photographs
- Appendix B - Exploratory Hole Record Sheets & Exploratory Hole Photographs
- Appendix C - Geotechnical Test Results
- Appendix D - Chemical Test Results
- Appendix E - Ground Gas Monitoring
- Appendix F - Former Site Assessment Reports

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Appendix A - Site Location Plan, Exploratory Hole Location Plan, Proposed
Development & Foundation Plan & Site Photographs



Site Centre:
OS X (Eastings) 372540
OS Y (Northings) 437521

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Project:

PHASE 1 GEOENVIRONMENTAL ASSESSMENT
Calderstone Hospital Development

Title:

SITE LOCATION MAP

Drawn:

BC

Scale:

NTS

Checked:

BC

Date:

February
2011

Status:

FINAL

Drawing No:

25608E Figure 1

Rev:

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GENERAL NOTES
 Do not scale this drawing.
 Contractor to check all dimensions and report all errors and omissions to the engineer.

Rev	Detail	By	Ck	Date

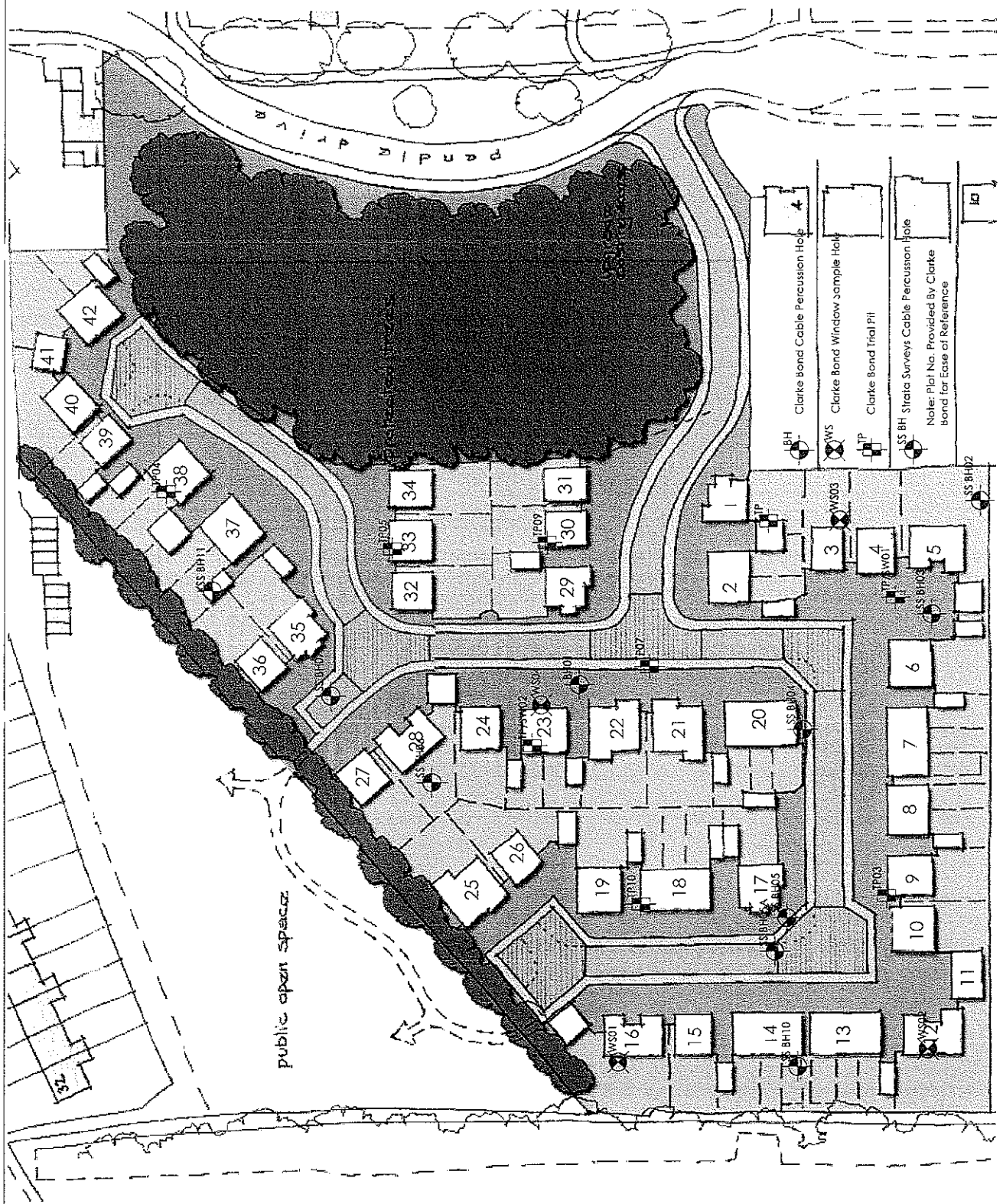
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Client
 Taylor Wimpey

Project
 Calderstone Hospital
 Phase 3 Preliminary
 Site Investigation

Drawing Title
 Proposed Development Plan

Project No.	ZM25608	Discipline	E	Drawing No.	0003
Scale	NFS	Sheet No.	A2	Revision	A
Date	11/02/11	Drawn	UC	Checked	MN



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Appendix B - Exploratory Hole Record Sheets & Exploratory Hole Photographs

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PERCUSSIVE BOREHOLE LOG

Project Phase 3 Calderstones Park, Whalley				PERCUSSIVE BOREHOLE No BH01	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		
Contractor GSS					Sheet 1 of 2

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.50	D					(1.80)	MADE GROUND: Black brown slightly clayey sandy angular to subrounded fine to coarse gravel of brick, concrete, sandstone and mudstone with frequent cobbles and boulders of brick and concrete		
1.20	D	N8				1.80			
2.00	D	N15				(1.80)	REWORKED CLAY: Soft to firm grey brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and occasional brick		
3.00	D	N3				3.60			
4.00	D	N4				(5.00)	Soft to firm grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
5.00	D	N45							
6.50	D	N6							

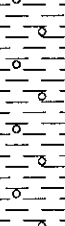
Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Depth	Casing Dia mm	Water Dpt	From	To	Hours	From	To	
											No visual or olfactory evidence of contamination Obstruction at 10.3m
All dimensions in metres Scale 1:50			Client Taylor Wimpey - Manchester			Method/ Plant Used Dando 2000			Logged By BC		

Log: '08a CBGE PERCUSSIVE BOREHOLE LOG - SALE PROJECT/S25680E CALDERSTONES HOSPITAL PHASE 3 WHALLEY CLUTHERBOPRODUCTIONDATA - GEO ENVC8 DATAGINT35680E GP1 CLARKE BOND GDT 16/02/2011 11:52:57

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PERCUSSIVE BOREHOLE LOG

Project Phase 3 Calderstones Park, Whalley				PERCUSSIVE BOREHOLE No BH01	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		
Contractor GSS				Sheet 2 of 2	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend (Thickness)	Depth (Thickness)	DESCRIPTION		
8.00	D	N7.5				8.60	Soft to firm grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone (continued)		
9.50	D	N9				(1.70) 10.30	Firm to stiff grey slight sandy slightly gravelly CLAY with occasional mudstone and sandstone cobbles. Gravel is angular to subrounded of mudstone and sandstone		
							End of hole at 10.3m		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia mm	Water Dpt	From	To	Hours	From	To	
						14	15	1h			No visual or olfactory evidence of contamination Obstruction at 10.3m
All dimensions in metres Scale 1:50			Client Taylor Wimpey - Manchester			Method/ Plant Used Dando 2000			Logged By BC		

TRIAL PIT LOG

Project Phase 3 Calderstones Park, Whalley				TRIAL PIT No TP01
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()	
Contractor GSS				Sheet 1 of 1

SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick- ness)		
0 10	D	0ppm			0.20	MADE GROUND TOP SOIL: Grass onto black brown organic slightly sandy gravelly clay. Gravel is angular to subrounded fine to coarse of brick, concrete, sandstone, tarmac, limestone and mudstone.		
0 40	D	0ppm			(0 60) 0.80	MADE GROUND: Black slightly clayey sandy angular to subrounded fine to coarse gravel of brick, concrete, tarmac sandstone and mudstone with frequent cobbles of brick and concrete.		
1 00	SV	49			(0 70) 1.50	REWORKED CLAY: Soft to firm grey brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and occasional brick.		
1 50	D	0ppm				End of hole at 1.5m		

Shoring/Support: None Stability: Good		GENERAL REMARKS No visual or olfactory evidence of contamination	
Diagram showing a rectangular area with dimensions: width 3.1, height 1.1, and labels A, B, C, D.			
All dimensions in metres Scale 1:50	Client Taylor Wimpey - Manchester	Method/ Plant Used JCB 3CX	Logged By BC

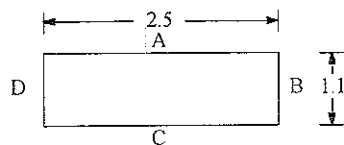
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Clarkebond

TRIAL PIT LOG

Project Phase 3 Calderstones Park, Whalley				TRIAL PIT No TP02	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		
Contractor GSS				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.10	D	0ppm				0.20	MADE GROUND (TOP SOIL): Black brown organic slightly sandy gravelly clay. Gravel is angular to subrounded fine to coarse of brick, concrete, sandstone, tarmac, limestone and mudstone.		
0.30	D	0ppm				(0.38) 0.58	MADE GROUND (TARMAC): Black sandy angular to subrounded fine to coarse gravel of tarmac.		
1.00	SV	46				(0.82)	REWORKED CLAY: Firm to stiff grey brown slightly sandy slightly gravelly clay. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and occasional brick		
1.00	D	0ppm				1.40			
1.50	D	0ppm				(0.50)	REWORKED CLAY: Soft to firm grey brown slightly sandy gravelly clay. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and occasional brick.		
1.80	SV	35				1.90			
							End of hole at 1.9m		

Shoring/Support: None
Stability: Good



GENERAL REMARKS

No visual or olfactory evidence of contamination
Intact basement wall on south face of pit

All dimensions in metres
Scale 1:50

Client Taylor Wimpey - Manchester

Method/
Plant Used

JCB 3CX

Logged By

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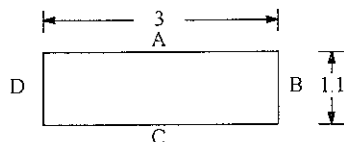
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TRIAL PIT LOG

Project Phase 3 Calderstones Park, Whalley				TRIAL PIT No TP03	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		
Contractor GSS				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.20	CBR	1.3				0.20	MADE GROUND (TOP SOIL): Grass onto black brown organic slightly sandy gravelly clay. Gravel is angular to subrounded fine to coarse of brick, concrete, sandstone and mudstone.		
0.30	D	0ppm				0.50			
0.50	CBR	1.6					MADE GROUND: Black brown red slightly clayey sandy angular to subrounded fine to coarse gravel of brick, concrete, sandstone and mudstone with frequent cobbles of brick and concrete		
0.70	CBR	1.6							
1.00	SV	42.3					Firm to stiff grey slight sandy slightly gravelly clay. Gravel is angular to subrounded of mudstone and rare sandstone		
1.50	D	0ppm							
2.00	SV	63.3				(2.80)			
3.00	SV	107.3				3.30			
							End of hole at 3.3m		

Shoring/Support: None
Stability: Good



GENERAL REMARKS

No visual or olfactory evidence of contamination

All dimensions in metres
Scale 1:50

Client Taylor Wimpey - Manchester

Method/
Plant Used

JCB 3CX

Logged By

BC

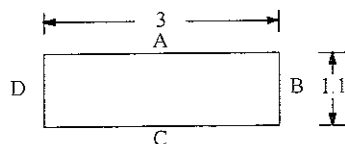
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TRIAL PIT LOG

Project Phase 3 Calderstones Park, Whalley				TRIAL PIT No TP04	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		
Contractor GSS				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.10	D	0ppm				0.20	MADE GROUND (TOP SOIL): Grass onto black brown organic slightly sandy gravelly clay. Gravel is angular to subrounded fine to coarse of brick, concrete, sandstone and mudstone.		
0.20	CBR	1				(0.80)	REWOKED CLAY: Firm to stiff grey brown slightly sandy slightly gravelly clay with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and occasional brick.		
0.50	CBR	1.25				1.00	Firm to stiff grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
0.50	SV	36							
0.50	D	0ppm							
0.70	CBR	1.38							
1.50	SV	48.3							
2.00	D	0ppm				(2.00)			
3.00	SV	119.3				3.00	End of hole at 3.0m		

Shoring/Support: None
Stability: Good



GENERAL REMARKS

No visual or olfactory evidence of contamination

All dimensions in metres
Scale 1:50

Client Taylor Wimpey - Manchester

Method/
Plant Used

JCB 3CX

Logged By

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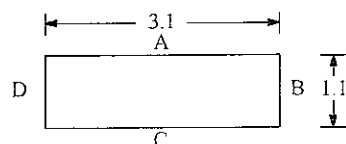
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TRIAL PIT LOG

Project Phase 3 Calderstones Park, Whalley				TRIAL PIT No TP05	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		
Contractor GSS				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.20	CBR	Refusal				0.20	MADE GROUND (TOP SOIL): Grass onto black brown organic slightly sandy gravelly clay. Gravel is angular to subrounded fine to coarse of brick, concrete, sandstone and mudstone.		
0.40	D	0ppm				0.50	MADE GROUND: Black slightly clayey sandy angular to subrounded fine to coarse gravel of brick, concrete, sandstone and mudstone with frequent cobbles of brick and concrete.		
0.50	CBR	113							
0.70	CBR	113							
1.00	D	0ppm				(1.40)	REWORKED CLAY: Firm to stiff grey brown slightly sandy slightly gravelly clay with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and occasional brick		
1.50	SV	49.3				1.90			
2.00	D	0ppm				(1.00)	Firm to stiff grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
2.50	SV	101				2.90			
							End of hole at 2.9m		

Shoring/Support: None
Stability: Good



GENERAL REMARKS

No visual or olfactory evidence of contamination
Brick infill wall on north face of pit

All dimensions in metres
Scale 1:50

Client Taylor Wimpey - Manchester

Method/
Plant Used

JCB 3CX

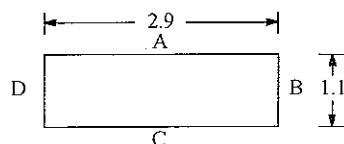
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TRIAL PIT LOG

Project Phase 3 Calderstones Park, Whalley				TRIAL PIT No TP06	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		
Contractor GSS				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.20	CBR	Refusal				0.20	MADE GROUND (TOP SOIL): Black brown organic slightly sandy gravelly clay. Gravel is angular to subrounded fine to coarse of brick, concrete, sandstone and mudstone.		
0.50	CBR	Refusal				(0.80)	MADE GROUND: Black slightly clayey sandy angular to subrounded fine to coarse GRAVEL of brick, concrete, sandstone and mudstone with frequent cobbles of brick and concrete.		
0.50	B	Oppm				1.00			
1.00	SV	38.7					Firm to stiff grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
1.50	B	Oppm							
2.00	SV	45.3				(2.20)			
3.00	SV	68.7				3.20			
							End of hole at 3.2m		

Shoring/Support: None
Stability: Poor



GENERAL REMARKS

No visual or olfactory evidence of contamination

All dimensions in metres
Scale 1:50

Client Taylor Wimpey - Manchester

Method/
Plant Used JCB 3CX

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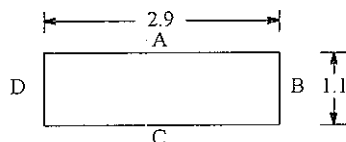
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TRIAL PIT LOG

Project Phase 3 Calderstones Park, Whalley				TRIAL PIT NO TP07	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		
Contractor GSS				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.30	D	0ppm				(0.50) 0.50	MADE GROUND (TARMAC): Black sandy angular to subrounded fine to coarse gravel of tarmac underlain by angular to subrounded fine to coarse gravel of limestone.		
1.50	D	0ppm				(2.00) 2.50	MADE GROUND: Black brown slightly clayey sandy angular to subrounded fine to coarse gravel of brick, concrete, sandstone and mudstone with frequent cobbles and boulders of brick and concrete		
3.00	SV	112				(0.60) 3.10	Firm to stiff grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
3.00	D	0ppm					End of hole at 3.1m		

Shoring/Support: None
Stability: Good



GENERAL REMARKS

No visual or olfactory evidence of contamination

All dimensions in metres
Scale 1:50

Client Taylor Wimpey - Manchester

Method/
Plant Used JCB 3CX

Logged By BC

Log: 08c/08 TRIAL PIT LOG L:\SALE PROJECTS\25680E CALDERSTONES HOSPITAL PHASE 3 WHALLEY, CLUTHIER\PRODUCTION\DATA - GEO ENV\GEO DATA\GINT\25680E.GPJ CLARKE BOND.GDT 16/02/2011 12:00:42

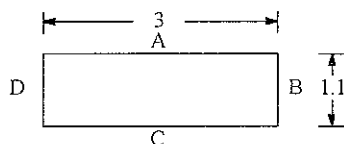
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clarkebond

TRIAL PIT LOG

Project Phase 3 Calderstones Park, Whalley				TRIAL PIT NO TP09	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		Sheet 1 of 1
Contractor GSS					

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
0.20	CBR	1				0.20	MADE GROUND (TOP SOIL): Grass onto black brown organic slightly sandy gravelly clay. Gravel is angular to subrounded fine to coarse of brick, concrete, sandstone and mudstone.		
0.50	CBR	1.13					REWORKED CLAY: Firm to stiff grey brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and occasional brick		
0.70	CBR	1.25				(1.30)			
1.00	SV	33.3				1.50			
1.00	D	0ppm							
2.00	SV	57.67				(1.50)	Firm to stiff grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
2.00	D	0ppm				3.00			
							End of hole at 3.0m		

Shoring/Support: None
Stability: Good



GENERAL REMARKS

No visual or olfactory evidence of contamination

All dimensions in metres
Scale 1:50

Client Taylor Wimpey - Manchester

Method/
Plant Used JCB 3CX

Logged By BC

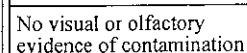
08c/08

Log 108C CB06 TRIAL PIT LOG L15ALE PROJECT\56608E CALDERSTONES HOSPITAL PHASE 3, WHALLEY CLUTHERO PRODUCTION DATA - GEO ENVOIS DATA\GIN T25680E.GPJ CLARKE BOND.GDT 16/02/2011 12:00:42

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GENERAL
REMARKS

Logged By	BC
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WINDOW SAMPLE LOG

Project Phase 3 Calderstones Park, Whalley				WINDOW SAMPLE NO. WS01	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		
Contractor GSS				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
						0.10	MADE GROUND (TOP SOIL): Black brown organic slightly sandy gravelly CLAY. Gravel is angular to subrounded fine to medium of brick, concrete, sandstone and mudstone.		
						0.30			
						(2.70)	REWORKED CLAY: Firm to stiff grey brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and occasional brick. Firm to stiff grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
2.00	SPT	N13							
2.00	D	0ppm							
3.00	SPT	N10				3.00			
3.00	D	0ppm					End of hole at 3.0m		

Boring Progress and Water Observations						GENERAL REMARKS
Date	Time	Depth	Tube Depth	Tube Dia mm	Water Dpt	
						No visual or olfactory evidence of contamination
All dimensions in metres Scale 1:50		Client Taylor Wimpey - Manchester		Method/ Plant Used Competitor		Logged By BC

Project Phase 3 Calderstones Park, Whalley				WINDOW SAMPLE No WS02	
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()		
Contractor GSS				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick- ness)		
1 00 1 00	D SPI	0ppm N10			0.20	MADE GROUND (TOP SOIL): Black brown organic slightly sandy gravelly clay. Gravel is angular to subrounded fine to medium of brick, concrete, sandstone and mudstone.		
					(1 10)	REWOKED CLAY: Firm to stiff grey brown slightly sandy slightly gravelly CLAY with occasional rootlets. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and occasional brick		
					1.30			
					(0 70)	Firm to stiff grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
2 00	D	0ppm			2.00			
						NO RECOVERY		
					(1 00)			
					3.00			
3 00	SPI	N5			(1 00)	Firm to stiff grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
					4.00			
4 00 4 00	D SPI	0ppm N10				End of hole at 4 0m		

Boring Progress and Water Observations						GENERAL REMARKS
Date	Time	Depth	Tube Depth	Tube Dia mm	Water Dpt	
						No visual or olfactory evidence of contamination
All dimensions in metres Scale 1:50			Client Taylor Wimpey - Manchester		Method/ Plant Used	Competitor
Logged By BC						

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WINDOW SAMPLE LOG

Project Phase 3 Calderstones Park, Whalley				WINDOW SAMPLE No WS03
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()	Sheet 1 of 1
Contractor GSS				

SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	DESCRIPTION		
						MADE GROUND (TOP SOIL): Black brown organic slightly sandy gravelly clay. Gravel is angular to subrounded fine to medium of brick, concrete, sandstone and mudstone.		
						MADE GROUND (SUBBASE): Grey slightly clayey sandy angular to subangular fine to medium gravel of limestone		
						Firm to stiff grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
						Soft to firm band at location of water strike at 4.0m		
2.00 2.00	SPT D	N13 0ppm						
3.00	SPT	N9						
4.00	SPT	N8						
5.00 5.00	SPT D	N12 0ppm				End of hole at 5.0m		

Boring Progress and Water Observations

Date	Time	Depth	Tube Depth	Tube Dia. mm	Water Dpt	GENERAL REMARKS
						No visual or olfactory evidence of contamination

All dimensions in metres
Scale 1:50

Client Taylor Wimpey - Manchester

Method/
Plant Used

Competitor

Logged By
BC

Log: 08f CBGE WINDOW SAMPLE LOG L:\SALE PROJECTS\25680E CALDERSTONES HOSPITAL PHASE 3, WHALLEY, CLUTHORE\PRODUCTION\DATA - GEO ENV\CBG DATA\GINT\25680E GPJ CLARKE BOND.GDT 16/02/2011 12:02:00

WINDOW SAMPLE LOG

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Project Phase 3 Calderstones Park, Whalley				WINDOW SAMPLE No WS04
Job No 25680E	Date 24-01-11	Ground Level (m)	Co-Ordinates ()	Sheet 1 of 1
Contractor GSS				

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thickness)	DESCRIPTION		
						0.30	MADE GROUND (TARMAC): Black sandy angular to subrounded fine to coarse gravel of tarmac.		
1.00	D/I					(1.00)	MADE GROUND: Black brown slightly clayey sandy angular to subrounded fine to coarse gravel of brick, concrete, sandstone and mudstone with frequent cobbles of brick and concrete		
						1.30			
2.00	D/I					(1.10)	REWORKED CLAY: Firm to stiff grey brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse of sandstone, mudstone and occasional brick		
						2.40			
3.00	SPI	N13					Firm to stiff grey slight sandy slightly gravelly CLAY. Gravel is angular to subrounded of mudstone and rare sandstone		
						(2.60)			
4.00	SPI	N12							
						5.00			
5.00	SPI	N10					End of hole at 5.0m		

Boring Progress and Water Observations

Date	Time	Depth	Tube Depth	Tube Dia mm	Water Dpt	GENERAL REMARKS
						No visual or olfactory evidence of contamination

All dimensions in metres Scale 1:50	Client Taylor Wimpey - Manchester	Method/ Plant Used	Competitor	Logged By BC
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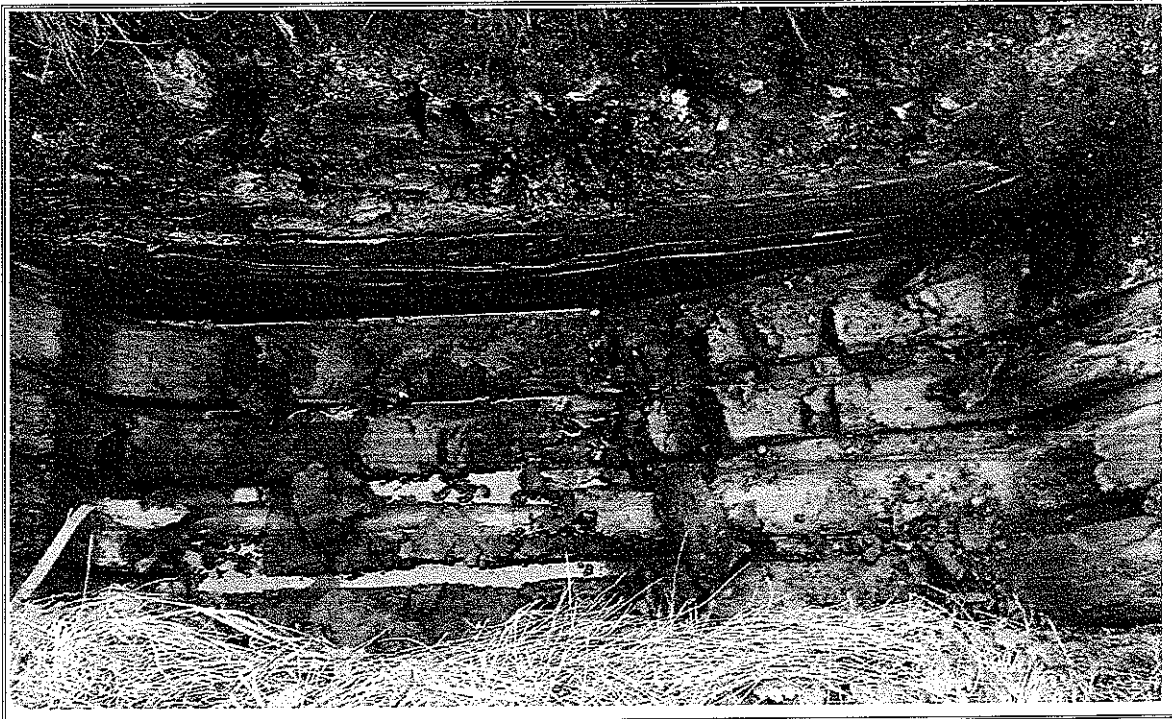


Figure 1 – TP1/SW1



Figure 2 – TP1/SW1 Arisings



Figure 3 – TP2/SW2



Figure 4 – TP2/SW2 Arisings

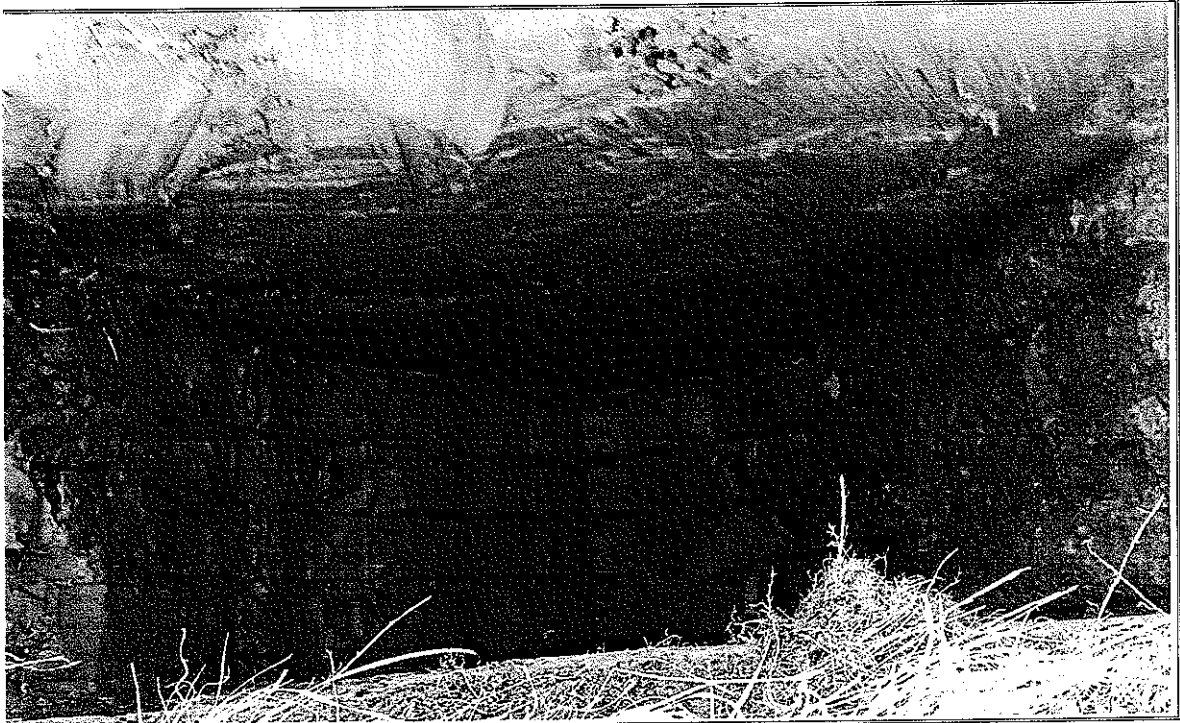


Figure 5 – TP3



Figure 6 – TP3 Arisings

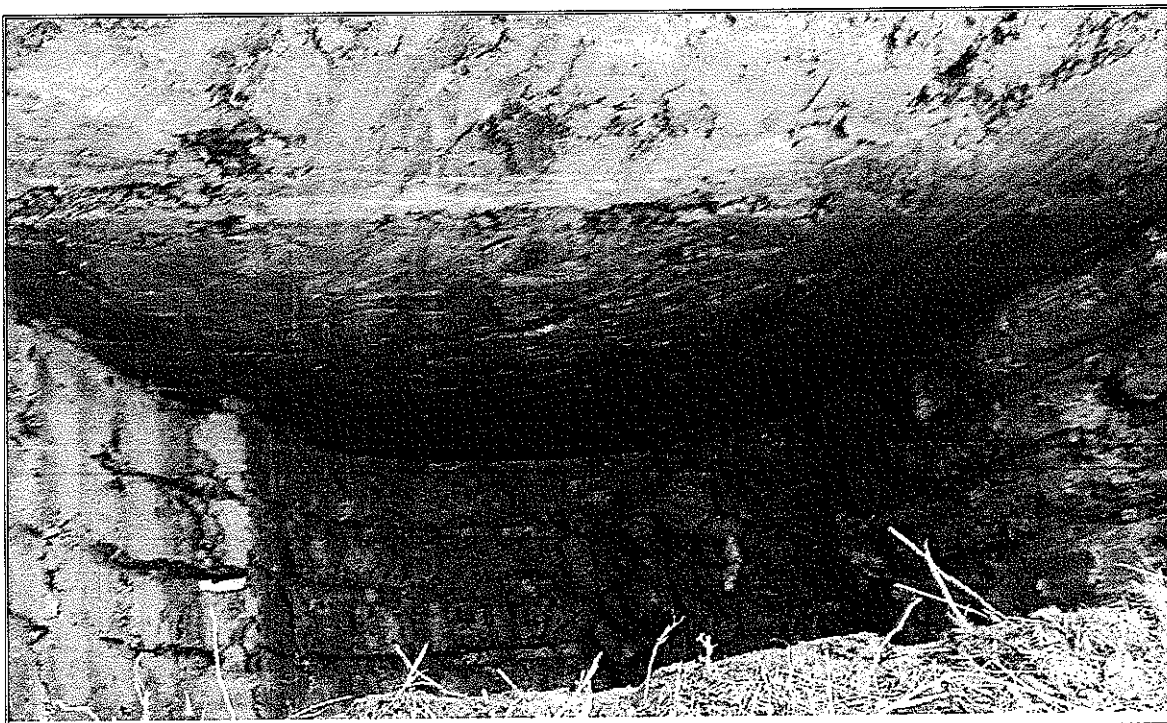


Figure 7 – TP4



Figure 8 – TP4 Arisings



Figure 9 – TP5



Figure 10 – TP5 Arisings

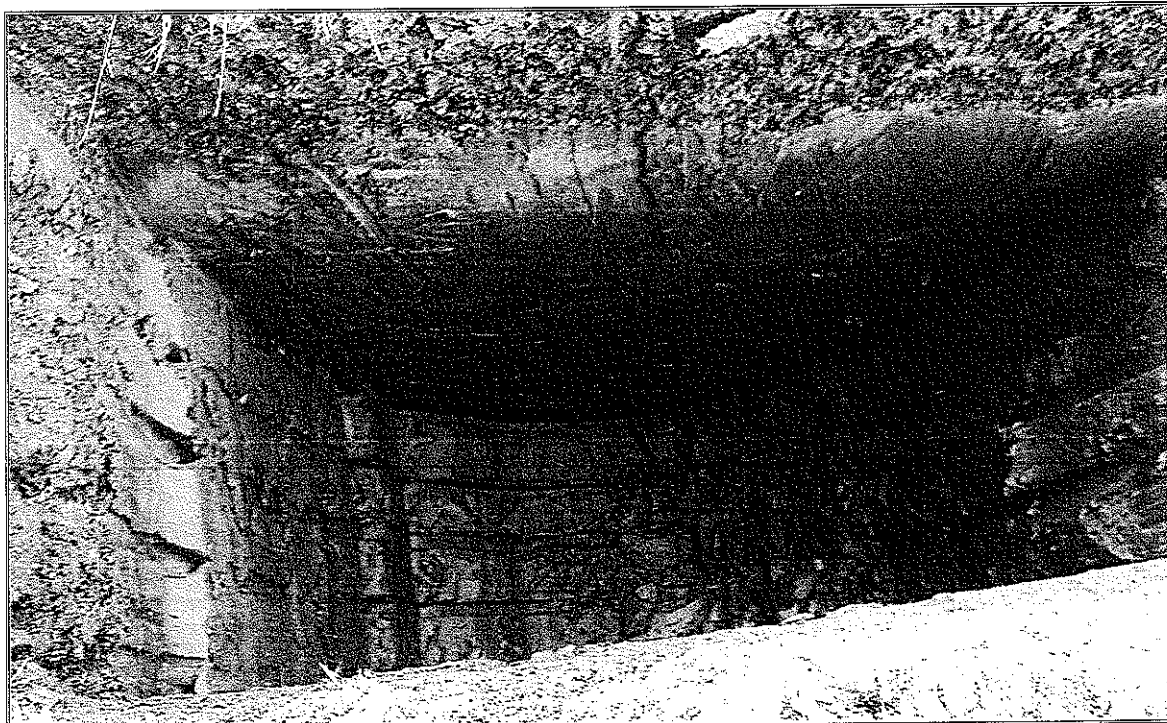


Figure 11 – TP6



Figure 12 – TP6 Arisings

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Figure 13 – TP7



Figure 14 – TP7 Arisings

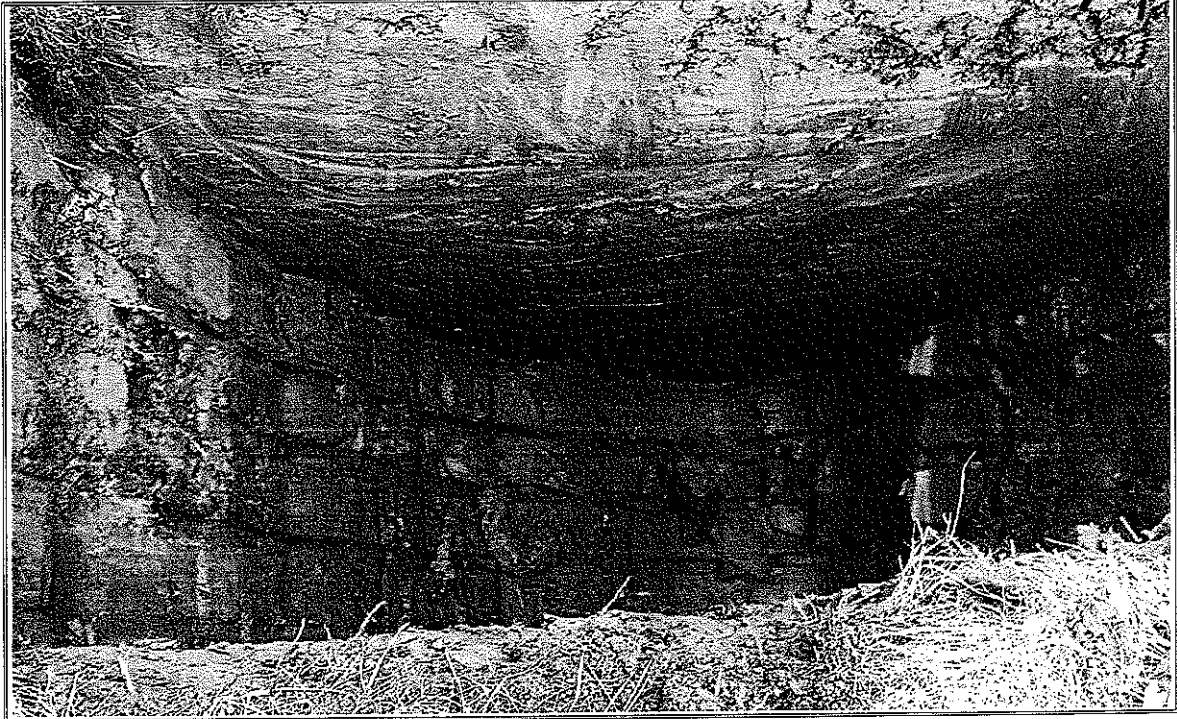


Figure 15 – TP9

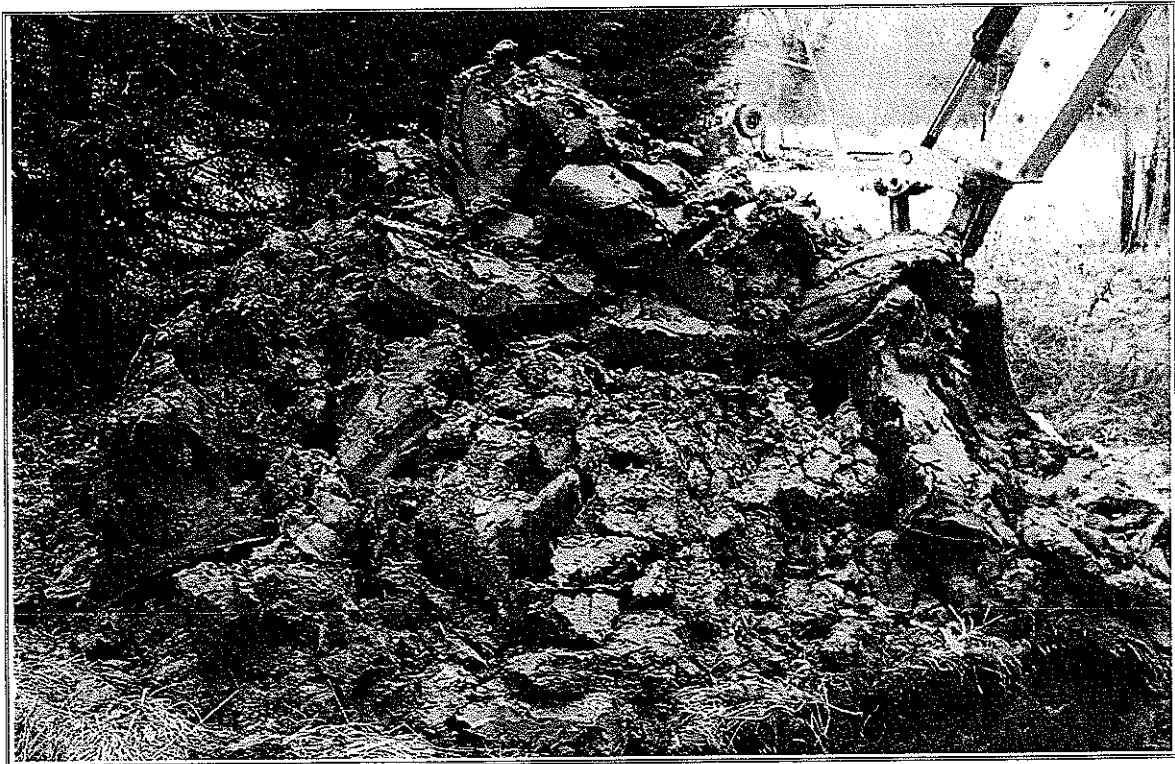


Figure 16 – TP9 Arisings

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Figure 17 – TP10



Figure 18 – TP10 Arisings

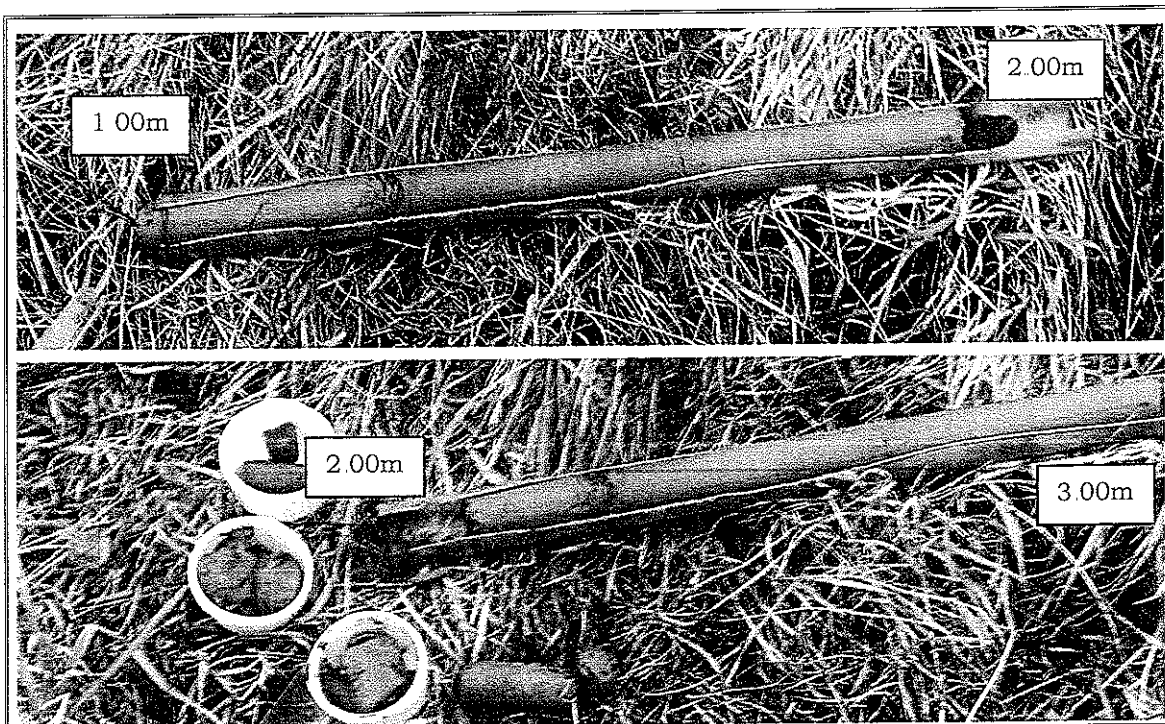


Figure 19 – WS1

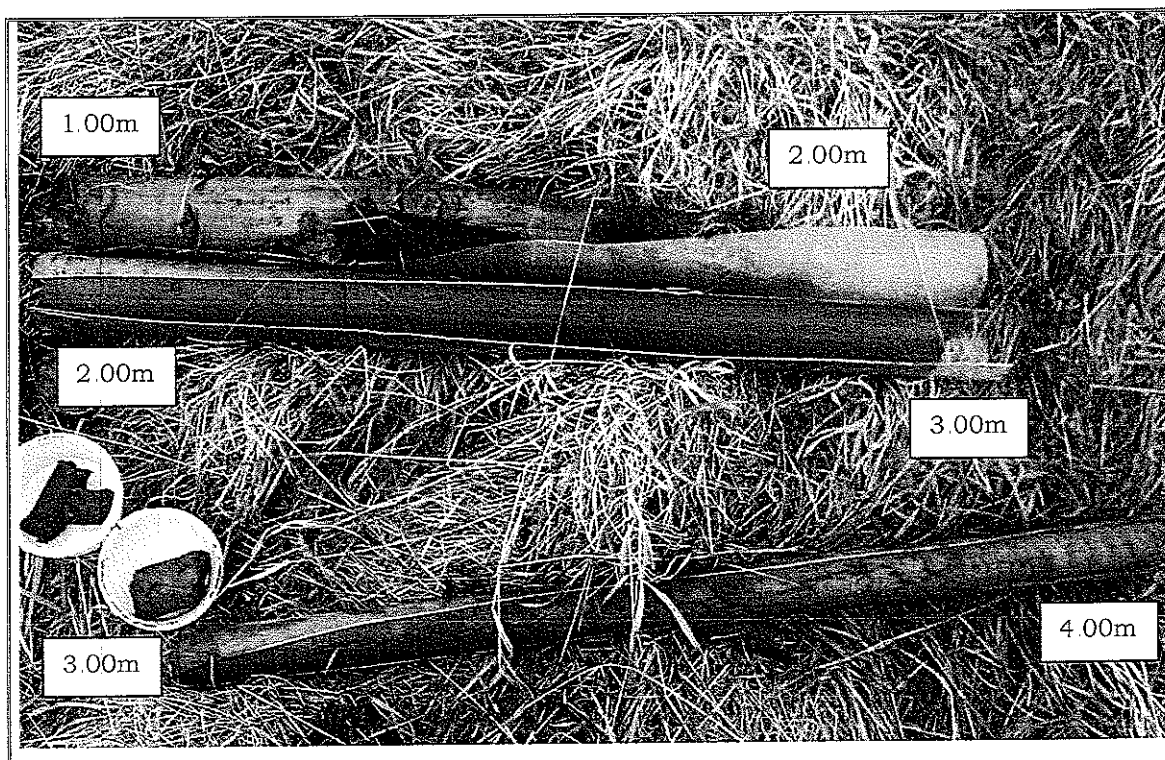


Figure 20 – WS2

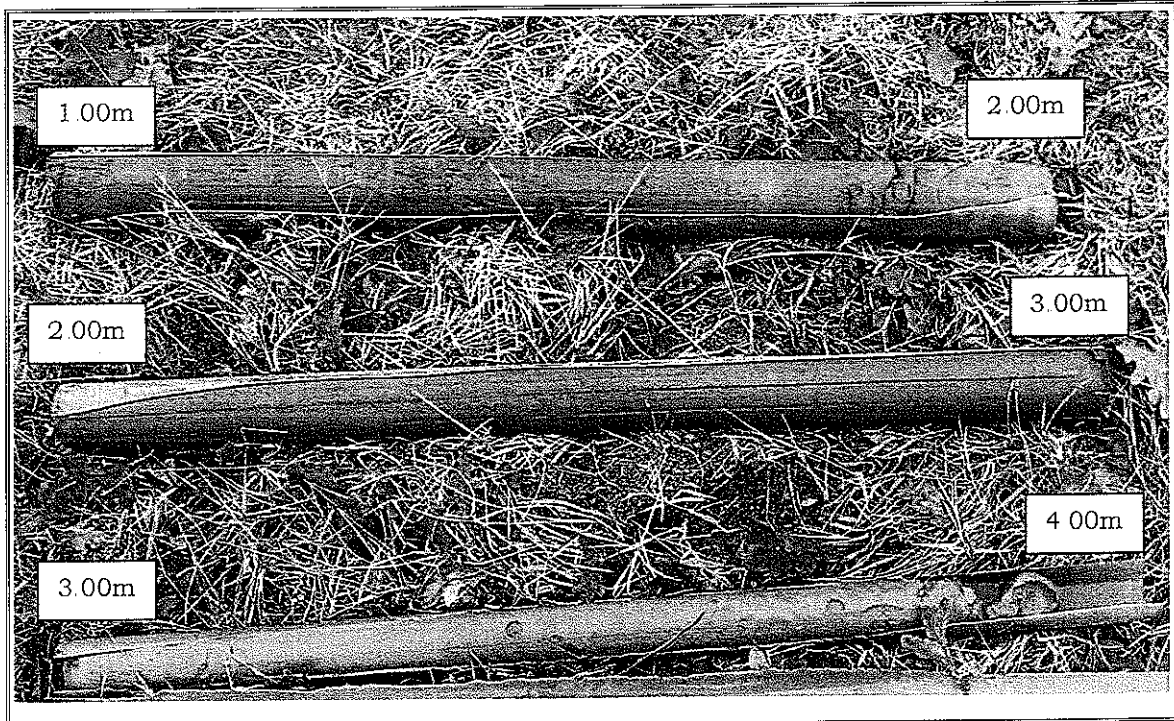


Figure 21 – WS3

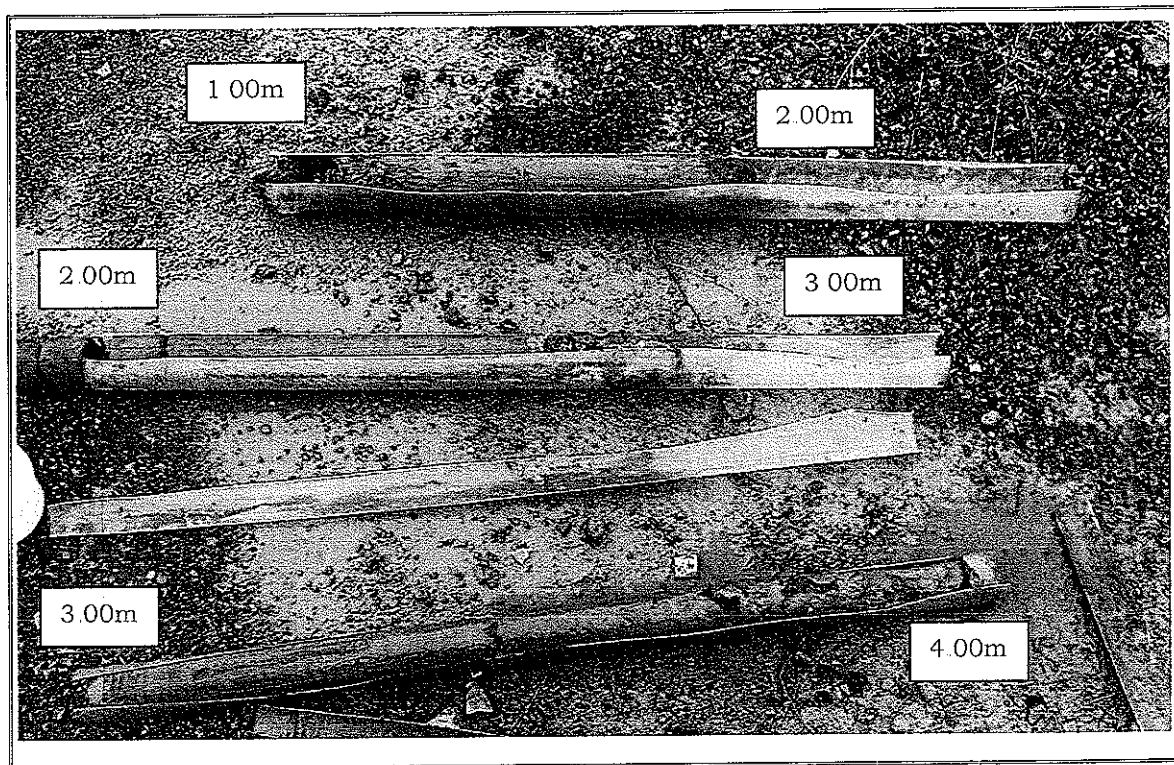


Figure 22 – WS4

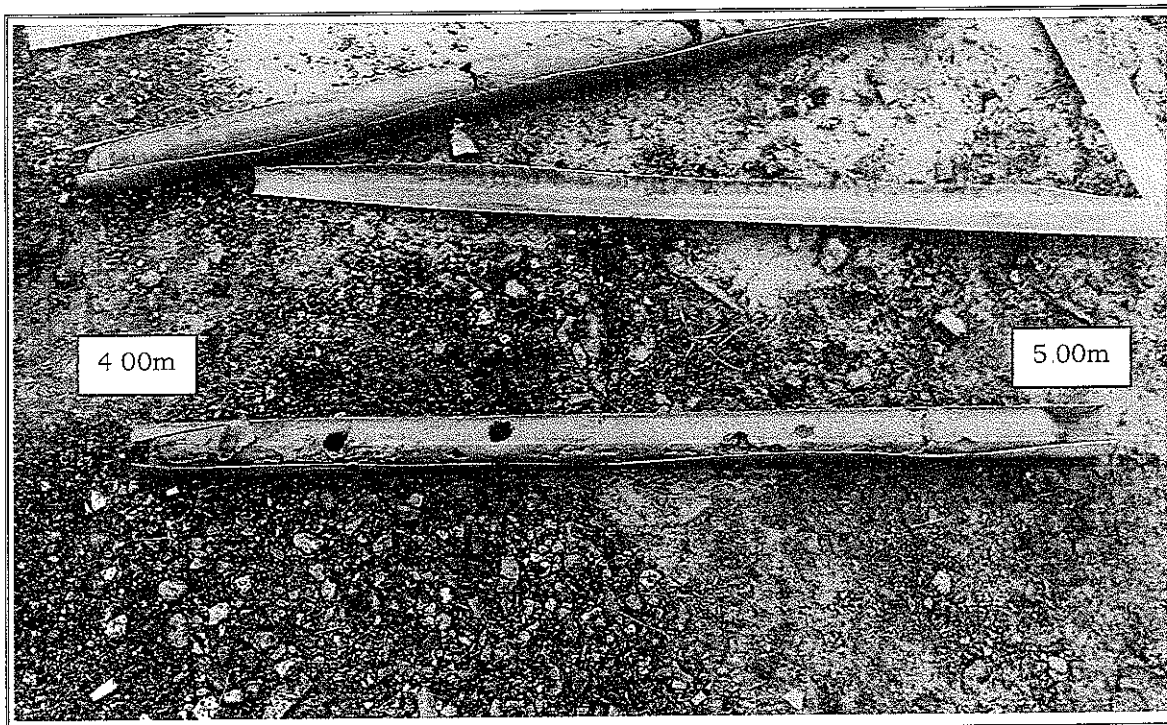
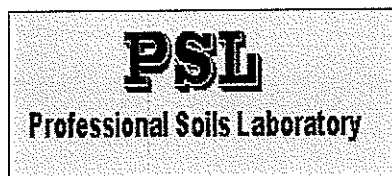


Figure 23 – WS4

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Appendix C - Geotechnical Test Results



LABORATORY REPORT



4043

Contract Number: PSL11/0215

Client's Reference:

Report Date: 03 February 2011

Client Name: Clarke Bond
Bridgewater Street
Sale
Cheshire

M33 7EQ

For the attention of: Ben Calpin

Contract Title: Calderstones Hospital

Date Received: 31-January-11
Date Commenced: 31-January-11
Date Completed: 03-February-11

Notes: Observations and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

R Gunson
(Director)

A Watkins
(Director)

M Beastall
(Laboratory Manager)

320110837P

 Professional Soils Laboratory				CALDERSTONES HOSPITAL			
Compiled by	<i>[Signature]</i>	Date	02/02/11	Checked by	<i>[Signature]</i>	Date	03/02/11
				Approved by		<i>[Signature]</i>	
				Contract No:		PSL11/0215	
				Client Ref:		25608E	

(B.S. 1377 : PART 2 : 1990)

SYMBOLS: NP : Non Plastic

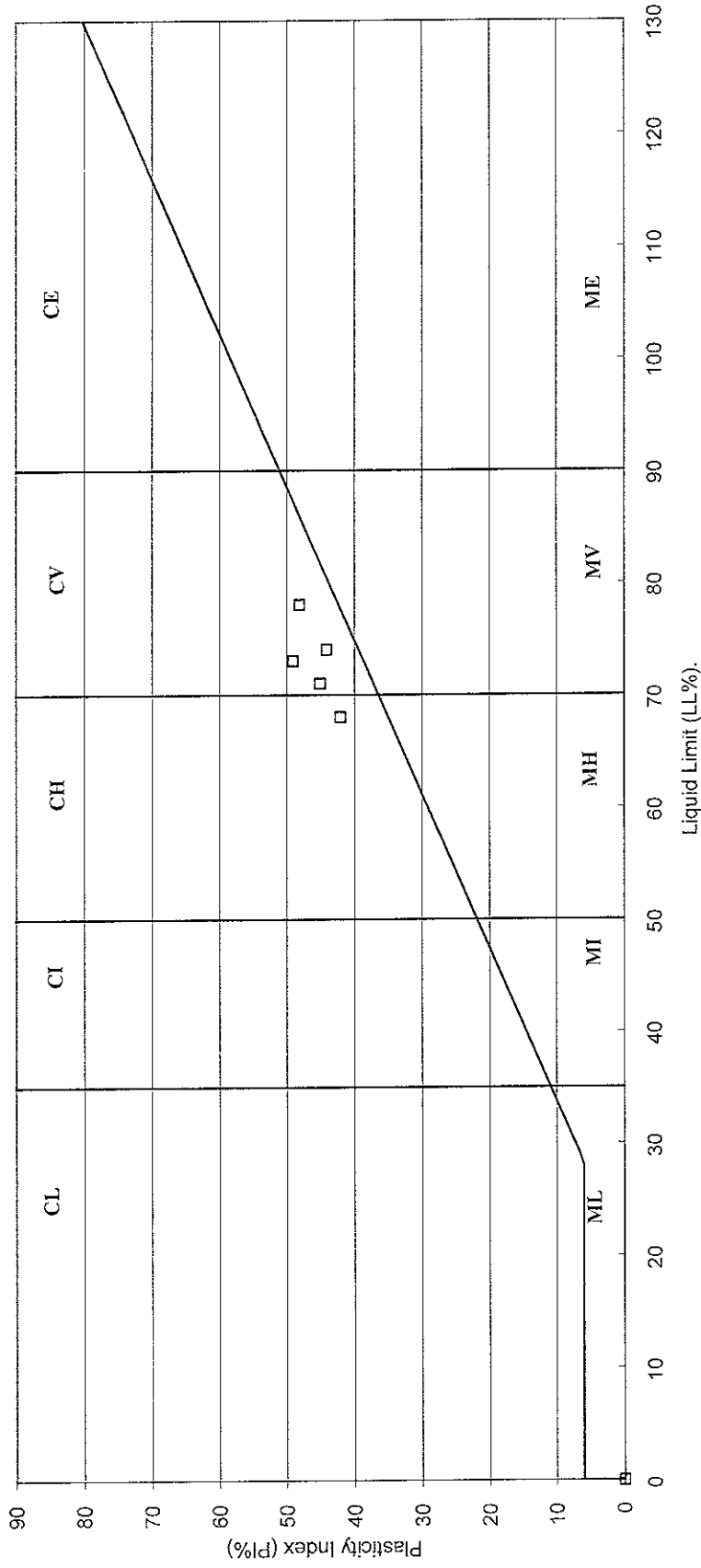
* : Liquid Limit and Plastic Limit Wet Sieved.

PSLR002 Issue 1

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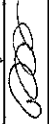
PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.

(B.S.5930 : 1999)





Professional Soils Laboratory

Compiled by	Date	Checked by	Date	Approved by	Date
	02/02/11		03/02/11		03/02/11
CALDERSTONES HOSPITAL			Contract No: PSL11/0216 Client Ref: (25608E)		

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Appendix D - Chemical Test Results

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Scientific Analysis Laboratories is a
limited company registered in England and
Wales (No 2514788) whose address is at
Hadfield House Hadfield Street Manchester M16 9FE

Scientific Analysis Laboratories

Certificate of Analysis

Hadfield House
Hadfield Street
Cornbrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2468

Report Number: 226022-1

Date of Report: 04-Feb-2011

Customer: Clarke Bond Group Ltd
Bridgewater House
Bridgewater Street
Sale
Cheshire
M33 7EQ

Customer Contact: Mr Ben Calpin

Customer Job Reference: 25608E

Date Job Received at SAL: 27-Jan-2011

Date Analysis Started: 28-Jan-2011

Date Analysis Completed: 04-Feb-2011

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs



1549

Report checked
and authorised by :
Mr Ross Walker
Customer Services Manager

Issued by :
Mr Ross Walker
Customer Services Manager

A handwritten signature in black ink, appearing to read 'Mr Ross Walker', is placed next to the text 'Customer Services Manager'.

320110837P

SAL Reference: 226022 Customer Reference: 25608E														
Soil ICRCL (Max)				Analysed as Soil										
SAL Reference					226022 001	226022 002	226022 003	226022 004	226022 005	226022 006	226022 007	226022 008	226022 009	226022 010
Customer Sample Reference					TP4 0.1	TP51.0	TP9 1.0	TP1 0.4	TP10 0.1	TP2 0.1	TP10 2.0	TP3 0.3	TP1 1.5	TP1 0.1
Date Sampled					24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011
Determinand	Method	Test Sample	LOD	Units										
Arsenic	T6	AR	1	mg/kg	29	18	22	11	17	10	13	28	13	11
Boron (water-soluble)	T6	AR	1	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium	T6	AR	1	mg/kg	1	1	2	<1	1	<1	2	1	<1	<1
Chromium	T6	AR	1	mg/kg	26	36	41	18	32	20	34	26	38	16
Chromium VI	T6	AR	1	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Copper	T6	AR	1	mg/kg	52	35	41	31	35	30	36	60	26	34
Lead	T6	AR	1	mg/kg	150	60	38	300	970	180	34	61	45	98
Mercury	T6	AR	1	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Nickel	T6	AR	1	mg/kg	29	48	69	21	43	19	48	40	29	16
Selenium	T6	AR	3	mg/kg	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Zinc	T6	AR	1	mg/kg	170	100	120	220	280	190	110	100	100	110
Cyanide(Total)	T4	AR	1	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cyanide(free)	T4	AR	1	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Phenols(Mono)	T4	AR	1	mg/kg	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
SO4(Total)	T6	AR	0.01	%	0.20	0.08	0.03	0.31	0.35	0.25	0.08	0.22	0.10	0.19
Sulphide	T4	AR	10	mg/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Sulphur(Free)	T2	AR	500	mg/kg	<500	<500	<500	<500	<500	<500	<500	<500	<500	<500
Thiocyanate	T4	AR	10	mg/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	T149	AR	0.01	mg/kg	0.08	0.01	0.02	1.6	0.03	0.33	0.01	0.17	0.05	0.23
Acenaphthylene	T149	AR	0.01	mg/kg	0.04	<0.01	<0.01	0.12	<0.01	0.09	<0.01	0.05	0.01	0.04
Acenaphthene	T149	AR	0.01	mg/kg	0.04	<0.01	<0.01	1.8	0.01	0.46	<0.01	0.23	0.10	0.47
Fluorene	T149	AR	0.01	mg/kg	0.05	<0.01	<0.01	1.3	0.01	0.34	0.01	0.22	0.07	0.33
Phenanthrene	T149	AR	0.01	mg/kg	0.72	0.06	0.03	13	0.10	4.0	0.03	2.2	0.80	3.5
Anthracene	T149	AR	0.01	mg/kg	0.19	0.02	<0.01	3.0	0.02	0.83	<0.01	0.64	0.17	0.84
Fluoranthene	T149	AR	0.01	mg/kg	1.5	0.17	0.02	16	0.19	5.7	0.01	2.5	0.93	4.5
Pyrene	T149	AR	0.01	mg/kg	1.3	0.14	0.02	14	0.15	4.8	0.01	2.2	0.78	3.9
Benzo(a)Anthracene	T149	AR	0.01	mg/kg	0.66	0.09	0.01	6.8	0.09	2.5	0.01	1.3	0.42	2.3
Chrysene	T149	AR	0.01	mg/kg	0.66	0.08	0.02	6.9	0.10	2.5	0.02	1.3	0.41	2.1
Benzo(b)Fluoranthene	T149	AR	0.01	mg/kg	0.89	0.11	0.01	8.1	0.12	3.2	0.01	1.6	0.50	2.8
Benzo(a)Pyrene	T149	AR	0.01	mg/kg	0.52	0.06	<0.01	4.9	0.06	1.8	0.01	1.0	0.28	1.6
Indeno(123-cd)Pyrene	T149	AR	0.01	mg/kg	0.25	0.03	<0.01	2.1	0.03	0.80	<0.01	0.47	0.12	0.65
Dibenzo(ah)Anthracene	T149	AR	0.01	mg/kg	0.06	0.01	<0.01	0.59	0.01	0.22	<0.01	0.14	0.03	0.19
Benzo(ghi)Perylene	T149	AR	0.01	mg/kg	0.25	0.03	<0.01	2.1	0.03	0.85	0.01	0.47	0.12	0.65
PAH(total)	T149	AR	0.01	mg/kg	7.2	0.81	0.13	82	0.95	28	0.13	14	4.8	24

SAL Reference: 226022 Customer Reference: 25608E														
Soil pH and Sulphate (2:1)				Analysed as Soil										
SAL Reference					226022 001	226022 002	226022 003	226022 004	226022 005	226022 006	226022 007	226022 008	226022 009	226022 010
Customer Sample Reference					TP4 0.1	TP51.0	TP9 1.0	TP1 0.4	TP10 0.1	TP2 0.1	TP10 2.0	TP3 0.3	TP1 1.5	TP1 0.1
Date Sampled					24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011	24-JAN- 2011
Determinand	Method	Test Sample	LOD	Units										
SO4(2:1)	T6	AR	0.1	g/l	-	-	<0.1	<0.1	-	-	<0.1	-	-	-
pH	T7	AR			7.2	7.2	7.3	8.3	7.5	7.9	8.2	8.1	7.9	8.2

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SAL Reference: 226022															
Customer Reference: 25608E															
Soil		Analysed as Soil													
TOC															
SAL Reference		226022 001	226022 002	226022 003	226022 004	226022 005	226022 006	226022 007	226022 008	226022 009	226022 010				
Customer Sample Reference		TP4 0.1	TP51.0	TP9 1.0	TP1 0.4	TP10 0.1	TP2 0.1	TP10 2.0	TP3 0.3	TP1 1.5	TP1 0.1				
Date Sampled		24-JAN-2011	24-JAN-2011	24-JAN-2011	24-JAN-2011	24-JAN-2011	24-JAN-2011	24-JAN-2011	24-JAN-2011	24-JAN-2011	24-JAN-2011				
Determinand	Method	Test Sample	LOD	Units											
Total Organic Carbon	T21	AR	0.1	%	7.7	2.8	1.7	4.2	8.5	5.5	1.5	9.4	1.6	2.6	

Index to symbols used in 226022-1

Value	Description
AR	As Received
U	Analysis is UKAS accredited
N	Analysis is not UKAS accredited

Method Index

Value	Description
T4	Colorimetry
T7	Probe
T2	Grav
T21	OX/IR
T149	GC/MS (SIR)
T6	ICP/OES

Accreditation Summary

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Total Organic Carbon	T21	AR	0.1	%	N	001-010
SO4(2:1)	T6	AR	0.1	g/l	N	003-004,007
pH	T7	AR			U	001-010
Arsenic	T6	AR	1	mg/kg	U	001-010
Boron (water-soluble)	T6	AR	1	mg/kg	N	001-010
Cadmium	T6	AR	1	mg/kg	U	001-010
Chromium	T6	AR	1	mg/kg	U	001-010
Chromium VI	T6	AR	1	mg/kg	N	001-010
Copper	T6	AR	1	mg/kg	U	001-010
Lead	T6	AR	1	mg/kg	U	001-010
Mercury	T6	AR	1	mg/kg	U	001-010
Nickel	T6	AR	1	mg/kg	U	001-010
Selenium	T6	AR	3	mg/kg	U	001-010
Zinc	T6	AR	1	mg/kg	U	001-010
Cyanide(Total)	T4	AR	1	mg/kg	U	001-010
Cyanide(free)	T4	AR	1	mg/kg	U	001-010
Phenols(Mono)	T4	AR	1	mg/kg	U	001-010
SO4(Total)	T6	AR	0.01	%	N	001-010
Sulphide	T4	AR	10	mg/kg	N	001-010
Sulphur(Free)	T2	AR	500	mg/kg	N	001-010
Thiocyanate	T4	AR	10	mg/kg	N	001-010
Naphthalene	T149	AR	0.01	mg/kg	U	001-010
Acenaphthylene	T149	AR	0.01	mg/kg	U	001-010
Acenaphthene	T149	AR	0.01	mg/kg	U	001-010
Fluorene	T149	AR	0.01	mg/kg	U	001-010
Phenanthrene	T149	AR	0.01	mg/kg	U	001-010
Anthracene	T149	AR	0.01	mg/kg	U	001-010
Fluoranthene	T149	AR	0.01	mg/kg	U	001-010
Pyrene	T149	AR	0.01	mg/kg	U	001-010
Benzo(a)Anthracene	T149	AR	0.01	mg/kg	U	001-010
Chrysene	T149	AR	0.01	mg/kg	U	001-010
Benzo(b/k)Fluoranthene	T149	AR	0.01	mg/kg	U	001-010
Benzo(a)Pyrene	T149	AR	0.01	mg/kg	U	001-010
Indeno(123-cd)Pyrene	T149	AR	0.01	mg/kg	U	001-010

Determinand	Method	Test Sample	LOD	Units	Symbol	SAL References
Dibenzo(ah)Anthracene	T149	AR	0.01	mg/kg	U	001-010
Benzo(ghi)Perylene	T149	AR	0.01	mg/kg	U	001-010
PAH(total)	T149	AR	0.01	mg/kg	U	001-010

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Appendix E - Ground Gas Monitoring

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clarkebond

Job No:	25608E
Date:	04/02/11
Engineer:	DT

Site:	Calderstone Hospital
Client:	Taylor Wimpey
Equipment:	GA2000 Gas Analyser

BH01	Flow Rate (l/h)	Pressure Differential	Gas Concentration										Water		Start		Finish	
			Peak					Steady					Depth to Water	Depth to Base	Time	Barometric Pressure	Time	Barometric Pressure
			CH ₄ %	CO ₂ %	O ₂ %	LEL %	H ₂ S/ CO (ppm)	CH ₄ %	CO ₂ %	O ₂ %	LEL %	H ₂ S/ CO (ppm)						
04/02/11	0	-0.18	0	0.1	20.2	79.7	210	0	0.1	20.2	79.7	210	1.34	2.1	2 30pm	997		
15/02/11	0	0.12	0.1	0.1	21	78.8	290	0.1	0.1	21	78.8	274	1.68	2.3	3 00pm	977		

WS01	Flow Rate (l/h)	Pressure Differential	Gas Concentration										Water		Start		Finish	
			Peak					Steady					Depth to Water	Depth to Base	Time	Barometric Pressure	Time	Barometric Pressure
			CH ₄ %	CO ₂ %	O ₂ %	LEL %	H ₂ S/ CO (ppm)	CH ₄ %	CO ₂ %	O ₂ %	LEL %	H ₂ S/ CO (ppm)						
04/02/11	0	-0.12	0	0.2	20.3	79.5	137	0	0	20.5	79.5	137	0.57	2.1	2 45pm	997		
15/02/11	-4.9	0	0.1	0.5	20.8	78.6	233	0.1	0.5	20.8	78.6	233	0.4	2.1	3 15pm	977		

WS02	Flow Rate (l/h)	Pressure Differential	Gas Concentration										Water		Start		Finish	
			Peak					Steady					Depth to Water	Depth to Base	Time	Barometric Pressure	Time	Barometric Pressure
			CH ₄ %	CO ₂ %	O ₂ %	LEL %	H ₂ S/ CO (ppm)	CH ₄ %	CO ₂ %	O ₂ %	LEL %	H ₂ S/ CO (ppm)						
04/02/11			Vandalised: cannot locate															

WS03	Flow Rate (l/h)	Pressure Differential	Gas Concentration										Water		Start		Finish	
			Peak					Steady					Depth to Water	Depth to Base	Time	Barometric Pressure	Time	Barometric Pressure
			CH ₄ %	CO ₂ %	O ₂ %	LEL %	H ₂ S/ CO (ppm)	CH ₄ %	CO ₂ %	O ₂ %	LEL %	H ₂ S/ CO (ppm)						
04/02/11			Vandalised: gas readings as atmosphere										0.79		4 10pm	997		
15/02/11	0	-0.08	0.1	0.2	20.2	79.5	181	0.1	0.2	20.2	79.5	181	0.7	2.36	3 40pm	977		
			Note: Borehole again tampered with. Difficult to locate															

CH₄ Above the 1.0% v/v guideline value in Waste Management Paper no 27 (WMP27)CO₂ Above the 1.5% v/v guideline value given in WMP27

Date	Weather	Pressure Trend	Ground Conditions
04/02/11	Cloudy, mild, poor light		997 Damp
15/02/11	Light rain, 4 degrees		977 Wet

Appendix F - Former Site Assessment Reports

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RSK

GROUP PLC

**GEOENVIRONMENTAL SITE
INVESTIGATION REPORT**

CALDERSTONES PARK, WHALLEY

REFERENCE: 16372-R1 (01)

TAYLOR WIMPEY MANCHESTER

4 JUNE 2010

CONFIDENTIAL

320110837P



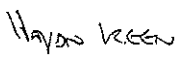
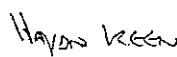
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GEOENVIRONMENTAL SITE INVESTIGATION REPORT CALDERSTONES PARK, WHALLEY

REPORT NO : 16372-R1 (01)

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DOCUMENT issue status

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Title	Name	Signature	Date
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Technical Reviewer	Haydn Keen		4 June 2010

This report is not to be used for contractual or engineering purposes unless the above is signed where indicated by the author, the project manager and the technical reviewer of the report and the report is designated 'FINAL'



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Appendix D	Methodology for Risk Assessment
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Appendix G	Ground Gas Monitoring Data
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EXECUTIVE SUMMARY

It is proposed to redevelop a parcel of land within Calderstones Park, Whalley, near Clitheroe with low-rise residential properties.

A Preliminary Risk Assessment (PRA) in relation to potentially contaminated land has been carried out based on a site walkover and review of published data, including historical maps and an environmental database

The site is indicated to be underlain directly by Boulder Clay, which is in turn underlain by solid geology consisting of the Clitheroe Limestone Formation and Hodder Mudstone Formation (undifferentiated). The geology is classed as a minor aquifer by the Environment Agency and the superficial deposits are indicated to have low leaching potential.

The site has been occupied by agricultural land with a small pond to the west and, more recently, a playing field. The area surrounding the site was largely occupied by agricultural land until the 1930s, when the Calderstones Hospital was constructed adjacent to the site. Some residential development took place to the south east of the site in the 1970s.

The PRA undertaken by RSK has identified a number of potential pollutant linkages associated with the site. These include ground gas migration (in particular from the backfilled pond) into excavations or buildings, and ingestion, inhalation or dermal contact with potentially contaminated soils / leachate from on- and off-site sources. It was therefore deemed necessary to carry out an intrusive investigation to confirm ground conditions prior to redevelopment.

The site investigation comprised the drilling of nine probeholes one borehole and ten shallow hand-dug pits across the site. During the investigation, soil samples were recovered and submitted to the laboratory for a range of testing. In situ geotechnical testing was also undertaken while drilling the probeholes and boreholes. A monitoring well was installed in two of the probeholes and the borehole to enable future monitoring of ground gas and groundwater.

Made ground was encountered to depths of less than 1.00m. Ashy made ground was encountered in the vicinity of WS2. It appears, from the hand-dug pits around WS2, that the ashy made ground represents a drainage layer placed across the playing field. The made ground was generally underlain by soft to firm sandy clay to depths of up to 2.10m, underlain in turn by firm/firm to stiff sandy clay to the full depth of drilling. In borehole BH1, however, the clay was soft/soft to firm to a depth of approximately 9.00m, and firm to stiff beneath this. A layer of peat was encountered in WS7 in the vicinity of the former pond.

The investigation has indicated the presence of elevated concentrations of a polyaromatic hydrocarbon compound (Benzo-a-pyrene) and some semi volatile organic compounds (SVOC's) within the thin layer of ashy made ground when compared against generic assessment criteria (GAC) for human health. It is therefore recommended that either a 600mm layer of clean cover

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material be placed over the ashy made ground in garden areas or the ashy layer is removed off-site in which case no cover would be required.

The ground gas assessment indicates that gas protection measures are not required at the site. However, depleted oxygen concentrations were recorded and it will therefore be necessary to continually monitor excavations for oxygen concentrations and a policy of no man-entry into excavations should be adopted unless suitable conditions are proven by gas monitoring.

The findings of the geotechnical assessment indicated that a Design Sulphate Class of DS-1 may be adopted for the site, and that an Aggressive Chemical Environment for Concrete classification of AC-1 may be assumed for design purposes. Wide strip or trench foundations are likely to be suitable for most of the development, whilst engineered fill with a semi-rigid raft foundation will be an option for foundations within the area of the former pond.

1. INTRODUCTION

RSK STATS Geoconsult Limited (RSK) was commissioned by Taylor Wimpey Manchester to carry out an environmental and geotechnical assessment of a parcel of land within Calderstones Park, Whalley, near Clitheroe. This assessment was carried out with the understanding that the site is to be redeveloped for residential end-use.

1.1 OBJECTIVES

The objectives of this assessment are as follows:

- To enable sufficient information regarding ground conditions to be obtained from which risks to end-users and the environment can be assessed; and
- To obtain sufficient information pertaining to ground conditions to assist in the design of foundations and infrastructure.

1.2 SCOPE

The scope of the investigation and layout of this report has been designed in accordance with CLR11 ⁽¹⁾ (all numbered references are listed at the end of this report in Section 8) and PPS23, as well as guidance issued by the Environment Agency in July 2005 for land contamination reports ⁽²⁾. A summary of relevant legislation and government policies applicable to land development is included in Appendix A.

The risk management process comprises up to three stages of risk assessment: preliminary, generic quantitative and detailed quantitative (PRA, GQRA and DQRA). The basis for the risk assessment is a conceptual model that is produced as part of the PRA and is updated throughout the risk management process.

The scope of works for the environmental assessment includes:

- A PRA involving the review of geological, hydrogeological and hydrological information, a commercially available database (Envirocheck report), historical plans and a site walkover. This information is used to construct an outline conceptual model and consider any possible pollutant linkages (where a receptor may be connected to a source by a viable pathway) that may be present and design intrusive investigation if required;
- Evaluation of possible pollutant linkages by intrusive investigation and laboratory analysis. This information is used to refine the conceptual model;
- GQRA to assess possible pollutant linkages identified in the PRA and enable outline conceptual model to be refined; and
- Provide recommendations for further works, DQRA and remedial actions of ground and groundwater (if deemed applicable)

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The scope of works for the geotechnical assessment includes:

- Review of published geological data including a commercially available database with information pertaining to ground stability;
- Review of utility location information and site walkover;
- Coal mining search/solution features search/cavities search;
- Intrusive investigation and laboratory analysis to enable soil parameters for geotechnical purposes to be ascertained; and
- Interpretation of ground conditions and geotechnical data to provide recommendations with respect to foundation, floor slab and infrastructure design.

1.3 LIMITATIONS

The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater and ground gas levels may vary from those reported due to seasonal, or other, effects.

This report is subject to the RSK STATS Geoconsult Limited service constraints given in Appendix B.

1.4 PREVIOUS WORK

RSK has not been provided with records of any previous site investigations undertaken at the site.

2. SITE DETAILS

The site location, description and future development are discussed below.

2.1 SITE LOCATION

The site is situated off Pendle Drive and currently forms part of Calderstones Park. It is located at National Grid reference SD 725 373, to the north west of the village of Whalley. The site lies within the grounds of Calderstones Hospital and is bounded to the east and west by residential properties, to the north by Pendle Drive and to the south by the remainder of Calderstones Park, an area of public open space. A site location plan is presented as Figure 1.

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2.2 SITE DESCRIPTION

The site occupies approximately 1.4ha, lies at an elevation of approximately 61m above Ordnance Datum (AOD) and is sensibly level. A site plan is presented as Figure 2.

2.3 FUTURE DEVELOPMENT

It is proposed to redevelop the site with low-rise residential properties. The proposed layout of the development is included on Figure 2.

3. PRELIMINARY RISK ASSESSMENT

The following describes the results of the review of available information for the site and the findings from the site inspection. The information, together with that presented in Section 2, has been used to identify potential contaminant sources and sensitive receptors, from which an outline conceptual model has been developed.

3.1 GEOLOGY

Published geological records, included in the Envirocheck report (reproduced in CD format in Appendix C) indicate the site to be underlain directly by drift deposits consisting of Devensian Till (Boulder Clay). This is underlain in turn by solid geology consisting of the Clitheroe Limestone Formation and Hodder Mudstone Formation (undifferentiated).

The mining and ground stability report, contained within the Envirocheck report, indicates the property is not within an area likely to be affected by coal mining or brine subsidence.

The potential for collapsible/compressible ground, ground dissolution, landslide, running sand, and shrinking/swelling clay ground stability are considered very low or no hazard.

The Envirocheck report indicates that the site is not in a radon affected area, as less than 1% of homes are above the action level; no radon protective measures are necessary in the construction of new dwellings or extensions.

3.2 HYDROGEOLOGY

The Groundwater Vulnerability Map provided within the Envirocheck report indicates the geology beneath the site to be classified as a minor aquifer, defined as fractured or potentially fractured rocks, which do not have a high primary permeability, or other formations of variable permeability including unconsolidated deposits. These aquifers will seldom produce large quantities of water for abstraction, but are important for both local supplies and in supplying base flow to rivers. The aquifer designation relates to the underlying solid geology.

3.2.1 Groundwater Abstractions

The Environment Agency has defined source protection zones (SPZ) for nearly 2,000 groundwater sources used for public drinking water supply. The SPZ provides an indication of the potential risk of pollution. Three zones (Inner, Outer and Total Catchment) are usually defined. The site is not situated within a groundwater SPZ

Groundwater abstractions identified within a 2km radius of the site are summarised in Table 1.

Reference	Distance and Orientation from Site	Comment
2671310010	1057m to north west	Abstraction borehole for general agricultural use (medium loss)
2671309052	1891m to north east	Abstraction borehole for general industrial/commercial/public services (medium loss)

Table 1: Groundwater Abstractions

3.2.2 Soil Leaching Potential

The soils beneath the site are classified as having low leaching potential. These are soils where pollutants are unlikely to penetrate the soil layer either as a result of largely horizontal water movement or because the soil has the ability to attenuate diffuse pollutants. Lateral flow in these soils may contribute to groundwater recharge elsewhere in the catchment and generally they have a high clay content.

3.3 HYDROLOGY

The nearest surface water feature to the site is a drain, approximately 200m to the south. Other drains/streams are present between 250m and 500m to the south east of the site. A pond is present approximately 400m to the north west. The River Calder and Barrow Brook are present approximately 700m to the south west and north of the site, respectively.

The River Calder, in a reach approximately 700m to the south west, is classified as having River Quality C grade water (fair).

3.3.1 Surface Water Abstractions

There is one surface water abstraction within 1km of the site, details of which are provided in Table 2

Reference	Distance and Orientation from Site	Comment
2671309037	606m to east	Impoundment of stream for Clitheroe Golf Club

Table 2: Surface Water Abstractions

3.3.2 Flooding

Information from the Envirocheck report indicates that the site is not located within a flood zone.

3.4 SENSITIVE LAND USES

The site is in a nitrate vulnerable zone. There are otherwise no identified sensitive land uses in the immediate vicinity of the site.

A comprehensive evaluation of ecological receptors is outside the scope of this report.

3.5 SITE HISTORY REVIEW

A review of the site history has been carried out through the study of Ordnance Survey maps dating from the late 1800s, and information from the regulatory authorities and trade directories. The review is designed to identify potential historic sources of contamination that may have impacted soil or groundwater quality beneath the site and to identify any potentially contaminative land uses in the area that may have impacted the site.

3.5.1 Historic Maps

A review of the historical maps for the site from between 1848 and 2009 were undertaken using the extracts provided within the Envirocheck report. Selected maps are presented as Figures 3 to 11. These are not to scale, although all the evaluations in this report have been made from the scaled plans.

3.5.1.1 History of the Site

The 1893 map (Figure 4) indicates the site to be occupied by agricultural land, with a pond and small strip of woodland in the western section of the site.

The 1912 map (Figure 5) indicates the presence of a small building (unspecified use) in the very north eastern most corner of the site. On later maps this is indicated to have been extended and named 'The Bungalow'

By 1932 (Figure 7) the pond appears to have been backfilled and the area replanted with trees. A football ground is now present across the main body of the site.

The 1968 map (Figure 8) indicates the site to be part of the Calderstones Hospital, although it remains occupied by a playing field, with no buildings on the site itself, other than the Bungalow.

The 1992 map (Figure 10) indicates a structure (possibly an area of hardstanding, not thought to be a building) in the western section of the site, though this has been removed from later mapping. The site remains largely unchanged to the latest date of mapping (2009).

3.5.1.2 History of the Surrounding Area

The 1848 map (Figure 3) indicates the area surrounding the site to be largely occupied by agricultural land, with some areas of woodland and a number of ponds nearby. A road (later indicated as Mitton Road) is present approximately 50m to the east of the site, while the Blackburn Railways lies approximately 500m to the east. A brick and tile works is present approximately 350m to the south east and a tile works approximately 500m to the north west

By 1913 (Figure 6) the brick and tile works to the south east and north west are indicated to no longer be operational. A new brick works, with a private railway leading to it, is present approximately 200m to the north of the site, with an associated clay pit approximately 175m to the west. Whalley railway station, with its associated goods sheds, is present approximately 1km to the south east.

The 1932 map (Figure 7) indicates the presence of a mental institution (later indicated simply as a hospital) immediately to the west of the site, with an isolation unit to the north and a pavilion and football club buildings to the south. Houses are now present immediately to the east. A sewage works is present approximately 600m to the south west.

The 1970 map (Figure 9) indicates a transport depot and cattle breeding centre approximately 200m to the east and north east, respectively.

By 2006 (Figure 11) the northern section of the hospital has been redeveloped with residential properties, while the southern section remains in use as a hospital. The area surrounding the site remains largely unchanged to the latest date of mapping (2009).

3.5.2 Database and Regulatory Information

3.5.2.1 Pollution Incidents

There have been three recorded pollution incidents within 500m of the site, all but one of which were classed as Category 3 (minor) incidents. The Category 2 (significant) incident

occurred approximately 420m to the north west of the site and involved the release of crude sewage into a nearby watercourse. A further eight incidents have occurred within 1km of the site, all but one of which was classed as Category 3, with the remaining one classed as Category 2, for the release of filter backwash water into a nearby watercourse.

3.5.2.2 Discharge Consents

There is one current discharge consent within 500m of the site (~400m to the north), for the discharge of final or treated sewage effluent into nearby watercourses. A further consent is held within 1km of the site, also for the discharge of sewage into watercourses.

3.5.2.3 Waste

There are three historical landfill sites within 1km of the subject site, which lie approximately 145m and 220m to the north west and 975m to the south (references EAHLD07479, EAHLD07517, EAHLD07127, respectively). The specified waste for each site was Commercial and Household. No further details are supplied.

There was one registered waste treatment or disposal site within 1km of the subject site (~250m to the west). It was classed as very small (<10,000 tonnes/yr) and was licensed to Burnley, Pendle and Rossendale H.A. (license no longer active), generally for clinical waste.

There were three BGS recorded mineral sites within 1km of the subject site, all of which were opencast clay and shale quarries whose operations have now ceased. The closest was approximately 80m to the west of the site.

3.5.2.4 Trade Directories

There are five active trade directory entries within 500m of the site. These are for a paper and cardboard products facility, road haulage services, a hospital, a washing machine service and repair facility and a fireplaces and mantelpieces centre.

3.5.3 Summary of Historic Potentially Contaminative Land Uses

The review of the site history indicates that there has been no potentially contaminative land use on the site itself, other than perhaps the presence of an infilled pond within the western section of the site, which may be a potential source of ground and ground gas contamination.

A number of brick/tile works, waste/landfill sites, quarries, as well as a sewage farm, are present within 1km of the site; however, none are in the immediate vicinity of the site and are therefore considered unlikely to represent potential contamination sources.

As with any site, it is possible that made ground will be present across the site and the surrounding area, having been used to raise levels. Any made ground present may have resulted in the generation of hazardous ground gases and/or soil/groundwater contamination.

3.6 SITE WALKOVER

An engineer from RSK carried out a site inspection on 20 January 2010. The key findings are summarised below:

- No visual or olfactory evidence of contamination was noted during the site walkover;
- No invasive plant species were noted on-site (however a detailed inspection was not completed and the walkover was carried out outside the growing season for such plants);
- No buildings, and very little hardstanding, were observed on site; and
- The site is in a predominantly residential area.

3.7 SUMMARY OF POTENTIAL CONTAMINANT SOURCES

There are a number of potential sources of contamination to soils, groundwater and soil gas. These include:

- Inorganic and organic soil contamination from any made ground/fill materials used to raise site levels;
- Inorganic and organic soil contamination from the on-site former pond; and
- Ground gas and leachate from any made ground on or close to the site (in particular the infilled former pond).

3.8 SENSITIVE RECEPTORS

There are a number of sensitive receptors that may be affected by the potential contamination hazards identified above. These may include:

- Nearby ponds and land drains;
- River Calder and Barrow Brook;
- Shallow (perched) water in any made ground materials or superficial deposits;
- Deeper groundwater in the minor aquifer;
- Plant uptake of contaminated soils;
- Site operatives during redevelopment works;
- Future site occupants;
- Neighbouring residents and surrounding areas; and
- Building infrastructure and services.

3.9 SUMMARY OF PLAUSIBLE PATHWAYS

The routes by which potential contamination could plausibly come into contact with the receptors are:

- Surface water run-off and/or infiltration;
- Groundwater migration in any permeable soils and existing/proposed service runs;
- Phytotoxic effects on plants;
- Direct human ingestion, dust inhalation and/or dermal contact;
- Ground gas migration in permeable soils or existing/proposed service runs; and
- Vapour migration from volatile compounds

3.10 OUTLINE CONCEPTUAL MODEL

The information presented in the preceding sections has been used to compile an outline conceptual model. The identified potential contaminants and receptors have been considered with any possible pathways that may link them. The resulting pollutant linkages are considered in Table 3. The risk classification has been estimated in accordance with information in Appendix D.

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk
Organic and inorganic soil and groundwater contamination and leachate associated with fill materials on or close to the site, including backfilled former pond	Off site surface water features	Surface water run-off, groundwater migration	Unlikely	Mild	Very low. The nearest surface water feature is 200m from the site (a land drain); this is considered sensitive and there is no evidence to suggest that any contamination is present on-site. The closest river is 700m from the site.
	Perched water, Groundwater (minor aquifer)	Vertical and horizontal migration of perched water and groundwater	Unlikely	Medium	Low. There is no reason to suspect that any fill material present on-site is contaminated. Furthermore, the low permeability superficial deposits beneath the site will reduce the likelihood of the pathway being realised.
	Site operatives	Vapour and dust inhalation, human ingestion, and dermal contact	Unlikely	Medium	Low. Although contact with soil is likely during the redevelopment works, risks can be mitigated during the development process using personal protective equipment (PPE).

Potential Source	Potential Receptor	Possible Pathway	Likelihood	Severity	Risk
	Future site occupants	Vapour and dust inhalation, human ingestion, and dermal contact	Unlikely	Medium/severe	Moderate/low Contact with soil by future occupants is likely given that gardens will be present; however, there is no evidence to suggest that the soil will be contaminated
	Plant uptake (phytotoxic effects)	Plant uptake from contaminated soil	Unlikely	Minor	Very low. Although any made ground at the site may contain determinants that are detrimental to the growth of plants, this can be easily mitigated by placing a suitable growing medium in garden areas
	Neighbouring residents	Groundwater and leachate migration in permeable soils	Unlikely	Medium	Low. There is no reason to suspect that any fill material present on-site is contaminated, and the site is underlain by impermeable superficial deposits, thereby reducing the likelihood of migration of any contaminants off-site
	Plastic utilities	Permeation	Unlikely	Mild	Very low. There is no reason to suspect the presence of organic soil contamination on site at this stage
Hazardous ground gases associated with backfilled pond	Site operatives	Ground gas migration in permeable soils	Low likelihood	Medium/severe	Moderate The potential risk to human health of any ground gas associated with the backfilled pond is potentially severe
	Future site occupants	Ground gas migration in permeable soils	Low likelihood	Medium/severe	Moderate The potential risk to human health of any ground gas associated with the backfilled pond is potentially severe
	Neighbouring residents, building infrastructure & services	Ground gas migration in permeable soils	Unlikely	Medium/severe	Moderate/low The potential risk to human health of any ground gas associated with the backfilled pond (e.g. explosion from methane build-up) is potentially severe

Table 3: Risk Estimation for Potential Pollutant Linkages in Outline Conceptual Model

The conceptual model identifies the following potential pollutant linkages with a severity of moderate or higher:

- Inhalation of vapours, dust inhalation, ingestion and dermal contact with any soils contaminated from on-and off-site sources by future site occupants;
- Inhalation of hazardous ground gases from on- and off-site made ground by site operatives and future site occupants; and
- Build-up of explosive concentrations of migrating gases into buildings (on- and off-site)

3.11 PRELIMINARY RISK ASSESSMENT CONCLUSIONS AND RECOMMENDATIONS

Based on the outline PRA, it is considered unlikely that significant remediation of soil and/or groundwater will be necessary prior to redevelopment of the site. Given that there are a number of potential sources of contamination on or close to the site, however, it will be necessary to undertake a basic intrusive investigation of the site, which will provide further information on actual contaminants present and viable pathways to sensitive receptors. A number of wells should be installed to enable future gas monitoring and groundwater sampling.

4. ENVIRONMENTAL SITE INVESTIGATION

RSK carried out intrusive investigation work on 25 February 2010. Subsequent ground gas and groundwater monitoring was carried out between 8 March and 4 June 2010. The investigation has been designed to further investigate the potential pollutant linkages identified in the outline conceptual model

4.1 SCOPE OF WORKS

The site investigation comprised the following scope of works:

- Drilling of nine probeholes to a maximum depth of 4.00m bgl using a competitor (windowless sample) rig;
- Drilling of one cable percussive borehole to 10.80m bgl using a shell and auger drilling rig;
- Excavation of ten hand-dug inspection pits to a maximum depth of 0.50m bgl;
- Recovery of soil samples for laboratory chemical and geotechnical analyses;
- Recovery of groundwater samples for laboratory chemical analysis; and
- Undertaking six ground gas monitoring visits

Upon completion, each exploratory hole was backfilled either with gravel and bentonite or a monitoring installation (consisting of bentonite seal, pea gravel, backfill and groundwater/gas monitoring pipework). The installations enable future monitoring of ground gas concentrations and flow rates and obtaining groundwater samples (if present). The installations were finished with a lockable cover to maintain the integrity of the exploratory hole.

The investigation locations were chosen to target areas of potential concern and to provide a spread of data across the site.

4.1.1 Health and Safety Considerations

Service plans were not available for review. A utility clearance survey was therefore carried out at each investigation location to confirm the presence or otherwise and location of any underground services. The utility survey was carried out by RSK personnel using a cable avoidance tool (CAT) and Genny.

4.1.2 Investigation Locations

The intrusive investigation locations are shown in Figure 2. The rationale for these locations is given in Table 4.

Exploratory Hole Number	Location and Rationale	Rationale for Installation
WS1 to WS6, WS8, BH1	To provide spread of data across site	To enable future gas and groundwater monitoring
WS7	In the vicinity of the former pond	N/A
WS9	In the vicinity of the former building	N/A

Table 4: Exploratory Hole Location Rationale

Note that no standpipe was installed in WS7 (the former pond) because Taylor Wimpey intends to remove any pond material prior to development.

The depths of the exploratory holes, descriptions of strata encountered, comments on groundwater conditions, samples obtained and installation details are included on the probehole and borehole records in Appendices E and F, respectively.

4.1.3 Soil Sampling

At least one sample of soil was recovered from each stratum encountered. Where visual or olfactory evidence of contamination was observed, where possible samples were obtained above, below and in the area of contamination. Samples were stored in accordance with the RSK quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination. The samples were transported to the laboratory in chilled cool boxes. The samples are recorded, together with their depths, on the probehole and borehole logs presented in Appendices E and F, respectively. Laboratory Chain of Custody Forms can be provided if required.

Samples were selected and scheduled for a range of organic and inorganic chemical analysis in order to classify the near surface ground conditions with regards to contamination.

4.1.4 Groundwater Monitoring

Depths to groundwater were recorded using an electronic dip meter during each of the gas monitoring visits.

The groundwater monitoring data are included with the ground gas monitoring data presented in Appendix G

4.1.5 Groundwater Sampling

The groundwater monitoring wells were purged during the monitoring visit on 8 March 2010. The wells were purged dry due to the limited volume of water and the slow recharge rate.

Groundwater sampling was subsequently carried out during the visit on 31 March 2010. Samples were taken using disposable bailers dedicated to each monitoring location to avoid the risk of cross contamination of samples. The groundwater samples were collected in a variety of containers appropriate to the anticipated testing suite required. The containers were filled to capacity and placed in a cool box to minimise volatilisation. Samples were transported to the testing laboratory in a cool box under Chain of Custody documentation directly to the testing laboratory.

4.1.6 Ground Gas Monitoring

Ground gas monitoring has been carried out over six monitoring rounds, as considered the minimum for residential properties, in line with the NHBC report ⁽³⁾.

An infrared gas analyser meter was used to measure concentrations of carbon dioxide (CO₂), methane (CH₄) and oxygen (O₂) in percentage by volume, whilst hydrogen sulphide (H₂S) and carbon monoxide (CO) were recorded in parts per million (ppm). Initial and steady state concentrations were recorded. A flow meter was used to measure flow rates in litres per hour (l/hr).

In addition, the atmospheric pressure during monitoring, together with the weather conditions, was recorded.

All monitoring results, together with the temporal conditions, are contained within Appendix G and discussed in Section 4.2.3.

4.2 GROUND CONDITIONS

On-site observations are detailed below. The probehole and borehole records are presented in Appendices E and F, respectively, and include notes on soil samples

recovered, in-situ testing, visual or olfactory evidence of contamination and details of the probehole/borehole/pit completion, i.e. installation of monitoring wells or reinstatement.

4.2.1 Soil Stratigraphy

Ground conditions generally consisted of a surface covering of brown sandy topsoil from ground level up to approximately 0.40m, underlain at most locations directly by natural superficial deposits. In WS2 it was underlain by made ground consisting of ashy gravel from 0.20m to 0.40m. In probeholes WS7, WS8 and WS9 the surface materials consisted of brick gravel to depths of between 0.80m and 1.00m, underlain by natural superficial deposits.

The natural deposits consisted generally of soft to firm grey mottled orange slightly sandy thinly laminated clay to depths of between 1.40m and 2.10m, underlain in turn by firm/firm to stiff grey thinly laminated slightly sandy clay to the full depth of drilling (up to 4.45m in the window sampling locations). In borehole BH1, however, the clay was stiff and soft to firm to a depth of approximately 9.00m, and firm to stiff beneath this to the full depth of drilling (10.80m).

A peat horizon was encountered directly beneath the made ground in WS7 from 1.00m to 1.50m. Occasional peat partings were also encountered in WS2, within the clay horizon from 0.40m to 1.30m.

Eight shallow hand dug inspection pits were excavated on a 10m grid centred around WS2 to delineate the extent of the ashy made ground, with a further 2 pits extended 25m north and west from WS2. The ashy made ground observed in WS2 was found to be present in all of the hand dug pits from approximately 0.10m to between 0.20m and 0.40m. A slight hydrocarbon sheen was observed on the surface of perched water within one of the hand-dug pits.

Three of the investigation locations (WS2, WS8, and BH1) were installed with ground gas/groundwater monitoring standpipes.

4.2.2 Groundwater Regime

Groundwater was not encountered during drilling. The results of the subsequent groundwater monitoring are included within the gas monitoring records presented in Appendix G.

4.2.3 Ground Gas Regime

The gas monitoring results are included in Appendix G and are summarised in Table 5, where calculated gas screening values (GSVs) are also provided (GSVs are the product of gas concentration and gas flow from a borehole and therefore provide an indication of

the flow of the particular gas in question out of the ground). Approximate atmospheric pressure data for 3 days prior to each monitoring visit (taken from www.weatheronline.co.uk and the readings extrapolated from Keighley to Whalley) has also been provided

Methane was not detected in any of the installations. The results indicate measurable concentrations of carbon dioxide (up to 5.1% in probehole WS8) at each location. Hydrogen sulphide and carbon monoxide concentrations were negligible. Oxygen concentrations were generally near atmospheric, although depleted concentrations were encountered in WS8.

Flow rates were negligible in WS2 and WS8; however, measureable positive flow rates were recorded in BH1 on two occasions (4.4l/hr and 3.5l/hr).

Date	Methane		Carbon Dioxide		Oxygen		Flow Rate l/hr		GSV CO ₂ and Methane	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Monitoring round 1 8 March 2010	<0.1	<0.1	0.1	4.2	14.7	20.1	<0.1	<0.1	0.000	0.004
Monitoring round 2 31 March 2010	<0.1	<0.1	0.2	1.6	18.6	20.2	<0.1	4.4	0.000	0.070
Monitoring round 3 14 April 2010	<0.1	<0.1	0.5	3.2	18.5	20.4	<0.1	3.5	0.001	0.112
Monitoring round 4 21 May 2010	<0.1	<0.1	0.2	5.1	8.9	20.5	<0.1	<0.1	0.000	0.005
Monitoring round 5 28 May 2010	<0.1	<0.1	0.1	2.4	17.7	19.0	<0.1	<0.1	0.000	0.002
Monitoring round 6 4 June 2010	<0.1	<0.1	0.1	1.4	17.9	19.1	<0.1	0.1	0.000	0.001

Date	Atmospheric pressure during the preceding three days prior to the			Temporal conditions during the monitoring round		
	3	2	1	Atmospheric Pressure	Rainfall	Other
Monitoring round 1 8 March 2010	1024	1025	1030	1028	Dry	Sunny, clear
Monitoring round 2 31 March 2010	1001	996	980	983	Light rain	Cloudy
Monitoring round 3 14 April 2010	1029	1027	1024	1021	Dry	Sunny, clear
Monitoring round 4 21 May 2010	1023	1023	1027	1027	Dry	Sunny, clear

Monitoring round 5 28 May 2010	1006	1003	1003	1006	Dry	Sunny, clear
Monitoring round 6 4 June 2010	1010	1014	1015	1012	Dry	Sunny, clear

Table 5: Summary of Ground Gas Monitoring Data

The gas monitoring data indicate that there may be a risk posed to site end users in relation to elevated carbon dioxide and oxygen depletion.

4.2.4 Observed Contamination

Ashy made ground was encountered in WS2 and the hand-dug inspection pits nearby, indicating the potential for heavy metal impact in this area.

An oily sheen was noted on the perched water surface in one of the inspection pits (H2).

4.3 ANALYTICAL STRATEGY AND METHODOLOGY

A total of nine soil samples were tested for chemical contamination, as listed in Table 6. Three groundwater samples were also tested for chemical contamination, as listed in Table 7. In addition, six soil samples were submitted for asbestos screening. The analytical schedule was based on the ground conditions encountered, as discussed in Section 4.2. All analyses were undertaken by UKAS and MCERTS certified laboratories (Envirolab Ltd.). The details of the laboratory certification are included on the certificates in Appendices H and I, respectively.

Exploratory Hole No. & Sample Depth (m bgl)	Analyte	Rationale
BH1 @ 0.80-1.20	Asbestos screen	To assess the natural soils
WS5 @ 0.10-0.40		To assess the made ground
BH1 @ 2.50-3.00	Metals, Sulphate, Speciated TPH, Speciated PAH, TOC/FOC	To assess the natural soils
WS2 @ 0.10-0.40	Metals, Sulphate, Speciated TPH, Speciated PAH, SVOC, Asbestos screen	To assess the ashy made ground
WS7 @ 0.50-1.00		To assess the soils in the vicinity of the infilled pond
WS8 @ 0.10-0.40		To assess the made ground
WS9 @ 0.50-0.80		To assess the soils in the vicinity of the former building

Exploratory Hole No. & Sample Depth (m bgl)	Analyte	Rationale
WS2 @ 2.50-3.00	Metals, Sulphate, Speciated TPH, Speciated PAH, TOC/FOC, SVOC	To assess the natural soils beneath the ashy made ground
WS8 @ 1.50-2.00		To assess the natural soils
WS4 @ 0.10-0.40	Metals, Sulphate, Speciated TPH, Speciated PAH, TOC/FOC	To assess the natural soils
WS5 @ 1.00-1.50	Metals, Sulphate, Speciated TPH, Speciated PAH	To assess the natural soils

Table 6: Scheduled Analysis – Soil

Exploratory Hole No.	Analyte	Rationale
BH1	Metals, Sulphate, Speciated TPH, Speciated PAH	To assess the groundwater within in the natural sandy clay
WS2	Metals, Sulphate, Speciated TPH, Speciated PAH	To assess the groundwater within in the natural sandy clay
WS8	Metals, Sulphate, Speciated TPH, Speciated PAH	To assess the groundwater within in the natural sandy clay

Table 7: Scheduled Analysis – Groundwater

4.4 CHEMICAL CONDITIONS

Full analytical certificates are provided in Appendices H and I, respectively. The results are discussed in the GQRA, Section 5

5. GENERIC QUANTITATIVE RISK ASSESSMENT

In line with CLR11 ⁽¹⁾, there are two stages of quantitative risk assessment: generic and detailed. The generic quantitative risk assessment (GQRA) comprises the comparison of soil, groundwater and ground gas results with generic assessment criteria (GAC) that is appropriate to the linkage being assessed. The GAC used in this assessment are included in Appendix J for human health (together with details of their derivation) and in Appendix K for the assessment of phytotoxic effects, risks to plastic utilities and to controlled waters.

The site investigation work and subsequent monitoring indicates that there are relevant pollutant linkages at the site, which require further consideration.

5.1 RELEVANT LINKAGES FOR ASSESSMENT

The linkages for assessment are presented in Table 8.

Relevant Pollutant Linkage	GAC
Direct contact pathways to future residents	Human health GAC for a proposed residential end use with private gardens since proposed end use includes residential gardens (Appendix J).
Leaching and dissolved phase migration to minor aquifer and off-site surface water features	GAC recorded in Table 3 of Appendix K for minor aquifers.
Concentrations of methane and carbon dioxide in ground gas entering and accumulating in: - Depressions and excavations during any site works and development that could affect site workers; and - Enclosed spaces or small rooms in new buildings, which could affect future residents. In the case of methane, this could create a potentially explosive atmosphere, whilst death by asphyxiation could result from carbon dioxide.	Gas screening values (GSV) have been calculated using maximum methane and carbon dioxide concentrations with maximum flow rates recorded at the site. The GSV have been compared with the generic Traffic Lights, as presented within the NHBC ground gases guide ⁽³⁾ .
Plant uptake	GAC values presented in Appendix K for phytotoxic determinants.
Permeation of plastic utilities	GAC values presented in Appendix K for water supply pipes.

Table 8: Linkages for Generic Quantitative Risk Assessment

5.2 METHODOLOGY AND RESULTS

The methodology and results of the GQRA are presented for each relevant pollutant linkage in turn.

5.2.1 *Direct Contact and Vapour Inhalation by Future Residents*

The laboratory analytical data for soils (Appendix H) have been compared directly to the GAC, presented in Appendix J. The results are summarised in Tables 9, 10 and 11.

Contaminant	GAC mg/kg	Range of Results in mg/kg <u>Made Ground</u> (No. tested)	Pass/Fail (Failed sample and groundwater in mg/kg)	Range of Results in mg/kg <u>Natural</u> (No. tested)	Pass/Fail
Arsenic	32	8-26 (4)	Pass	9-19 (5)	Pass
Cadmium	29	<0.5-1.4 (4)	Pass	0.9-1.2 (5)	Pass
Chromium (hexavalent)	38	<0.1 (2)	Pass	<0.1 (5)	Pass
Copper	4,700	19-110 (4)	Pass	29-34 (5)	Pass
Lead	450	16-25,600 (4)	Fail WS7 @ 0.5-1.0m (25,600)	22-93 (5)	Pass
Mercury	170	<0.17-2.14 (4)	Pass	<0.17-0.26 (5)	Pass
Nickel	130	19-45 (4)	Pass	33-76 (5)	Pass
Selenium	350	<0.1-2 (4)	Pass	2-3 (5)	Pass
Zinc	25,000	34-203 (4)	Pass	97-131 (5)	Pass

Table 9: Summary of Soil Test Results – Metals

Contaminant	GAC mg/kg	Range of Results in mg/kg <u>Made Ground</u> (No. tested)	Pass/Fail (Failed above in mg/kg)	Range of Results in mg/kg <u>Natural</u> (No. tested)	Pass/Fail
Acenaphthene	7.1	<0.01-0.68 (4)	Pass	<0.01-0.06 (5)	Pass
Acenaphthylene	0.52	<0.01-0.32 (4)	Pass	<0.01 (5)	Pass
Anthracene	1,300	0.10-2.55 (4)	Pass	<0.01-0.19 (5)	Pass
Benz(a)anthracene	5.2	0.05-12.5 (4)	Fail WS7 @ 0.5-1.0m (12.5)	<0.01-0.29 (5)	Pass
Benzo(a)pyrene	0.95	0.13-15.5 (4)	Fail WS7 @ 0.5-1.0m (15.55) WS8 @ 0.1-0.4m (2.47) WS9 @ 0.5-0.8m (1.00)	<0.01-0.20 (5)	Pass
Benzo(b)fluoranthene	9.3	<0.01-9.14 (4)	Pass	<0.01-0.07 (5)	Pass
Benzo(ghi)perylene	2,300	<0.01-14.8 (4)	Pass	<0.01 (5)	Pass
Benzo(k)fluoranthene	9.6	<0.01-7.38 (4)	Pass	<0.01-0.05 (5)	Pass
Chrysene	80	0.31-20.7 (4)	Pass	<0.01-1.3 (5)	Pass
Dibenzo(ah)anthracene	0.93	<0.01-1.06 (4)	Fail WS7 @ 0.5-1.0m (1.06)	<0.01 (5)	Pass
Fluoranthene	13	0.28-32.4 (4)	Fail WS7 @ 0.5-1.0m (32.4)	<0.01-0.67 (5)	Pass
Fluorene	85	<0.01-0.52 (4)	Pass	<0.01 (5)	Pass
Indeno(123cd)pyrene	9.1	<0.01-13.4 (4)	Fail	<0.01 (5)	Pass

Contaminant	GAC mg/kg	Range of Results in mg/kg <u>Made Ground</u> (No. tested)	Pass/Fail (Failed above in mg/kg)	Range of Results in mg/kg <u>Natural</u> (No. tested)	Pass/Fail
			WS7 @ 0.5-1.0m (13.4)		
Naphthalene	1.5	0.05-0.28 (4)	Pass	<0.01-0.03 (5)	Pass
Phenanthrene	790	0.15-8.82 (4)	Pass	<0.01-0.50(5)	Pass
Pyrene	130	0.22-26.6(4)	Pass	<0.01-0.51(5)	Pass

Table 10: Summary of Soil Test Results – PAH

Contaminant	GAC mg/kg	Range of Results in mg/kg <u>Made Ground</u> (No. tested)	Pass/Fail	Range of Results in mg/kg <u>Natural</u> (No. tested)	Pass/Fail
Benzene	0.08	<0.01 (4)	Pass	<0.01 (5)	Pass
Toluene	120	<0.01 (4)	Pass	<0.01 (5)	Pass
Ethylbenzene	65	<0.01 (4)	Pass	<0.01 (5)	Pass
Xylene	44	<0.01 (4)	Pass	<0.01 (5)	Pass
MTBE	1.8	<0.01 (4)	Pass	<0.01 (5)	Pass
Aliphatic C ₅ –C ₆	25	<0.01 (4)	Pass	<0.01 (5)	Pass
Aliphatic C ₆ –C ₈	51	<0.01 (4)	Pass	<0.01 (5)	Pass
Aliphatic C ₈ –C ₁₀	11	<0.01 (4)	Pass	<0.01 (5)	Pass
Aliphatic C ₁₀ –C ₁₂	50	<0.1 (4)	Pass	<0.1 (5)	Pass
Aliphatic C ₁₂ –C ₁₆	22	<0.1 (4)	Pass	<0.1 (5)	Pass
Aliphatic C ₁₆ –C ₂₁	88,000	<0.1 (4)	Pass	<0.1 (5)	Pass
Aliphatic C ₂₁ –C ₃₅	88,000	<0.1 (4)	Pass	<0.1 (5)	Pass
Aromatic C ₈ –C ₁₀	16	<0.01 (4)	Pass	<0.01-0.03 (5)	Pass
Aromatic C ₁₀ –C ₁₂	58	<0.1 (4)	Pass	<0.1 (5)	Pass
Aromatic C ₁₂ –C ₁₆	130	<0.1-8.6 (4)	Pass	<0.1 (5)	Pass
Aromatic C ₁₆ –C ₂₁	88,000	<0.1-73.9 (4)	Pass	<0.1 (5)	Pass
Aromatic C ₂₁ –C ₃₅	1,100	<0.1-73.9 (4)	Pass	<0.1 (5)	Pass

Table 11: Summary of Soil Test Results – Petroleum Hydrocarbons

Six soil samples were submitted for asbestos screening, the results of which indicate there to be no detectable asbestos present

The GAC value for lead and some PAH compounds were exceeded in the made ground in WS7 at 0.50-1.00m. This location was drilled within the former pond. It is understood that Taylor Wimpey intends to remove and dispose of the material from this area prior to development as it is considered unsuitable. The pollutant pathway linkage can therefore be discounted for these soils, as long as they are indeed removed