

Pearson Crescent, Wombwell
Site Investigation Report
Bernard Williams Associates

Solmek Report Number S120313

April 2012

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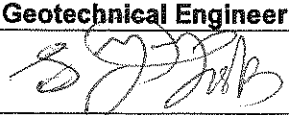
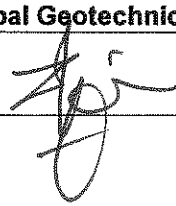
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Pearson Crescent, Wombwell

Site Investigation Report

1 INTRODUCTION AND SCOPE OF WORKS

At the request of Bernard William Associates, a ground investigation involving geotechnical and chemical testing was carried out on a parcel of land just off Pearson Crescent, Wombwell. A site location map and plan are included with Appendix A.

Scope of Works

The proposed development of the site is to include new residential housing with related hard landscaping as parking and soft landscaping as garden areas.

A geotechnical and environmental investigation was requested. The fieldwork and testing was generally carried out according to the recommendations of BS5930:1999 "Code of Practice for Site Investigations" and all stratum descriptions are as recommended in that publication. A desk study was carried out by Solmek (S120125, February 2012) and should be read in conjunction with this report.

The information provided in this report is based on the investigation fieldwork, and is subject to the comments and approval of the various Regulatory Authorities.

There may be other conditions prevailing on the site which have not been disclosed by this investigation and which have not been taken into account by this report. Solmek reserve the right to alter conclusions and recommendations should further information be available or provided. Any schematic representation or opinion of the possible configuration of ground conditions between exploratory holes is conjectural and given for guidance only and confirmation of intermediate ground conditions should be considered if deemed necessary.

2 SITE DESCRIPTION AND FIELDWORK

The site comprises two areas of undeveloped land situated around three roads within an existing housing estate. Pearson Crescent lies along the southern and western boundaries with Wortley Avenue to the east and north. Mill Hill bisects the site centrally from Wortley Avenue. Housing is present along each of the three roads and it is the grassed open space behind the existing properties that form the site. There is a general moderate to gentle fall in slope from the south towards the north.

The site is located within a residential estate with housing in all directions, however a number of properties on the estate have been removed.

In terms of surface contamination there was no obvious evidence of fly tipping or vandalism. Service manhole covers were noted across the site.

Fieldwork

The initial fieldwork was carried out on Monday 19th March 2012. Six small percussive boreholes (BHs 1 to 6 inclusive) were drilled, to a maximum depth of 3.45m below ground level (bgl). Eight machine excavated trial pits (TPs 1 to 8 inclusive) were excavated to depths of between 1.40m and 2.00mbgl to supplement the borehole data.

Standard penetration tests (SPT) were undertaken at various depths within the boreholes. Samples were taken for both geotechnical and contamination analysis. Descriptions of the strata encountered in the boreholes and trial pits together with details of testing, sampling and groundwater are presented in Appendix B of this report. A plan showing the location of the boreholes and trial pits can be found in Appendix A (Figure 2).

Ground gas monitoring installations were placed within BH's 1, 3, and 6. Two monitoring visits have been undertaken to date and an initial assessment has been made. One further visit is planned and the full results will be reported in an addendum to this report. The remaining boreholes and trial pits were backfilled with the arisings.

3 GROUND CONDITIONS

Made Ground

Made Ground was encountered within all of the boreholes and trial pits to a maximum depth of 1.45mbgl (BH4) and generally comprised grass over topsoil to depths of between 0.15m (TP6) and 0.50mbgl (TP2). This was underlain by clay fill in BHs 1, 4 and 6 and TPs 4, 6 and 8 to depths of between 0.35m and 1.45mbgl. Clay fill was also noted within BH3 between 0.85-1.20mbgl.

Red (sandy) gravel of brick rubble was noted within BH3 and TPs 3, 5 and 6, encountered at depths of between 0.25m (TP5) and 0.35m (TP6) and proven to a maximum depth of 1.30mbgl (TP5).

Natural Deposits

Within the trial pits the natural deposits encountered directly beneath the made were generally shown to comprise medium dense clayey gravelly sand and gravelly sand encountered from 0.45m (TP1) to 1.30mbgl (TP3) and proven to a maximum of 2.00mbgl (TP4). Within TPs 5 and 7 medium dense sand and gravel deposits were noted between 0.35m and 1.80mbgl. Stiff clay deposits were noted within TP6 and TP8 only. Within TP6 the clay was noted directly below the made ground at 1.10m and in TP8 below the sand deposits at 1.20mbgl. The clay was proven to a maximum depth of 1.90mbgl (TP6).

Within the boreholes firm to stiff slightly to very sandy, slightly gravelly clay deposits were noted directly beneath the made ground at depths of between 0.30m (BH2) and 1.45mbgl (BH4). This was underlain by medium dense to very dense sand within BHs 1-3 and BH5 encountered at depths of between 1.20m (BH1) and 2.30mbgl (BH2) and proven to a maximum depth of 3.45mbgl (BH2).

Rockhead

Inferred weathered very dense sandstone rockhead was encountered within TPs 2 and 5 and BHs 1, 3, 4 and 6 at depths of between 1.30mbgl (BH6) and 2.60mbgl (BH3) and was proven to a maximum depth of 3.05mbgl (BH3). The sandstone was generally recovered as sand and gravel.

Groundwater

No groundwater was encountered within any of the boreholes or trial pits during the site works. It should be noted that groundwater levels can fluctuate with seasonal and climatic variations as well as in proximity to local dewatering and abstraction schemes.

4 GEOTECHNICAL TESTING

Samples taken from the boreholes underwent a series of geotechnical tests (BS 1377:1990) to aid foundation design and soil description. In addition, insitu Standard Penetration Tests (SPTs) were undertaken at regular intervals during drilling. The geotechnical results are presented in Appendix C.

In-situ Testing (SPTs)

SPT testing was undertaken at regular depths within the boreholes. N-values of between 18 and 50+ were recorded within the granular material indicating medium dense to very dense conditions. Within the cohesive material N-values of between 9 and 28 were recorded, indicating firm to stiff conditions.

Particle Size Distribution

Five samples were selected for particle size distribution testing to classify the sub-strata materials. The material on site should generally be considered as slightly to very clayey sandy gravel to very sandy gravel/gravelly sand.

Moisture Contents

Disturbed samples recovered from the boreholes were subjected to moisture content tests to determine the moisture profile at depths adjacent to the proposed foundations. Moisture levels recorded were between 8% and 20%.

Atterberg Limit Determinations

Atterberg Limit Testing was carried out on two samples of cohesive material to determine the liquid and plastic limits and hence derive the plasticity index. The results when plotted on a Casagrande Chart show the cohesive stratum to be classified as intermediate plasticity clay. The moisture contents were noted both above and below the corresponding plastic limits. The results of the plasticity index tests were 21 and 24 with associated percentage passing the 425 sieve of 67.9 and 71.5% respectively. Taking into account percentage passing gives corrected plasticity indices of 16 and 15, indicating the clay should be considered as having a **low** shrinkage potential in accordance with NHBC Guidelines.

pH and Sulphate Results

Two samples of were tested for acidity and soluble sulphate content to assess whether the material may be potentially aggressive to building fabric. The results of the testing for pH were 7.7 and 7.8 indicating slightly alkaline conditions. Soluble sulphates were recorded at concentrations of 54 and 78mg/l.

Foundations

Traditional shallow strip foundations should be appropriate for the new development. Footing should be placed within the medium dense sand deposits or stiff clay at a minimum depth of 0.75mbgl locally deepened up to depths of 1.45mbgl where deeper made ground was noted.

Atterberg Limit testing indicates the fine grained soils at foundation depths have a **low** shrinkage potential. Reference should be made to NHBC Standards, Chapter 4.2 to determine the depth of foundations in the vicinity of existing trees and proposed trees.

Within the granular deposits the SPT tests show the deposits to be medium dense to very dense (N=18-50+). Using a conservative SPT N-value of N=18 and assuming 0.60m wide footings placed at a depth of 0.75mbgl which exert a load of 100kN/m² the predicted settlement will be less than 25mm.

Where clay strata is encountered a safe bearing pressure of 100kN/m^2 has been calculated using a conservative shear strength of $C_u=45\text{kPa}$, taken from the lowest in-situ N -value of 9 and using the rule of thumb that five times N -value approximates shear strength. Assuming strip footings of 0.60m in width at a depth of 0.75mbgl . Assuming any structures placed do not impart a loading of greater than 100kN/m^2 then settlements should be within normal tolerances.

Reinforcement should be used where changes in sub-strata are noted to ensure against differential settlement.

Prior to placing foundations all exposed formations should be well compacted and any soft or loose spots should be removed and backfilled with inert granular material ensuring the infill material is well compacted.

5 CONTAMINATION ANALYSIS AND RESULTS

The site is to be developed with a new residential housing including hard landscaping as car parking and soft landscaping as garden areas. To provide information upon the possibility of ground contamination five samples from between depths of 0.30mbgl and 1.30mbgl were subject to undergo chemical contamination analysis.

Given the nature of the proposed development, the test results have been compared to a series of Solmek Generic Assessment Criteria (GAC) thresholds based on a residential land use with plant uptake. Solmek GAC were derived using the EA CLEA Software Version 1.06 (December 2009) which produce Model Output Reports to compare the contamination concentrations against. In the absence of Solmek GAC values, WS Atkins Soil Screening Values (SSV) for residential land use with plant uptake have been used (which have been derived using EA CLEA Version 1.04, May 2009).

Solmek used the following input parameters within the CLEA Model to generate the GAC values:

➤	Land use:	Residential with home grown produce
➤	Receptor:	Female (residential)
➤	Building Type:	Semi-detached housing
➤	Soil Type:	Sandy Clay Loam
➤	Soil pH:	7.3 (Lowest Recorded Value)
➤	Soil Organic Matter:	2.0% (Lowest Recorded Value)

The samples were subjected to a range of tests to detect the levels of various metal, semi-metal and non-metal elements along with various organic and inorganic compounds. In addition the pH of the samples was tested. The results are provided in full in Appendix D and summarised in Table 1 and 2 below.

The CLEA UK Model Output Reports have been included in Appendix D.

Determinand	Units	Number of Samples Tested	Number Above Detection Limit	Minimum Level	Maximum Level	Threshold Value	Number of Results Exceeding Threshold Value
Metals							
Cadmium	mg/kg	5	5	0.4	1.6	5.17	0
Chromium (Total)	mg/kg	5	5	12	29	3000	0
Hexavalent Chromium	mg/kg	5	0	<1.0	-	4.25	0
Copper	mg/kg	5	5	8.1	64	2360	0
Lead	mg/kg	5	5	13	43	276	0
Mercury (Inorganic)	mg/kg	5	2	<0.05	0.10	169	0
Nickel	mg/kg	5	5	16	35	127	0
Zinc	mg/kg	5	5	33	76	2860	0
Semi-metals and non-metals							
Arsenic	mg/kg	5	5	4.3	51	32.4	2
Boron	Mg/kg	5	5	0.5	1.6	10.3	0
Selenium	mg/kg	5	3	<0.5	1.8	350	0
Inorganic chemicals							
Cyanide (Total)	mg/kg	5	0	<0.5	-	1.49	0
Sulphate (WS)	mg/l	5	4	<10	1700	500**	1
Sulphide	mg/kg	5	3	<10.0	52	250***	0
Other							
pH	pH	5	5	7.3	8.0	<5	0
Phenol	mg/kg	5	0	<0.3	-	290	0
TABLE 1: SUMMARY OF INORGANIC CHEMICAL CONTAMINATION TESTING RESULTS <i>* Atkins SSV (GAC), CLEA Software Version 1.04</i> <i>** BRE Special Digest 1, 2005 (3rd Edition) 'Concrete in Aggressive Ground'</i> <i>*** EA Lower Tier Threshold Values</i>							

Metals, Semi Metals and Inorganic Chemicals

The concentration of the metals, semi and non metals recorded were generally low. Two raised concentrations of arsenic and one raised level of sulphate were noted to be above the thresholds for long term harm to human health.

Soluble sulphates (potentially aggressive to foundation concrete) were recorded at <10 and 1700mg/l.

Organic Test Results

Determinant	Units	Number of Samples Tested	Number Above Detection Limit	Minimum Level	Maximum Level	Threshold Value	Number of Results Exceeding Threshold Value
TPH Aromatic Fractions							
C5-C7	mg/kg	2	0	<0.01	-	0.158	0
C7-C8	mg/kg	2	0	<0.01	-	245	0
C8-C10	mg/kg	2	0	<0.01	-	77.1	0

C10-C12	mg/kg	2	0	<0.9	-	108	0
C12-C16	mg/kg	2	0	<0.5	-	257	0
C16-C21	mg/kg	2	0	<0.6	-	417	0
C21-C35	mg/kg	2	0	<1.4	-	1060	0
TPH Aliphatic Fractions							
C5-C6	mg/kg	2	0	<0.01	-	85.8	0
C6-C8	mg/kg	2	0	<0.01	-	253	0
C8-C10	mg/kg	2	0	<0.01	-	71.1	0
C10-C12	mg/kg	2	0	<1.5	-	94.6**	0
C12-C16	mg/kg	2	0	<1.2	-	47.3**	0
C16-C21	mg/kg	2	0	<1.5	-	70800	0
C21-C35	mg/kg	2	0	<3.4	-	70800	0
Speciated PAH							
Acenaphthene	mg/kg	2	0	<0.1	-	397	0
Acenaphthylene	mg/kg	2	0	<0.1	-	326	0
Anthracene	mg/kg	2	0	<0.1	-	41.3	0
Benzo[a]anthracene	mg/kg	2	0	<0.1	-	4.62	0
Benzo[a]pyrene	mg/kg	2	0	<0.1	-	0.925	0
Benzo[b]fluoranthene	mg/kg	2	0	<0.1	-	6.39	0
Benzo[k]fluoranthene	mg/kg	2	0	<0.1	-	9.40	0
Benzo[g,h,i]perylene	mg/kg	2	0	<0.1	-	45.7	0
Chrysene	mg/kg	2	0	<0.1	-	7.77	0
Dibenzo[a,h]anthracene	mg/kg	2	0	<0.1	-	0.851	0
Fluoranthene	mg/kg	2	0	<0.1	-	409	0
Fluorene	mg/kg	2	0	<0.1	-	311	0
Indeno[1,2,3-cd]pyrene	mg/kg	2	0	<0.1	-	3.75	0
Naphthalene	mg/kg	2	0	<0.1	-	5.16	0
Phenanthrene	mg/kg	2	0	<0.1	-	168	0
Pyrene	mg/kg	2	0	<0.1	-	914	0
PAH Total	mg/kg	2	0	<1.6	-	50*	0
TABLE 2: SUMMARY OF ORGANIC CONTAMINATION TESTING RESULTS							
* EA derived thresholds							
** Soil Saturation Limit							

Organic Chemicals

No raised concentrations of any of the organic determinands were recorded within any of the samples subject to testing.

Other

The results of the pH testing ranged between 7.3 and 8.0. These pH levels are consistent with slightly alkaline conditions.

Four samples of the made ground were also tested for the presence of asbestos. No asbestos fibres were noted within any of the samples subject to testing.

Contamination Assessment

A qualitative approach using the statutory definition of Contaminated land, as defined within Section 78A (2) of Part 2A of the Environmental Protection Act (1990), has been adopted. This defines contaminated land as:

"Any land which appears to the local authority in whose area it is situated to be in such a condition by reason of substances in or on or under the land that "Significant harm is being caused or there is a significant possibility of such harm being caused; or pollution of controlled waters is being or is likely to be, caused".

The concept of "significant harm" is dealt with via Government guidance (DEFRA circular 01/2006 Contaminated Land). The statutory guidance uses the concept of pollutant linkages set out in the Circular. Before the local authority can make a judgment on whether "significant harm" and the significant possibility of harm is being caused they are required to identify a "significant pollution linkage". This means effectively that three elements (a source of contamination, a relevant receptor and a pathway) must be present. Without identification of all three elements together, land should not be regarded as "contaminated" in the statutory sense. See Appendix E for additional notes on contamination guidelines.

Conceptual Model and Pollution Linkages

The contamination conceptual model in Table 3 below identifies the **potential** pollution linkages present on site based on source – pathway – receptor relationships.

SOURCES	PATHWAYS	RECEPTORS
Made Ground proven to depths of up to 1.45mbgl and comprised topsoil over clay fill with localised areas of red gravel fill. Site currently an area of grassed common land. Former residential housing on site.	Dermal absorption	Users of site – Adult and possible child receptors.
	Inhalation of soil/volatilised compounds	
	Ingestion of soil	Soft landscaping is to be present within the development.
	Contact with contaminated groundwater	
	Dermal absorption	Construction Workers – Users of the site during construction phase of development.
	Inhalation of soil/volatilised compounds	
	Ingestion of soil	
	Contact with contaminated groundwater	Users of surrounding sites – Residential housing.
	Dermal absorption	
	Inhalation of soil/volatilised compounds	
	Ingestion of soil	Vegetation – Soft landscaping to be present within the development as garden areas.
	Taken up through roots and foliage	
	Direct contact	Groundwater – Solid geology classified as Secondary A Aquifer No groundwater encountered during the site works or within standpipes during subsequent monitoring visits.
	Slow seepage or leaching of contaminants	
	Slow seepage or leaching of contaminants and accumulation of contaminated sediments	Surface water – drain located 150m to the north with the River Dove beyond.
	Direct contact	Construction Materials – Concrete and underground service pipes.
TABLE 3: POTENTIAL POLLUTION LINKAGES		

In general terms, the users of the site, construction workers, users of the surrounding sites, vegetation, controlled waters and construction materials are considered to be at risk from potential contamination in the soils on site as pollution linkages may be present for these receptors. The actual risks posed are considered below.

Users of the Site Once Development is Complete

Soft landscaping is to comprise part of the proposed development and so the sites end users may be exposed to contaminants present in the soils beneath the site. **Potential** exposure pathways include dermal absorption after contact with contaminated ground, inhalation of soil or dust, inhalation of volatised compounds, and inadvertent soil ingestion (or deliberate soil ingestion in the case of some children).

To establish if the levels of contaminants present on site may pose a risk to the health of the future users of the site the results of the made ground contamination testing have been compared to a series of Solmek Generic Assessment Criteria (GAC) thresholds based on a residential end use with plant uptake.

Following comparison the results indicate that the levels of contamination across the site are generally low. Two elevated concentrations of arsenic and one of sulphate were noted within the samples from TP3 (0.30-0.40m) and TP6 (0.50-0.60m) which were taken from the red gravel fill of brick rubble and possible burnt red shale materials. The results from the samples taken of the topsoil and natural sand and clay encountered on site were all below the relevant thresholds for long term harm to human health.

It is therefore considered that the red gravel fill in the vicinity of TP3/BH3 and TP6 are hot spots of contamination. Remediation is not required beneath hardstanding areas or the proposed building footprints as the structure/hardstanding will sever the potential pathways between the contamination and receptors.

However, if soft landscaping areas are to be placed over the areas where this gravel fill was noted a clean cover system should be employed. The clean cover system should comprise of a minimum of 200mm of topsoil over 300mm of clay sub-soil. Given that the topsoil and natural strata on site showed no elevated concentration of contaminants site won material will be suitable for use within the clean cover system.

If any zones of odorous, brightly coloured or suspected contaminated ground are encountered then work should cease in that area until the material has been tested. The results of the tests will determine whether or not remediation will be required.

The current legislation on the disposal of waste soil materials involves the categorization of the material into either inert, non reactive hazardous or hazardous wastes. Once the material has been designated it should be subject to waste acceptance criteria (WAC) testing to ensure it satisfies the relevant landfill criteria.

Construction Workers and Users of Surrounding Sites

Short term human exposure to contaminants present in soils can occur via several pathways during the construction and ground works phase of the development. These include dermal absorption after contact with contaminated ground, inhalation of soil or dust (including windblown dust), inhalation of volatised compounds, inadvertent soil ingestion and contact with contaminated groundwater.

Using guidance in the HSE publication "*Protection of Workers and the General Public during the Development of Contaminated Land*", the made ground can generally be classed as contaminated with respect to construction workers due to elevated concentration of arsenic, cadmium, nickel, selenium, pH and sulphide. As a minimum PPE should be employed in accordance with HSE guidance and safeguards should be taken to limit dust during ground works, and limit access to the public. Gloves should be worn in contact with fill materials.

Vegetation

Plants can be affected by soil contamination in a number of ways resulting in growth inhibition, nutrient deficiencies and yellowing of leaves. Contaminants are taken up by plants through the roots and through foliage. Contaminants identified as being highly phytotoxic include cadmium, copper, nickel, and zinc.

To establish if the levels of contaminants present on site may pose a risk to vegetation the results of the contamination testing have been compared to a series of threshold values published in "*Code of Good Agricultural Practice for the Protection of Soil*". Following comparison, the levels of the phytotoxic determinants were generally low, with only one raised concentration of arsenic noted within the sample from TP3 (0.30-0.40mbgl). The on site topsoil, and clay sub-soils material are deemed suitable for re-use in soft landscaping areas.

Surface water and Groundwater

The principal pathway by which soil contamination may reach the water environment is through a slow seepage or leaching to groundwater or surface water. The potential for contaminants to migrate along such pathways is dependent on the chemical and physical characteristics of the contaminants and the local hydrogeology.

No groundwater was encountered during the ground works or within the standpipe positions during the subsequent monitoring visits to date. Given the low contamination profile and lack of groundwater and surface water noted on site groundwater and surface water are not considered to be at risk. It should be noted that groundwater levels vary with rainfall, time of year and in proximity to local abstractions and dewatering activities.

Construction Materials

Materials at risk from potential soil contamination include inorganic matrices such as cement and concrete and also organic material; e.g. plastics and rubbers. Acid ground conditions and elevated levels of sulphates can

accelerate the corrosion of building materials. Plastics and rubbers are generally used for piping and service ducts and are potentially attacked by a range of chemicals, most of which are organic, particularly petroleum based substances. Drinking water supplies can be tainted by substances that can penetrate piping and water companies enforce stringent threshold values.

BRE Special Digest One: *"Concrete in Aggressive Ground"*. 2005 3rd Edition has been used to assess the risks posed to underground concrete and to establish the design measures required to mitigate the risks. The results of the majority of the tests for pH and sulphate tests fall into Class DS-1 ACEC (Class AC-1) requirements for concrete protection assuming mobile groundwater conditions. The sample from TP6 (0.50-0.60mbgl) would fall into Class DS-3 (AC-3) assuming mobile groundwater conditions.

The levels of potential contaminants detected have been compared to thresholds supplied in the Water Regulations Advisory Scheme Guidance Note 9-04-03 *"The Selection of materials for Water Supply Pipes to be laid in Contaminated Land"*. One raised level of arsenic was recorded above the relevant threshold. As a minimum services should be placed within clean service trenches and liaison with service companies is recommended.

6 GROUND GAS ASSESSMENT

Ground gases such as carbon dioxide and methane can be classed as a form of contamination where there is a potential risk to human health. As a result, gas monitoring has been undertaken. Two visits have been carried out during April 2012 to confirm the potential risks posed by ground gases. One further visits is planned.

The ground gas was monitored by measuring emissions from monitoring points installed into BH's 1, 3 and 6 during the fieldwork. The results are tabulated in Appendix E. The monitoring was generally carried out in accordance with current guidance provided within CIRIA C665:2007.

The atmospheric pressure has an impact on the concentrations of gas released. The atmospheric pressure was between 990 and 997 millibars during the surveys. Falling and rising atmospheric pressure regional trends were noted during the surveys. This is considered to be a good range of conditions for the time of year.

Carbon dioxide was recorded at concentrations of between 0.30-1.30% volume, and oxygen levels were between 18.2 and 19.7%. Methane was not detected. No significant flow rates were noted within any of the boreholes during the visits.

The results obtained have been compared with relevant guidance that includes the following:

- BRE/Environment Agency BR414 (2001) - Protective Measures for housing on gas-contaminated land

- Wilson & Card (1999) - Reliability and Risk in Gas Protection Design
- CIRIA 149 (1995) - Protecting Development from Methane
- CIRIA C665 (2007) – Assessing risks posed by hazardous ground gases to buildings.

The Building Regulations set action levels for both methane and carbon dioxide from which an initial assessment can be made. The action threshold for methane is 1% while for carbon dioxide an initial consideration should be undertaken if gas concentrations exceed 1.5%. Action might be required if carbon dioxide concentrations exceed 5%. If these thresholds are exceeded, reference should be made to specific documentation to determine the nature and extent of the gas control measures required.

The proposed development involves the construction of residential units, the NHBC Traffic light system, shown in Table 1 has therefore been used to assess the gas regime.

Traffic light classification	Methane		Carbon dioxide	
	Typical max concentration (% v/v)	Gas screening value (litres/hr)	Typical max concentration (% v/v)	Gas screening value (litres/hr)
Green	1	0.16	5	0.78
Amber 1				
Amber 2	5	0.63	10	1.56
Red	20	1.56	30	3.13

TABLE 4: NHBC TRAFFIC LIGHT SYSTEM (FROM CIRIA C665)

Using Gas Screening Values (GSV) stated above, based on the levels observed to date the site would be classified as **Green**. Table 6 shows the necessary protective measures.

Traffic light classification	Protection measures required
Green	Gas protection measures not considered necessary.
Amber 1	Gas resistant membrane & ventilated sub-floor void to create permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as per BRE Report 414.
Amber 2	As Amber 1 but membrane should be installed by a specialist contractor; certification of correct installation is also required. Installation & certification 'package' is the ideal way to do this.
Red	Standard residential housing would be unacceptable without further risk assessment.

TABLE 5: NHBC PROTECTION MEASURES

No radon protection measures are required in accordance with the procedure described in BRE Publication BR211 *Radon: Guidance on Protective Measures for New Dwellings*.

7 CONCEPTUAL MODEL AND RISK ASSESSMENT

The conceptual model (Table 7) collates the salient aspects of the site to form a model. This model identifies the potential pollution linkages that may influence the proposed development. **The risk ratings are based on the likely outcome after mitigation and remediation.**

SOURCES	PATHWAYS	RECEPTORS	MITIGATION	RISK RATING
Made Ground proven to depths of up to 1.45mbgl and comprised a mix of topsoil, clay fill, and gravel fill Known worked seams at a minimum depth of 102m beneath the site. Human - elevated levels of sulphate and arsenic within the samples from TP3 and TP6 Ground Gas: No methane CO₂ 0.3-1.3% O₂ 18.2-19.7% Construction workers – elevated arsenic, cadmium, nickel, selenium, pH and sulphide. Vegetation – one raised level of arsenic Water supply pipes – one raised arsenic	Dermal absorption.	Human Residential housing Adults, possible elderly and infant.	The site will be partly capped by the development.	LOW
	Inhalation of soil/volatised compounds.		Remediation is not required beneath hardstanding or the building footprints.	
	Ingestion of soil.		Topsoil on site suitable for re-use in soft landscaping areas.	
	Contact with contaminated groundwater		GREEN classification according to the NHBC Traffic Light system from visits to date.	
	Gas migration	Construction workers	Made ground on site generally classed as contaminated (due to elevated arsenic, cadmium, nickel, selenium, pH and sulphide)	LOW
	Dermal absorption.		Appropriate PPE should be employed as a matter of course. Limit dust during ground works and demolition. Gloves to be worn in contact with fill.	
	Inhalation of soil/volatised compounds (dust).			
	Ingestion of soil.	Surrounding areas	Damping down of site in dry/windy conditions and limit access by the public.	LOW
	Contact with contaminated groundwater.			
	Dermal absorption.			
	Inhalation of soil/volatised compounds (dust).	Vegetation	Clean cover system in vicinity of BH3/TP3 and TP6 including 200mm of topsoil over 300mm of subsoil.	LOW
	Ingestion of soil.			
	Uptake via roots and leaf surfaces.			
	Seepage or leaching of contaminants.	Surface Water	No groundwater noted within any of the trial pits or boreholes.	LOW
	Accumulation of contaminated sediments in water body.		No groundwater noted within standpipe positions during monitoring visits to date.	
	Seepage or leaching of contaminants.	Groundwater Secondary A Aquifer	Surface water 150m north.	LOW
	Contact with contaminated soil/deleterious material.		Class DS-1, AC-1 assuming mobile groundwater conditions	
		Construction Materials and service fabrics	Consultation with utility providers recommended due to raised arsenic concentrations.	LOW-MOD

TABLE 7: CONCEPTUAL MODEL AND RISK ASSESSMENT

8 SUMMARY AND CONCLUSIONS

A site investigation was required for a proposed new housing development, including hardstanding as parking areas and soft landscaping as garden areas.

Extent of investigation

The extent of the investigation was to provide geotechnical and environmental information based on the drilling of six small percussive boreholes and eight machine excavated trial pits together with in-situ and laboratory testing.

Ground gas monitoring standpipes were installed in three boreholes and two monitoring visits have been undertaken to date. A full assessment will be published as an addendum to this report once the monitoring is complete.

Summary of Ground Conditions

Made Ground generally comprised grass over topsoil to between 0.15-0.50mbgl underlain by clay fill to depths of between 0.35m and 1.45mbgl.

Red sandy gravel fill of brick rubble was noted within TPs 3, 5 and 6 and BH3 between 0.25-0.35m and proven to a maximum of 1.30mbgl.

Within the trial pits the natural deposits were generally medium dense (clayey) gravelly sand/sand and gravel encountered from 0.35-1.80mbgl and proven to a maximum of 2.00mbgl. Stiff clay deposits were noted within TP6 and TP8 at 1.10m and 1.20mbgl respectively and proven to a maximum of 1.90mbgl.

Within the boreholes firm to stiff slightly to very sandy, slightly gravelly clay deposits were noted directly beneath the made ground at depths of between 0.30m-1.45mbgl. This was underlain by medium dense to very dense sand within BHs 1-3 and BH5 at depths from 1.20m and proven to a maximum of 3.45mbgl.

Inferred weathered very dense sandstone rockhead recovered as sand and gravel was encountered at depths of between 1.30m-2.60mbgl and proven to a maximum depth of 3.05mbgl.

Foundations

Traditional shallow strip foundations should be appropriate for the new development. Footing should be placed within the medium dense sand deposits or stiff clay at a minimum depth of 0.75mbgl locally deepened up to depths of 1.45mbgl where deeper made ground was noted.

Within granular strata, assuming 0.60m wide footings placed at a depth of 0.75mbgl which exert a load of 100kN/m² the predicted settlement will be less than 25mm.

Where clay strata is encountered a safe bearing pressure of 100kN/m^2 has been calculated using a assuming strip footings of 0.60m in width at a depth of 0.75mbgl. Assuming any structures placed do not impart a loading of greater than 100kN/m^2 then settlements should be within normal tolerances.

Prior to placing foundations all exposed formations should be well compacted and any soft or loose spots should be removed and backfilled with inert granular material ensuring the infill material is well compacted. Reinforcement should be added where changes in sub-strata occur to ensure against differential settlement and

Excavation

From the evidence of the investigation, excavations in the made ground should be easily achieved by means of a normal excavator. Stability of excavations is expected to be poor to moderate in the made ground but improve within the medium dense granular and clay deposits. Excavation sides should be designed, constructed and supported in accordance with the recommendations given in CIRIA Report No. 97: "Trenching Practice".

Groundwater

No groundwater was encountered within any of the boreholes or trial pits during the site works or within the standpipe positions during the monitoring visits to date. It is unlikely that groundwater will be encountered within shallow excavations, however, if excavations are to be left open for prolonged periods of time or during inclement weather then provision for dewatering may be required. It should be noted that groundwater levels can fluctuate with seasonal and climatic variations as well as in proximity to local dewatering and abstraction schemes.

Chemical Contamination Results

Following comparison the concentration of chemical testing results were low and within acceptable thresholds. Two raised arsenic and one raised sulphate values were noted within the samples from TPs 3 and 6 where red gravel fill materials were noted.

It is considered that the levels of contamination within the vicinity of TPs 3 and 6 may pose a risk to the current and future users of the site. Remediation is not required beneath proposed hardstanding areas or the proposed building footprints.

If proposed areas of soft landscaping are to be placed within the vicinity of TPs 3 or 6 a clean cover system should be implemented comprising 300mm of sub-soil material overlain with 200mm of clean topsoil material. Site won material may be used in the cover system.

Alternatively the client may wish to excavate the contaminated hot spots near to TPs 3/6 and place the material beneath hardstanding areas/building footprints to sever potential pollution pathway.

The made ground on site should be classified as “contaminated” with respect to construction workers and it is recommended that gloves are always worn when handling made ground.

One elevated level of arsenic was noted with regard to utilities. No groundwater was noted during the site works or monitoring visits to date. Consultation with the relevant utility companies is essential to ensure the risk of contamination entering water supplies and causing damage to other services is sufficiently reduced. Utilities should be laid in clean service trenches as a minimum.

If any zones of brightly coloured, odorous, hydrocarbon or obviously contaminated material is encountered then work should stop in that area. Further testing will be required to determine whether or not the material should remain on site.

The current legislation on the disposal of waste soil materials involves the categorization of the material into either inert, non reactive hazardous or hazardous wastes. Once the material has been designated it should be subject to waste acceptance criteria (WAC) testing to ensure it satisfies the relevant landfill criteria.

Sulphate results

The results of the pH and sulphate tests on the made ground and natural ground from the chemical analysis results generally fall into Class DS-1, ACEC (Class AC-1) requirements for concrete protection assuming mobile groundwater conditions. The sample from TP6 (0.50-0.60mbgl) would fall into Class DS-3 (AC-3) assuming mobile groundwater conditions.

Ground Gas Assessment

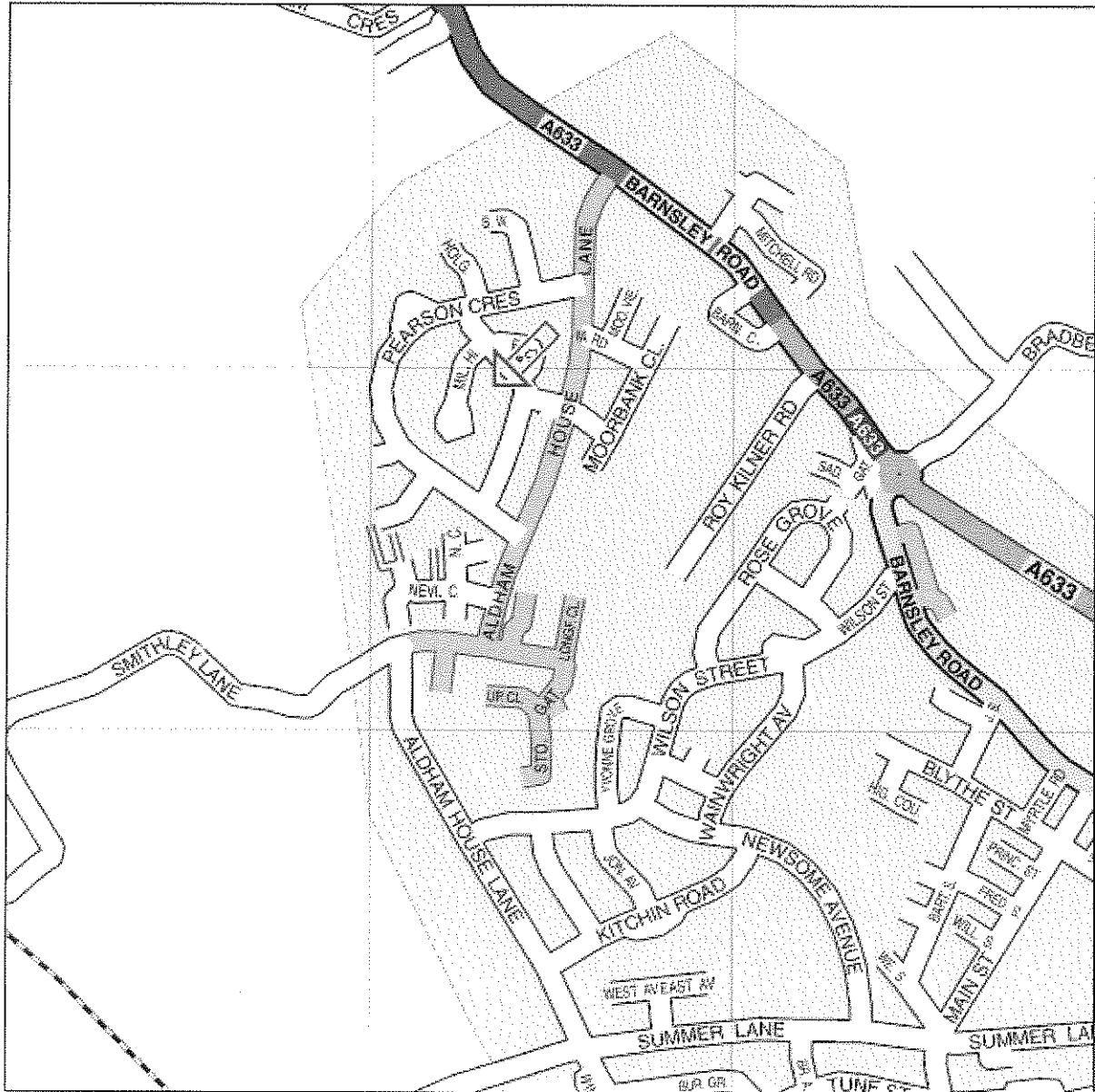
The visits to date would classify the site as **GREEN** according to the NHBC Traffic Light System.

No radon protection measures are required in accordance with the procedure described in BRE Publication BR211 *Radon: Guidance on Protective Measures for New Dwellings*.

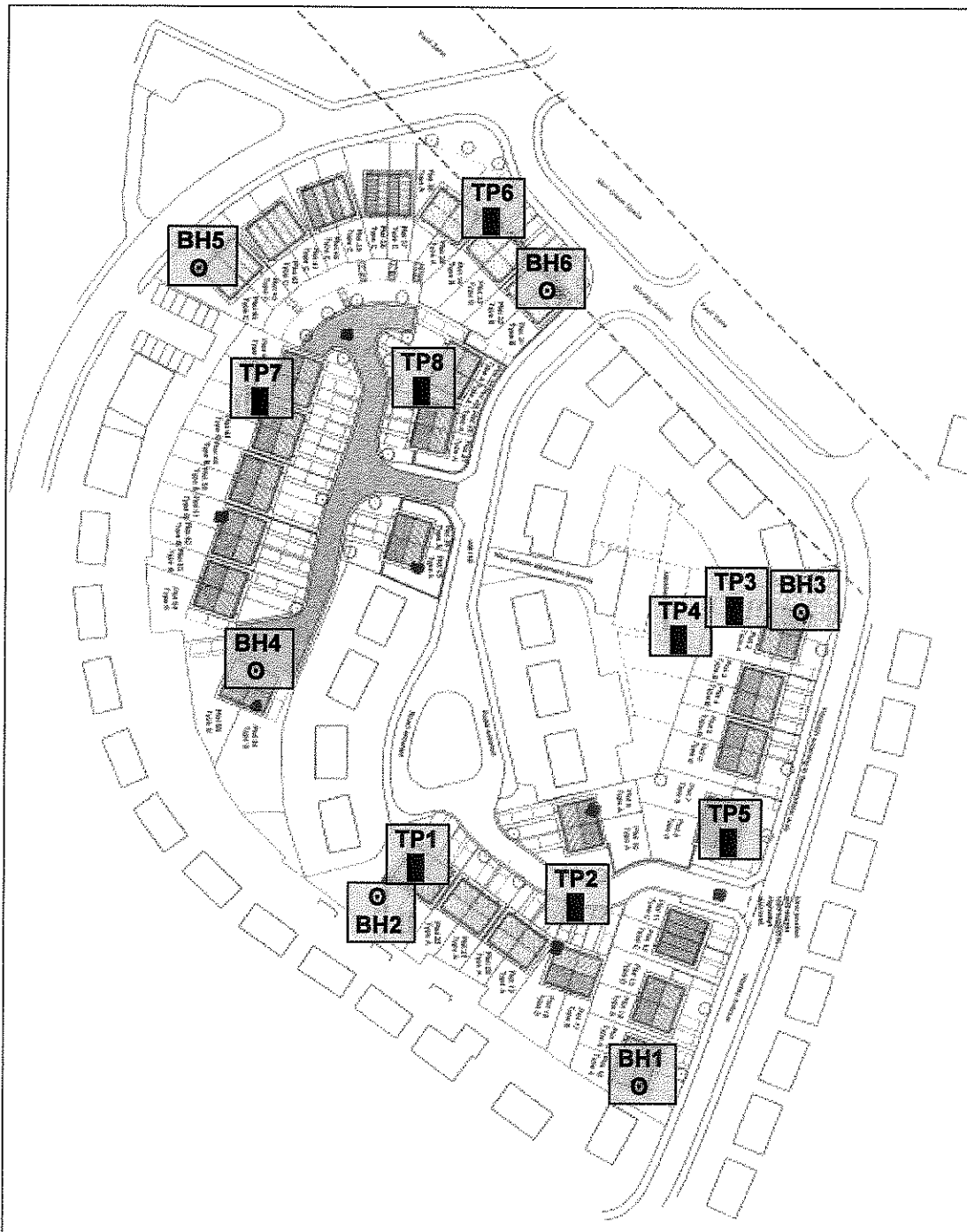
SOLMEK

APPENDIX A:

Figures



Title	Site Location Map		
Project	Pearson Crescent, Wombwell		
Client	Bernard William Associates		
Drawing Number	Figure 1	Scale	Not to scale
Date	April 2012		

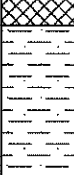


Title	Boreholes and Trial Pit Location Plan		
Project	Pearson Crescent, Wombwell		
Client	Bernard William Associates		
Drawing Number	Figure 2	Scale	Not to scale
Date	April 2012		

APPENDIX B:
Borehole and Trial Pit Logs

BOREHOLE LOG

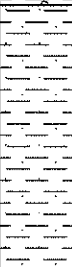
Project Pearson Crescent, Wombwell				BOREHOLE No BH1	
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()		
Contractor				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill	
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)			DESCRIPTION
0.10-0.20	B	N=18			(0.30) 0.30	MADE GROUND: Grass over slightly gravelly topsoil. Gravel is fine to coarse, angular of brick.			
					(0.35) 0.65	MADE GROUND: Dark brown sandy slightly gravelly clay. Sand is fine to coarse. Gravel is fine to coarse, angular of brick.			
0.65-0.75	B				(0.55) 1.20	Yellow sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.			
1.20-1.30 1.20-1.65	B SPT				(0.80) 2.00	Medium dense yellow gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.			
2.00-2.10 2.00-2.45	B SPT		N=50+			(0.45) 2.45	Very dense orangish yellow weathered SANDSTONE recovered as sand and gravel. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.		
							SPT Refusal. Borchole complete.		

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	
											No groundwater encountered.
All dimensions in metres Scale 1:25			Client			Method/ Plant Used Small Percussive Rig			Logged By SJF		

BOREHOLE LOG

Project Pearson Crescent, Wombwell				BOREHOLE No BH2	
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()		
Contractor				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick- ness)		
0.10-0.20	B	N=28				(0.35) 0.35	MADE GROUND: Grass over slightly gravelly topsoil. Gravel is fine to coarse, angular of brick.	
0.35-0.45	B					(1.05) 1.40	Stiff light brown very sandy slightly gravelly clay. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.	
1.20-1.65	SPT							
1.40-1.50	B							
		N=14				(0.90) 2.30	Stiff orangish brown very sandy CLAY.	
2.00-2.45	SPT							
2.30-24.00	B							
		N=50+				(0.60) 2.90	Medium dense yellowish brown SAND. Sand is fine to coarse.	
2.90-3.00	B							
3.00-3.45	SPT					(0.55) 3.45	Very dense dark brown SAND. Sand is fine to coarse.	
							SPT Refusal. Borehole complete.	

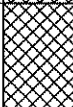
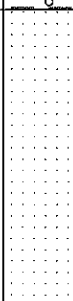
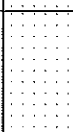
Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Dia. mm	Water Dpt	From	To	Hours	From	To	
											No groundwater encountered.

All dimensions in metres Scale 1:25	Client	Method/ Plant Used Small Percussive Rig	Logged By SJF
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GRD BOREHOLE LOG S120313.GPJ AGS3 ALL GDT 19/04/12

BOREHOLE LOG

Project Pearson Crescent, Wombwell				BOREHOLE No BH3	
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()		
Contractor				Sheet 1 of 1	

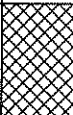
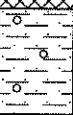
SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick-ness)		
0.10-0.20	B	N=9			(0.30) 0.30	MADE GROUND: Grass over slightly gravelly topsoil. Gravel is fine to coarse, angular of brick.		
0.35-0.45	B				(0.55) 0.85	MADE GROUND: Red gravel. Gravel is fine to coarse, angular of brick.		
0.85-0.95	B				(0.35) 1.20	MADE GROUND: Brown slightly gravelly clay. Gravel is fine to coarse, angular of brick rubble.		
1.20-1.65	SPT				(0.40) 1.60	Firm brown sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.		
1.60-1.20	B	N=25			(1.00) 2.60	Medium dense yellow gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.		
2.00-2.45	SPT				(0.45) 3.05	Very dense orangish yellow SANDSTONE recovered as sand and gravel. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.		
2.60-3.05	SPT		N=50+			SPT Refusal. Borehole complete.		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS
Date	Time	Depth	Casing Depth	Dia. mm	Water Dpt	From	To	Hours	From	To	
											No groundwater encountered.
All dimensions in metres Scale 1:25			Client			Method/ Plant Used			Small Percussive Rig		Logged By SJF

GRD_BOREHOLE_LOG S120313.GPJ AGSS ALL GDT 19/04/12

BOREHOLE LOG

Project Pearson Crescent, Wombwell				BOREHOLE No BH4	
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()		
Contractor				Sheet 1 of 1	

SAMPLES & TESTS			Water	STRATA				Geology	Instrument/ Backfill
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick- ness)	DESCRIPTION		
0.10-0.20	B	N=12				(0.40) 0.40	MADE GROUND: Grass over slightly gravelly topsoil. Gravel is fine to coarse, angular of brick.		
0.45-0.55	B					(1.05) 1.45	MADE GROUND: Brown sandy slightly gravelly clay. Sand is fine to coarse. Gravel is fine to coarse, angular of brick and sandstone.		
1.20-1.65	SPT								
1.50-1.60	B	N=50+				(0.35) 1.80	Firm orangish brown sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.		
2.00-2.45	SPT						(0.65) 2.45	Very dense yellowish orange SANDSTONE recovered as sand and gravel. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.	
							SPT Refusal. Borehole complete.		

Boring Progress and Water Observations						Chiselling			Water Added		GENERAL REMARKS No groundwater encountered.
Date	Time	Depth	Casing Depth	Dia. mm	Water Dpt	From	To	Hours	From	To	
All dimensions in metres Scale 1:25						Client			Method/ Plant Used Small Percussive Rig		Logged By SJF

GRD_BOREHOLE_LOG S120313.GPJ AGS3 ALL GDT 19/04/12

Tel 01642 607083
Fax 01642 612355

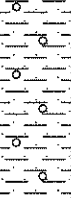
Tel 01642 607083
Fax 01642 612355

Tel 01642 607083
Fax 01642 612355

Tel 01642 607083
Fax 01642 612355

BOREHOLE LOG

Project Pearson Crescent, Wombwell				BOREHOLE No BH6	
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()		
Contractor				Sheet 1 of 1	

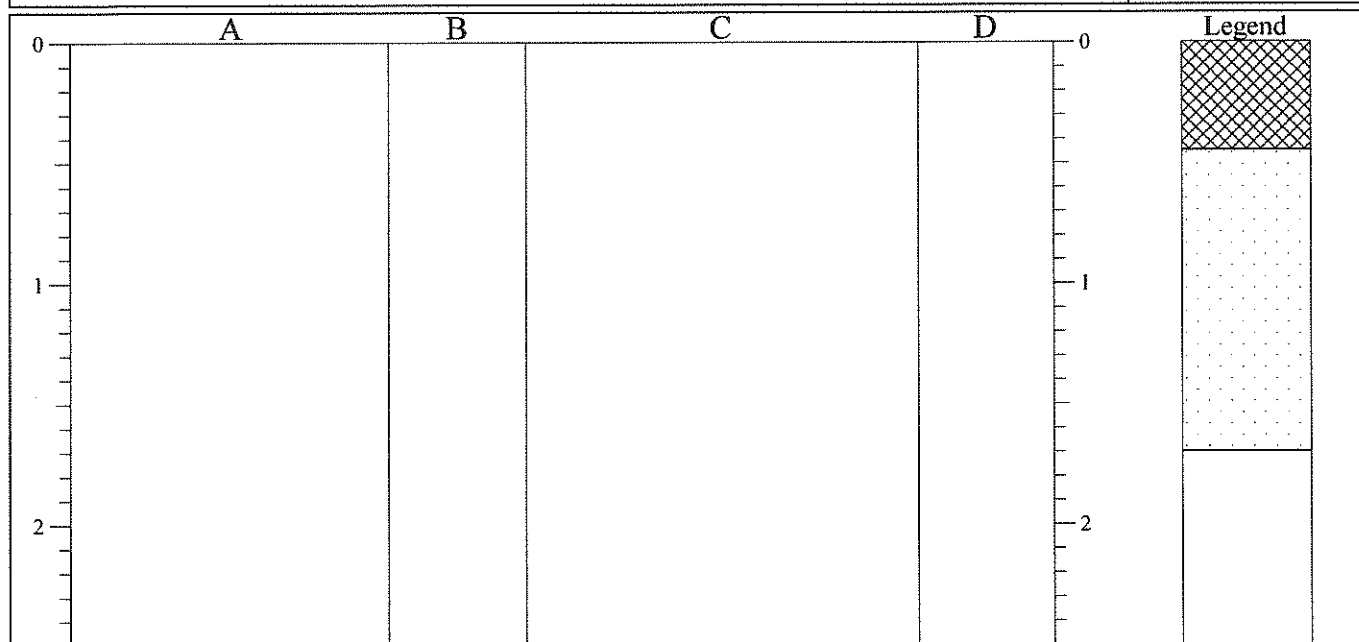
SAMPLES & TESTS			Water	STRATA			Geology	Instrument/ Backfill	
Depth	Type No	Test Result		Reduced Level	Legend	Depth (Thick- ness)			DESCRIPTION
0.10-0.20	B	N=26				(0.45)	MADE GROUND: Grass over slightly gravelly topsoil. Gravel is fine to coarse, angular of brick.		
0.45-0.55	B					0.45 0.60	MADE GROUND: Brown sandy slightly gravelly clay. Sand is fine to coarse.		
0.65-0.75	B				(0.70)	Gravel is fine to coarse, angular of brick and sandstone. Grey mottled yellow slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.			
1.20-1.65	SPT	1.30			Yellowish orange SANDSTONE recovered as sand and gravel. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone.				
1.40-1.50	B						(0.85)		
1.70-2.15	SPT			2.15					
		N=50+					SPT Refusal. Borehole complete.		

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	
											No groundwater encountered.
All dimensions in metres Scale 1:25			Client			Method/ Plant Used			Small Percussive Rig		Logged By SJF

GRD BOREHOLE LOG S120313.GPJ AGS3 ALL GDT 21/03/12

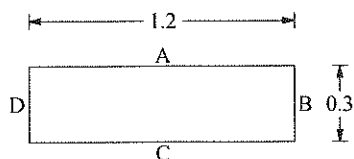
TRIAL PIT LOG

Project Pearson Crescent, Wombwell				TRIAL PIT No TP1
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.45		MADE GROUND: Grass over brown slightly clayey slightly gravelly sandy topsoil with rootlets.	0.30-0.40	J1	
0.45-1.70		Medium dense light yellowish brown clayey gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse, sub-angular to angular of sandstone.			
1.70		End of trial pit.			

Shoring/Support: None.
Stability: Fair.



GENERAL REMARKS

No groundwater encountered.

All dimensions in metres
Scale 1:31.25

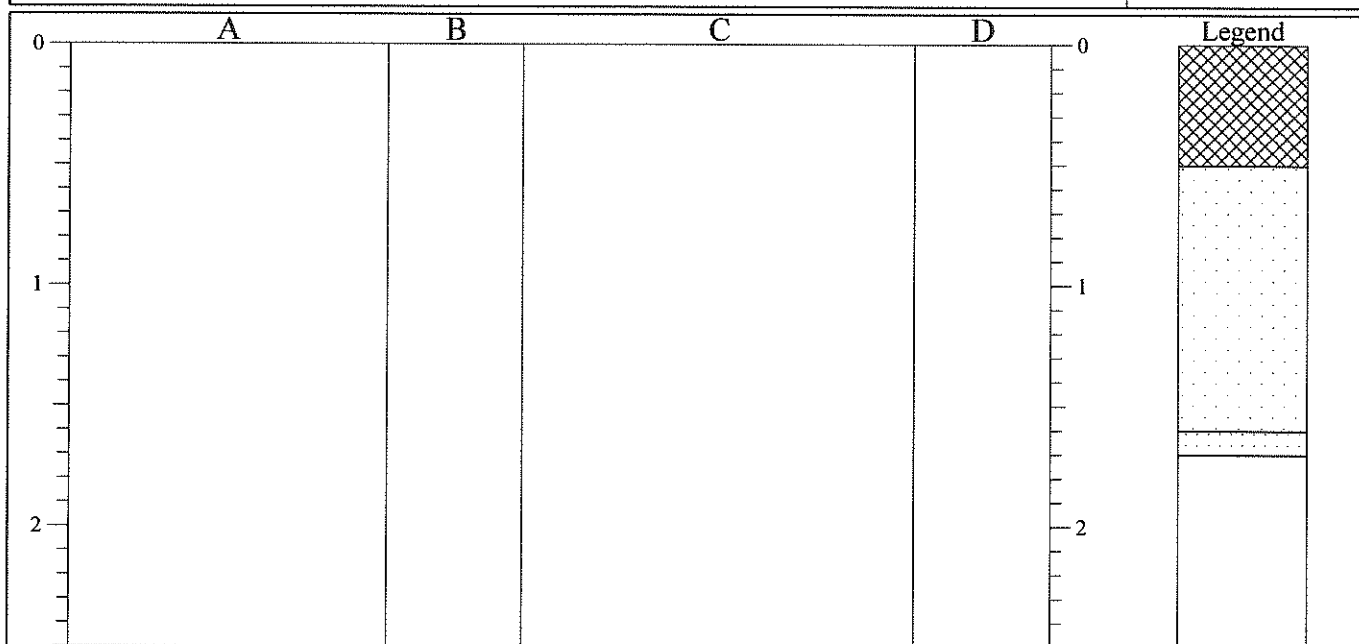
Client

Method/
Plant Used Neuson 1503 Excavator

Logged By
SJF

TRIAL PIT LOG

Project Pearson Crescent, Wombwell				TRIAL PIT No TP2
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



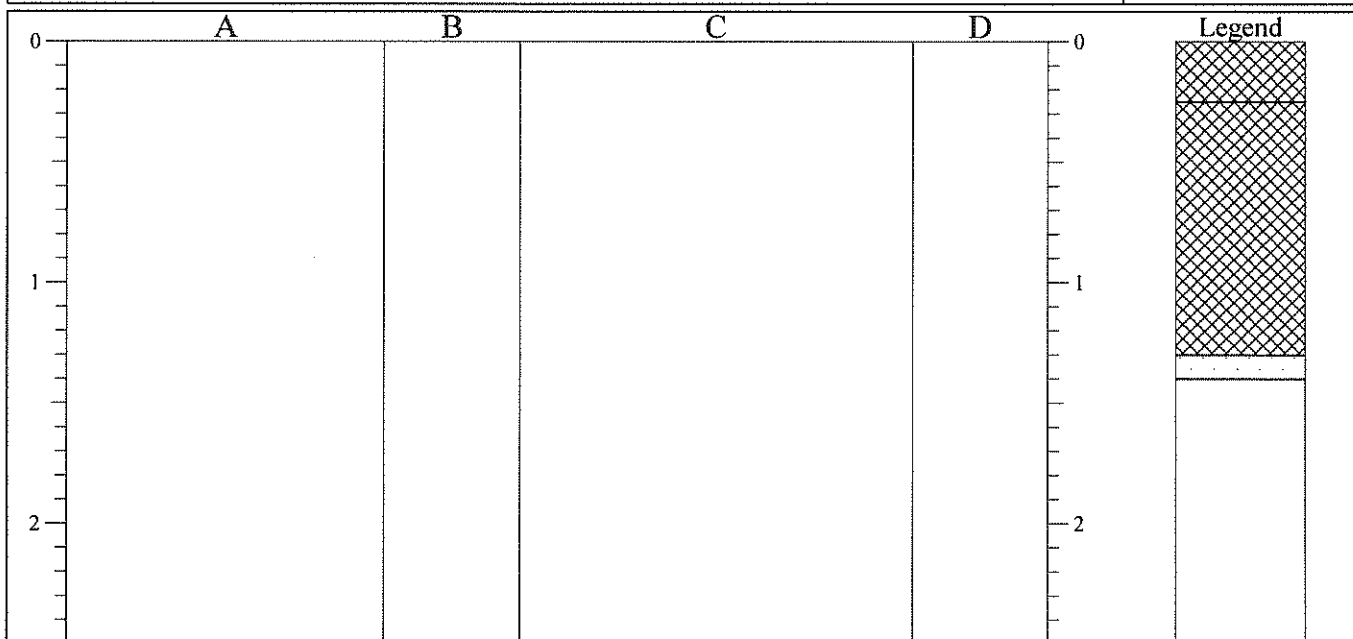
STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.50		MADE GROUND: Grass over brown slightly clayey slightly gravelly sandy topsoil with rootlets.	0.20-0.30	J1	
0.50-1.60		Medium dense light yellowish brown gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse, sub-angular to angular of sandstone.	0.60-0.70	J2	
1.60-1.70		Very dense yellowish brown/pale grey SANDSTONE recovered as sandy gravel. Sand is fine to coarse. Gravel is fine to coarse, angular of sandstone. End of trial pit.			

Shoring/Support: None. Stability: Fair.		GENERAL REMARKS No groundwater encountered.
All dimensions in metres Scale 1:31.25	Client	Method/ Plant Used Neuson 1503 Excavator
		Logged By SJF

GRD_TRIAL_PIT_LOG_S120313.GPJ AGS3 ALL GDT 17/04/12

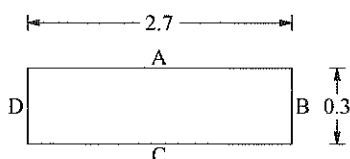
TRIAL PIT LOG

Project Pearson Crescent, Wombwell				TRIAL PIT No TP3
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.25		MADE GROUND: Grass over brown sandy, gravelly clay topsoil with rootlets.			
0.25-1.30		MADE GROUND: Red sandy gravel fill with whole bricks noted. Sand is fine to coarse. Gravel is fine to coarse, angular of brick rubble.	0.30-0.40	J1	
1.30-1.40		Loose yellowish brown gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse, sub-angular of sandstone. Trial pit abandoned due to relict brick obstructions.			
1.40					

Shoring/Support: None.
Stability: Fair.



GENERAL REMARKS

No groundwater encountered.

All dimensions in metres
Scale 1:31.25

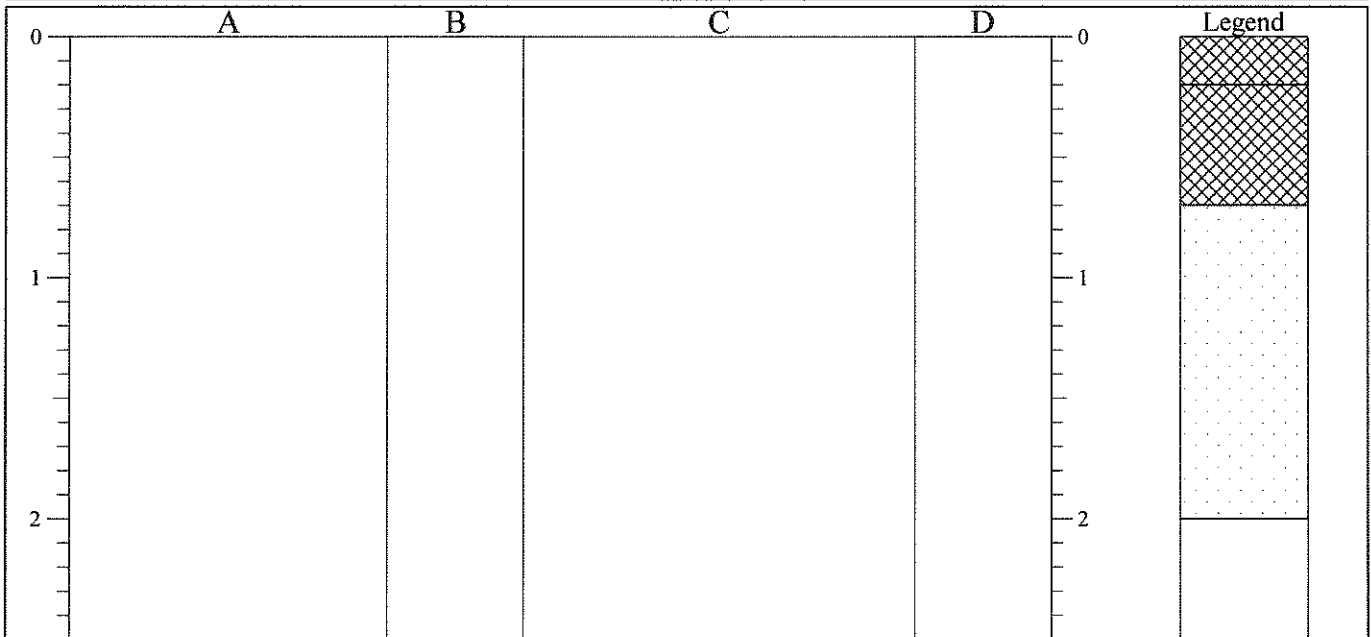
Client

Method/
Plant Used **Neuson 1503 Excavator**

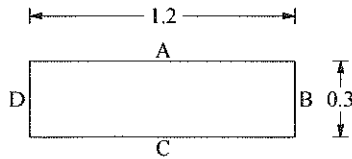
Logged By
SJF

TRIAL PIT LOG

Project Pearson Crescent, Wombwell				TRIAL PIT No TP4
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.20		MADE GROUND: Grass over sandy, slightly gravelly clay topsoil with rootlets.			
0.20-0.70		MADE GROUND: Firm brown slightly sandy, slightly gravelly clay fill. Sand is fine to coarse. Gravel is fine to coarse, sub-angular of brick and sandstone.			
0.70-2.00		Medium dense yellowish brown gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse, sub-angular to angular of sandstone.			
2.00		End of trial pit.			

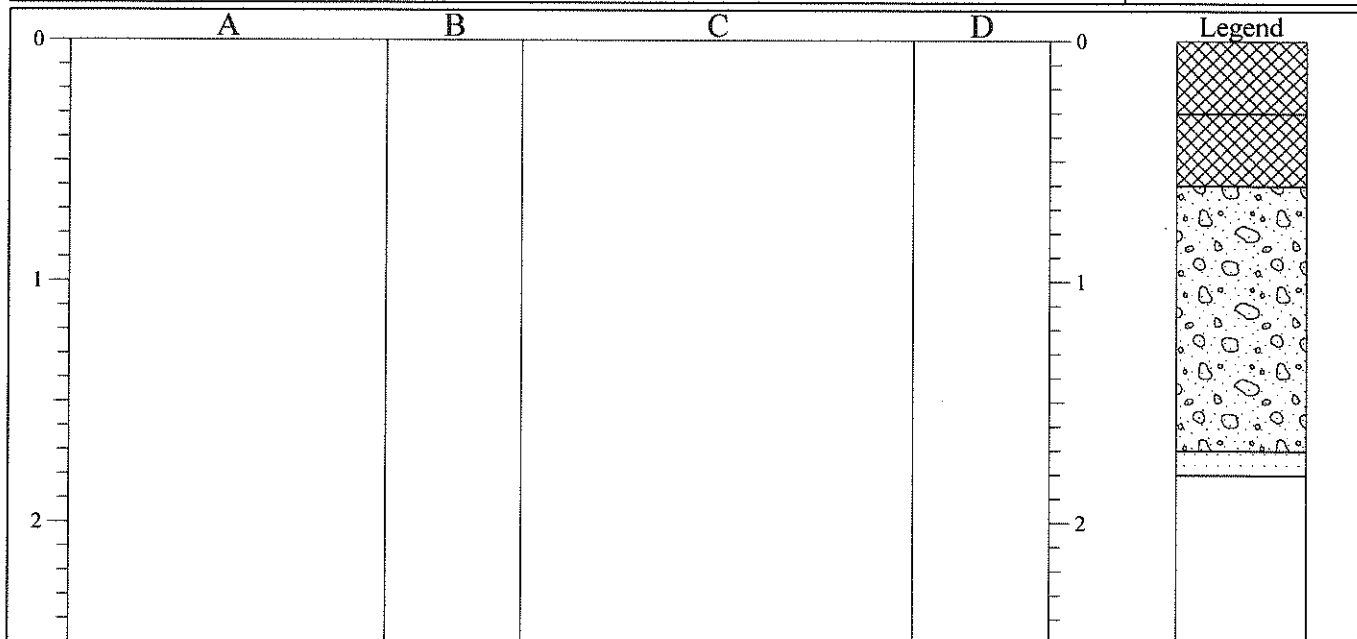
Shoring/Support: None. Stability: Fair. 	GENERAL REMARKS No groundwater encountered.
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All dimensions in metres Scale 1:31.25	Client	Method/ Plant Used Neuson 1503 Excavator	Logged By SJF
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GRD_TRIAL_PIT_LOG S120313.GPJ AG83_ALL.GDT 17/04/12

TRIAL PIT LOG

Project Pearson Crescent, Wombwell				TRIAL PIT No TP5
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1

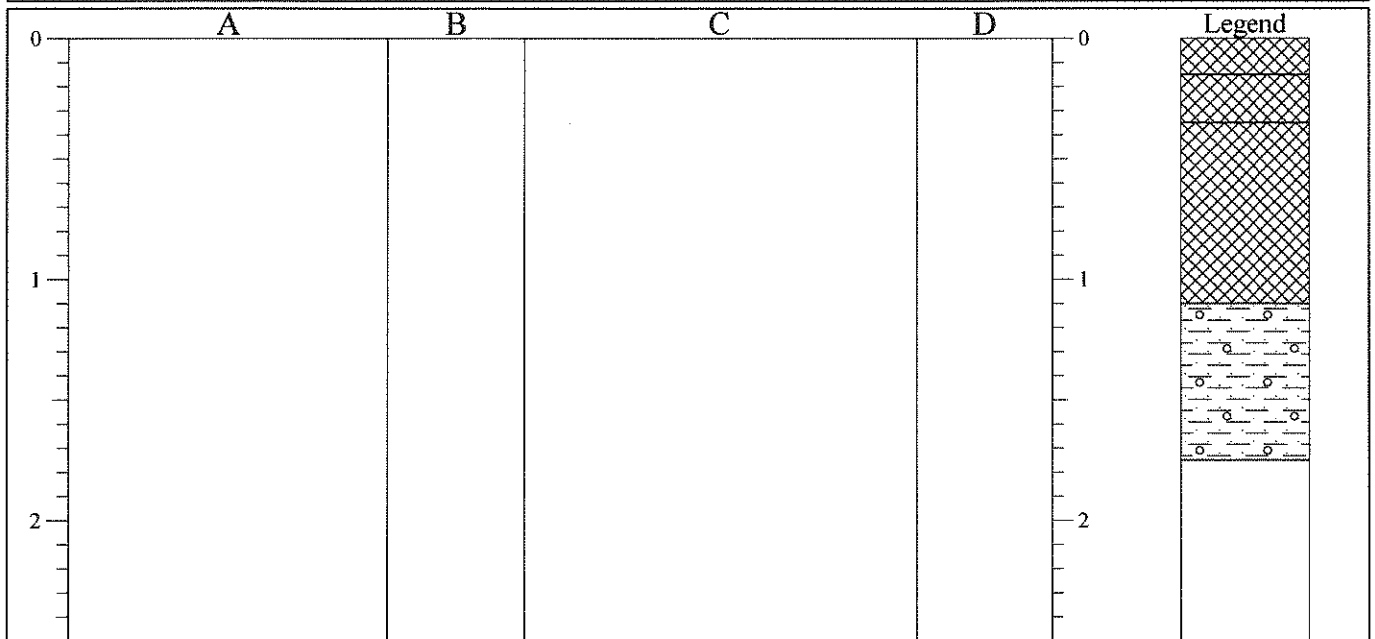


STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.30		MADE GROUND: Grass over clayey gravelly sandy topsoil with rootlets.			
0.30-0.60		MADE GROUND: grey/brown sandy gravel fill. Sand is fine to coarse. Gravel is fine to coarse, angular of concrete, brick and sandstone.	0.40-0.50	J1	
0.60-1.70		Medium dense yellowish/orangish brown SAND and GRAVEL. Sand is fine to coarse. Gravel is fine to coarse, sub-angular to angular of sandstone.	1.00-1.10	J2	
1.70-1.80		Very dense yellowish brown SANDSTONE recovered as yellowish brown sandy gravel. Sand is fine to coarse. Gravel are fine to coarse, angular of sandstone.			
1.80		End of trial pit.			

Shoring/Support: None. Stability: Fair.		GENERAL REMARKS No groundwater encountered.
All dimensions in metres Scale 1:31.25	Client	Method/ Plant Used Neuson 1503 Excavator
		Logged By SJF

TRIAL PIT LOG

Project Pearson Crescent, Wombwell				TRIAL PIT No TP6
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1

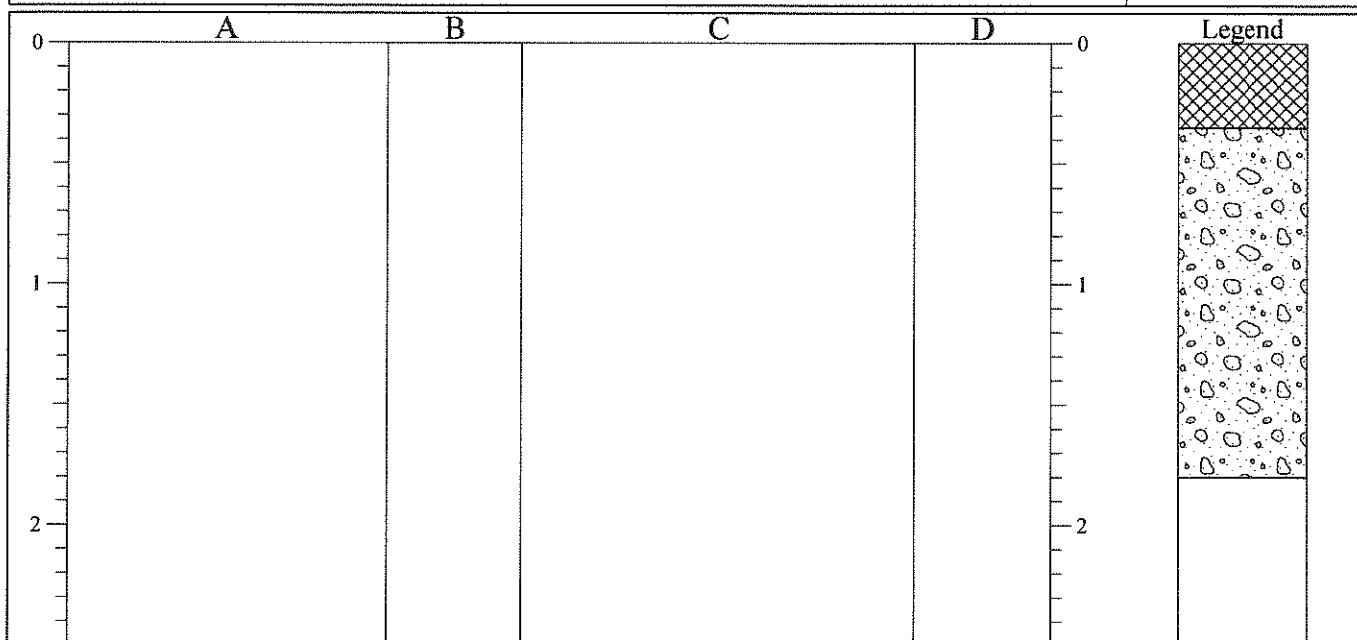


STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.15		MADE GROUND: Grass over sandy slightly gravelly clay topsoil with rootlets.			
0.15-0.35		MADE GROUND: Firm greyish brown slightly sandy clay fill. Sand is fine to coarse.	0.20-0.30	J1	
0.35-1.10		MADE GROUND: Reb/brown sandy gravel fill. Sand is fine to coarse. Gravel is fine to coarse, angular of shale and brick rubble.	0.50-0.60	J2	
1.10-1.75		Stiff yellowish brown mottled pale grey slightly sandy, slightly gravelly CLAY. Sand is fine to coarse. Gravel is fine to coarse, sub-angular of sandstone, mudstone and coal.	1.20-1.30	B1 J3	
1.75		End of trial pit.			

Shoring/Support: None. Stability: Fair.		GENERAL REMARKS No groundwater encountered.
All dimensions in metres Scale 1:31.25	Client	Method/ Plant Used Neuson 1503 Excavator
		Logged By SJF

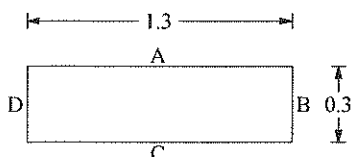
TRIAL PIT LOG

Project Pearson Crescent, Wombwell				TRIAL PIT No TP7
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.35		MADE GROUND: Grass over greyish brown sandy slightly gravelly clay topsoil with rootlets.			
0.35-1.80		Medium dense yellowish brown SAND and GRAVEL. Sand is fine to coarse. Gravel is fine to coarse, sub-angular to angular of sandstone.			
1.80		End of trial pit.			

Shoring/Support: None.
Stability: Fair.



GENERAL REMARKS

No groundwater encountered.

All dimensions in metres
Scale 1:31.25

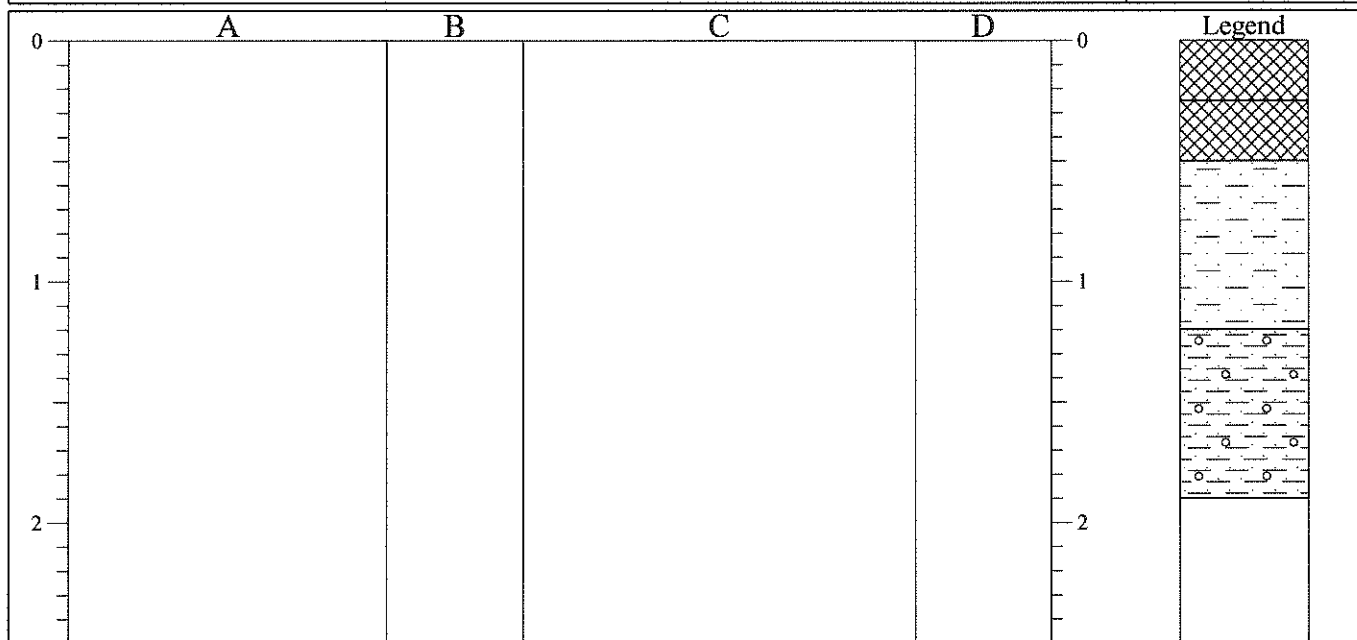
Client

Method/
Plant Used Neuson 1503 Excavator

Logged By
SJF

TRIAL PIT LOG

Project Pearson Crescent, Wombwell				TRIAL PIT No TP8
Job No S120313	Date 19-03-12 19-03-12	Ground Level (m)	Co-Ordinates ()	
Contractor				Sheet 1 of 1



STRATA			SAMPLES & TESTS		
Depth	No	DESCRIPTION	Depth	No	Remarks/Tests
0.00-0.25		MADE GROUND: Grass over clayey topsoil with rootlets.			
0.25-0.50		MADE GROUND: Firm brown/grey clay fill.			
0.50-1.20		Medium dense brown very clayey SAND. Sand is fine to coarse.			
1.20-1.90		Stiff yellowish brown mottled white slightly sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel si fine to coarse, sub-angular to angular of sandstone, mudstone and coal.			
1.90		End of trial pit.			

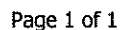
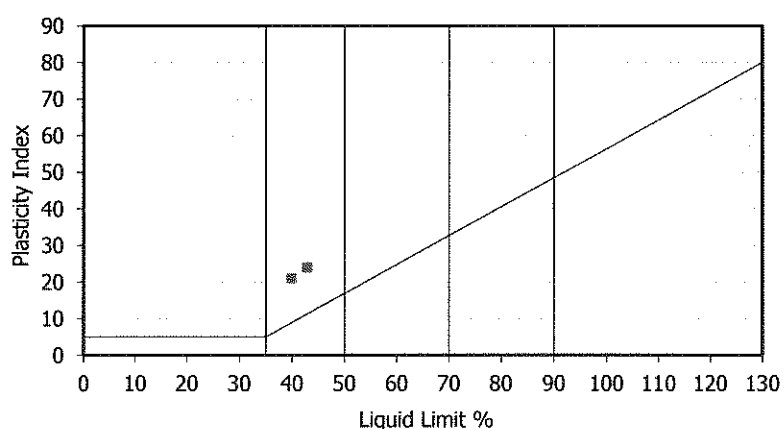
Shoring/Support: None. Stability: Fair.	GENERAL REMARKS

All dimensions in metres Scale 1:31.25	Client	Method/ Plant Used Neuson 1503 Excavator	Logged By SJF
---	--------	--	-------------------------

GRD_TRIAL_PIT_LOG S120313.GPJ AGS3 ALL GDT 17/04/12

APPENDIX C:
Laboratory Geotechnical Test Results

PEARSON CRESCENT, WOMBWELL
S120313

[illegible]

		Liquid Limit
CE	Extremely high plasticity CLAY	>90%
ME	Extremely high plasticity SILT	
CV	Very high plasticity CLAY	70 - 90%
MV	Very high plasticity SILT	
CH	High plasticity CLAY	50 - 70%
MH	High plasticity SILT	
CI	Intermediate plasticity CLAY	35 - 50%
MI	Intermediate plasticity SILT	
CL	Low plasticity CLAY	<35%
ML	Low plasticity SILT	

Comments

Prepared:

Date: 14/04/2012

Checked:

Date: 10/04/2012

Approved:

Date: 24/4/12

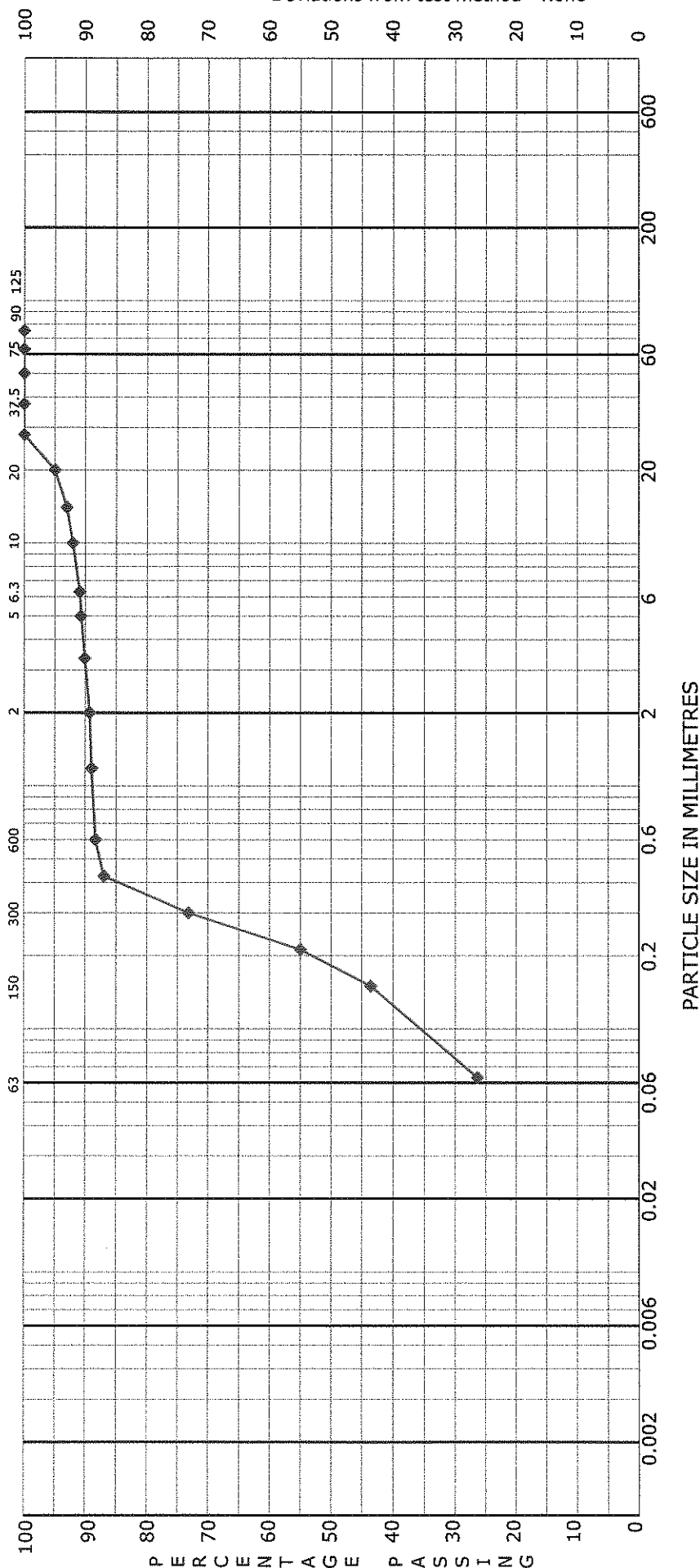


12 Yarm Road
Stockton-on-Tees
TS18 3NA
01642 607083



Scheme	:	Wombwell
Client	:	

BS Test Sieves In mm and microns

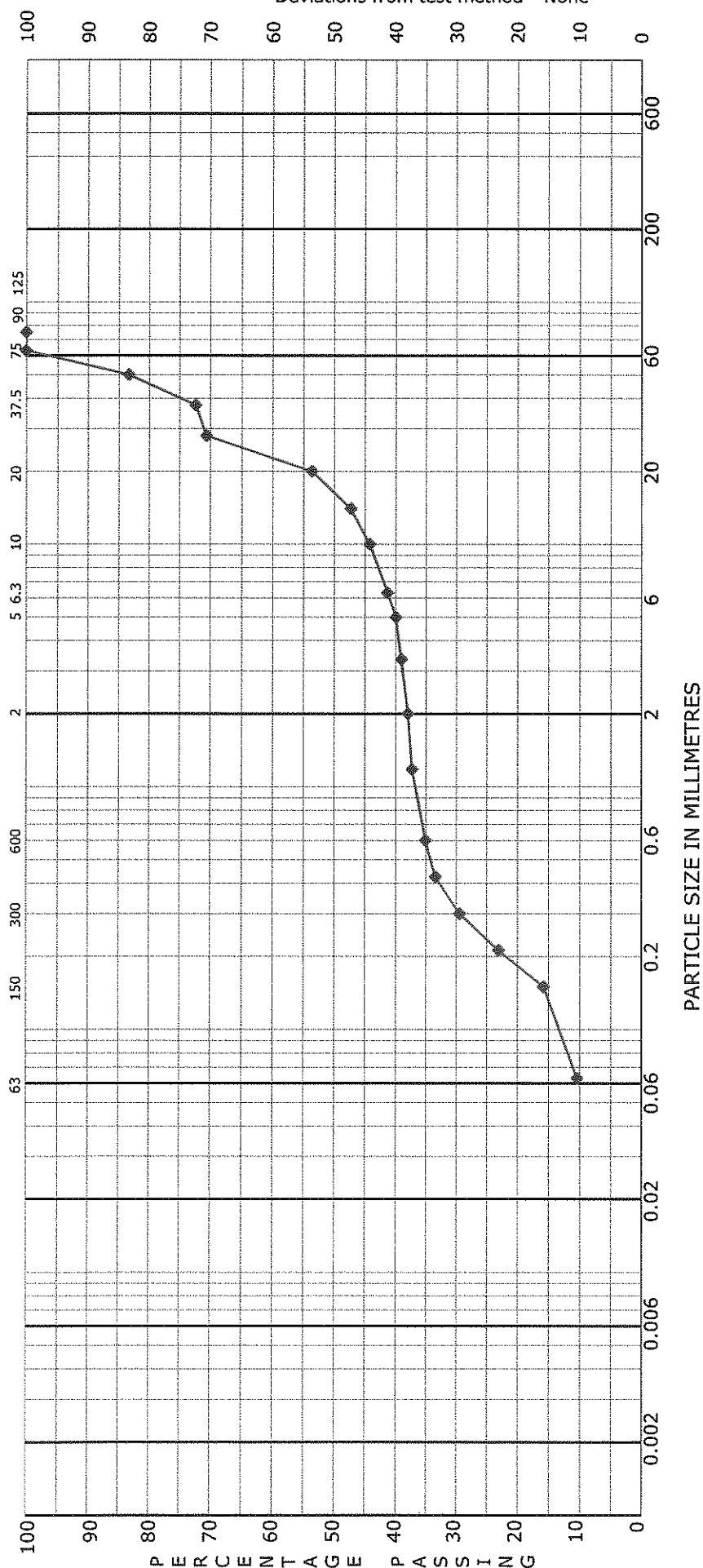
[illegible][illegible]

Scheme	:	Wombwell
Client	:	



12 Yarm Road
Stockton-on-Tees
TS18 3NA
01642 607083

BS Test Sieves In mm and microns

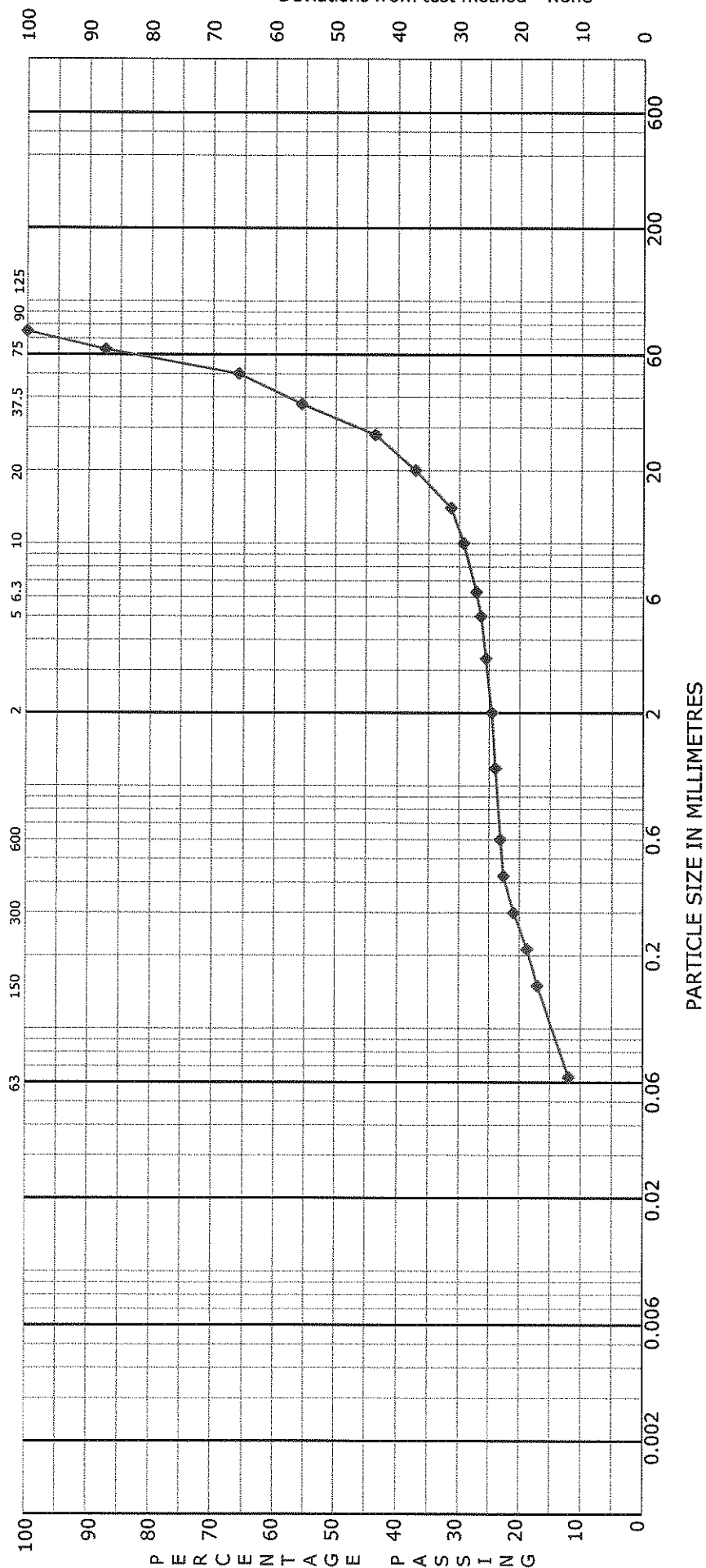
[illegible][illegible]

Scheme : Wombwell
Client :



12 Yarm Road
Stockton-on-Tees
TS18 3NA
01642 607083

BS Test Sieves In mm and microns



	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES	BOULDERS
CLAY											
		SILT			SAND			GRAVEL			

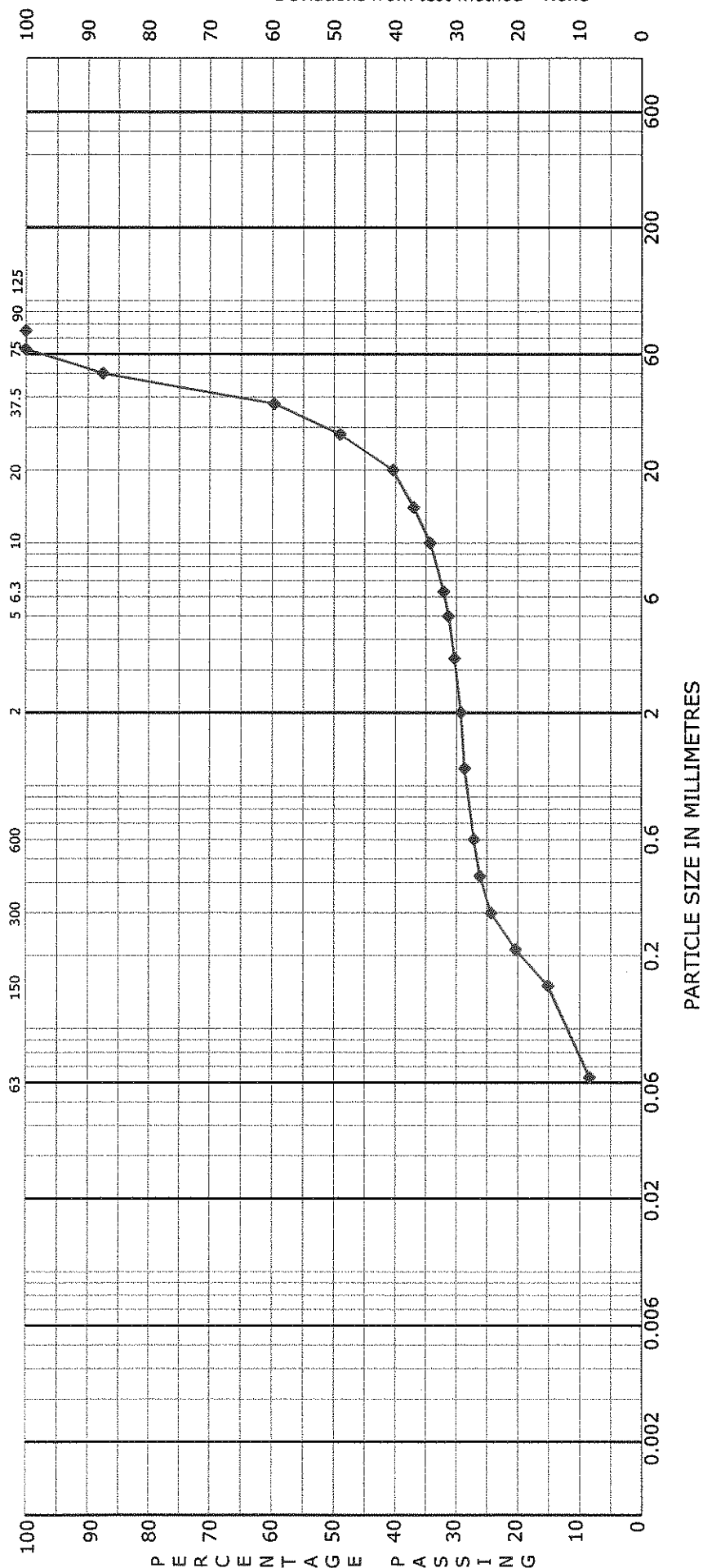
[illegible]

Scheme : Wombwell
Client :



12 Yarm Road
Stockton-on-Tees
TS18 3NA
01642 607083

BS Test Sieves In mm and microns

[illegible][illegible]

Scheme : Wombwell
Client :



12 Yarm Road
Stockton-on-Tees
TS18 3NA
01642 607083

APPENDIX D:
Laboratory Chemical Test Results and CLEA Model Output



2139

Certificate of Analysis

Date: 31/03/2012

Certificate Number: 12-60809

Client: SOLMEK
12 Yarm Road
Stockton On Tees
Cleveland
TS18 3NA

Our Reference: 12-60809

Client Reference: S1220313

Contract Title: Pearson Crescent, Wombwell

Description: 5 soil samples

Date Received: 20 March 2012

Date Started: 21 March 2012

Date Completed: 31 March 2012

Test Procedures: Identified by prefix DETSn (details on request), Asbestos Analysis (DETS 082).

Notes: Observations and interpretations are outside the scope of UKAS accreditation

Approved By: 
Paul Woodbridge, Senior Operations Manager

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 except in full, without the prior written approval of the laboratory.

Information in Support of the Analytical Results

Analysis

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425um sieve, in accordance with BS1377.

Organic soil analysis was carried out on an 'as received' sample.

Key

- * Denotes test not included in laboratory scope of accreditation
- # Denotes test that holds MCERTS accreditation, however, MCERTS accreditation is only implied if the report carries the MCERTS logo
- \$ Denotes tests completed by an approved subcontractor
- I/S Denotes insufficient sample to carry out test
- U/S Denotes that the sample is not suitable for testing

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-

Soils - 1 month

Liquids - 2 weeks

Asbestos (test portion) - 6 months

Summary of Chemical Analysis

Soil Samples

Our Ref: 12-60809

Client Ref: S1220313

Contract Title: Pearson Crescent, Wombwell

				Lab No.	398460	398461	398462	398463	398464
				Sample ID	TP1	TP2	TP3	TP6	TP6
				Depth	0.30-0.40	0.60-0.70	0.30-0.40	0.50-0.60	1.20-1.30
				Sample Ref					
				Sample Type					
				Sampling Date	19/03/2012	19/03/2012	19/03/2012	19/03/2012	19/03/2012
				Sampling Time					
Test	Units	DETSxx	LOD						
Arsenic	mg/kg	DETS 042#	0.2		11	4.3	51	43	6.6
Cadmium	mg/kg	DETS 042#	0.1		0.7	0.4	1.6	1.0	0.7
Chromium	mg/kg	DETS 042#	0.15		14	12	29	24	24
Hexavalent Chromium	mg/kg	DETS02204*	1		< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	mg/kg	DETS 042#	0.2		24	8.1	64	34	18
Lead	mg/kg	DETS 042#	0.3		30	13	33	43	14
Mercury	mg/kg	DETS02325#	0.05		0.09	< 0.05	< 0.05	0.10	< 0.05
Nickel	mg/kg	DETS 042#	1		16	18	35	22	24
Selenium	mg/kg	DETS 042#	0.5		0.8	< 0.5	1.8	1.5	< 0.5
Zinc	mg/kg	DETS 042#	1		61	33	76	49	56
Boron (water soluble)	mg/kg	DETS 020#	0.2		0.9	0.5	1.6	1.1	0.7
Cyanide total	mg/kg	DETS02130#	0.1		< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Organic matter	%	DETS02002#	0.1		2.4		2.0		
Sulphide	mg/kg	DETS02024#	10		< 10.0	22	20	52	< 10.0
Sulphate Aqueous Extract as SO4	mg/l	DETS02076#	10		36	< 10	110	1700	170
pH		DETS02008#			8.0	7.5	7.5	7.3	7.3
Aliphatic C5-C6	mg/kg	DETS02321*	0.01		< 0.01		< 0.01		
Aliphatic C6-C8	mg/kg	DETS02321*	0.01		< 0.01		< 0.01		
Aliphatic C8-C10	mg/kg	DETS02321*	0.01		< 0.01		< 0.01		
Aliphatic C10-C12	mg/kg	DETS02072#	1.5		< 1.5		< 1.5		
Aliphatic C12-C16	mg/kg	DETS02072#	1.2		< 1.2		< 1.2		
Aliphatic C16-C21	mg/kg	DETS02072#	1.5		< 1.5		< 1.5		
Aliphatic C21-C35	mg/kg	DETS02072#	3.4		< 3.4		< 3.4		
Aromatic C5-C7	mg/kg	DETS02321*	0.01		< 0.01		< 0.01		
Aromatic C7-C8	mg/kg	DETS02321*	0.01		< 0.01		< 0.01		
Aromatic C8-C10	mg/kg	DETS02321*	0.01		< 0.01		< 0.01		
Aromatic C10-C12	mg/kg	DETS02072#	0.9		< 0.9		< 0.9		
Aromatic C12-C16	mg/kg	DETS02072#	0.5		< 0.5		< 0.5		
Aromatic C16-C21	mg/kg	DETS02072#	0.6		< 0.6		< 0.6		
Aromatic C21-C35	mg/kg	DETS02072#	1.4		< 1.4		< 1.4		
Aliphatic C5-C35	mg/kg	DETS02072*	10		< 10		< 10		
Aromatic C5-C35	mg/kg	DETS02072*	10		< 10		< 10		
TPH Ali/Aro	mg/kg	DETS02072*	10		< 10		< 10		
Acenaphthene	mg/kg	DETS02301	0.1		< 0.1		< 0.1		
Acenaphthylene	mg/kg	DETS02301	0.1		< 0.1		< 0.1		
Anthracene	mg/kg	DETS02301	0.1		< 0.1		< 0.1		
Benzo(a)anthracene	mg/kg	DETS02301	0.1		< 0.1		< 0.1		
Benzo(a)pyrene	mg/kg	DETS02301	0.1		< 0.1		< 0.1		
Benzo(b)fluoranthene	mg/kg	DETS02301	0.1		< 0.1		< 0.1		
Benzo(k)fluoranthene	mg/kg	DETS02301	0.1		< 0.1		< 0.1		
Benzo(g,h,i)perylene	mg/kg	DETS02301	0.1		< 0.1		< 0.1		
Chrysene	mg/kg	DETS02301	0.1		< 0.1		< 0.1		
Dibenzo(a,h)anthracene	mg/kg	DESTC 3301	0.1		< 0.1		< 0.1		

Summary of Chemical Analysis

Soil Samples

Our Ref: 12-60809

Client Ref: S1220313

Contract Title: Pearson Crescent, Wombwell

				Lab No.	398460	398461	398462	398463	398464
				Sample ID	TP1	TP2	TP3	TP6	TP6
				Depth	0.30-0.40	0.60-0.70	0.30-0.40	0.50-0.60	1.20-1.30
				Sample Ref					
				Sample Type					
				Sampling Date	19/03/2012	19/03/2012	19/03/2012	19/03/2012	19/03/2012
				Sampling Time					
Test	Units	DETSxx	LOD						
Fluoranthene	mg/kg	DETSC 3301	0.1		< 0.1		< 0.1		
Fluorene	mg/kg	DETSC 3301	0.1		< 0.1		< 0.1		
Indeno(1,2,3-c,d)pyrene	mg/kg	DETSC 3301	0.1		< 0.1		< 0.1		
Naphthalene	mg/kg	DETSC 3301	0.1		< 0.1		< 0.1		
Phenanthrene	mg/kg	DETSC 3301	0.1		< 0.1		< 0.1		
Pyrene	mg/kg	DETSC 3301	0.1		< 0.1		< 0.1		
PAH	mg/kg	DETSC 3301	1.6		< 1.6		< 1.6		
Phenol - Monohydric	mg/kg	DETSC2130#	0.3		< 0.3	< 0.3	< 0.3	< 0.3	< 0.3

Summary of Asbestos Analysis Soil Samples

Our Ref: 12-60809

Client Ref: S1220313

Contract Title: Pearson Crescent, Wombwell

Lab No	Sample Ref	Material Type*	Result	Comment	Analyst
398460	TP1 0.30-0.40	Soil	NAD	None	John Leeson
398462	TP3 0.30-0.40	Soil	NAD	None	John Leeson
398463	TP6 0.50-0.60	Soil	NAD	None	John Leeson

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. NAD = No Asbestos Detected. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETS 082 using polarised light microscopy in accordance with HSG248 and documented in-house methods. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'.

Sample Comments

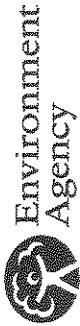
(The laboratory cannot be held responsible for the integrity of sample(s) received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note "Guidance on Deviating Samples".)

Lab No.	Sample ID	Date Sampled	Sample exceeded holding time for test	Sample not received in appropriate containers for test
No Sample deviations to report.				

CLEA Software Version 1.06		Page 1 of 11
Report generated	02-Apr-12	 Environment Agency
Report title	Pearson Crescent, Wombwell	
Created by	Stephen J Fisk at Solmek Ltd	
RESULTS		

[illegible]

CLEA Software Version 1.06		Page 1 of 11
Report generated	02-Apr-12	
Report title	Pearson Crescent, Wombwell	
Created by	Stephen J Fisk at Solmek Ltd	
RESULTS		



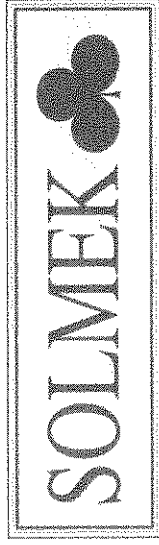
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CLEA Software Version 1.06		Page 1 of 11
Report generated	02-Apr-12	
Report title	Pearson Crescent, Wombwell	
Created by	Stephen J Fisk at Solmek Ltd	
RESULTS		



[illegible]

APPENDIX E
Ground Gas/Groundwater Monitoring Results



GAS MONITORING RESULTS

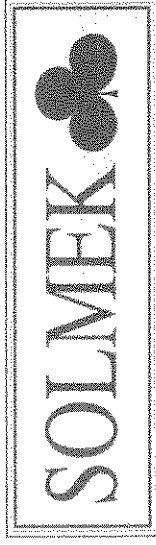
SITE	Pearson Crescent, Wombwell
JOB REF	S120313
CLIENT	Bernard William Associates
DATE	10/04/2011
TIME	11:00
VISIT NO	1 of 3
EQUIPMENT USED	GA2000 & GA5.3 Flow Pod
LAST CALIBRATED	September 2011
OPERATOR	S. J. Fisk

Weather Conditions: Cool, bright with slight breeze
Ground Conditions: Damp
Ambient Atmospheric Pressure: 997mb
Regional Trend: Rising

Position	Flow (l/hr)	Atmospheric Pressure (mB)	CH ₄		CO ₂		O ₂ (%v/v)	CO (ppm)	H ₂ S (ppm)	Water Level (mbgl)	Depth to Base (mbgl)	Notes
			(%v/v)	GSV (l/hr)	(%v/v)	GSV (l/hr)						
Ambient	-	997	0.0	N/A	0.1	N/A	19.9	0	0	N/A	N/A	-
BH1	ND	997	0.0	0.0	1.1	0.0011	18.2	0	0	Dry	1.14	-
BH3	ND	997	0.0	0.0	0.3	0.0003	19.5	0	0	Dry	2.93	-
BH6	ND	997	0.0	0.0	0.4	0.0004	19.5	0	0	Dry	2.02	-

KEY

CH₄ = Methane, CO₂ = Carbon Dioxide, O₂ = Oxygen, CO = Carbon Monoxide, H₂S = Hydrogen Sulphide, GSV = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed),
 ND = Not Detected, * = not measured, N/A = Not applicable, % = By volume, mbgl = m below ground level, ppm = parts per million



GAS MONITORING RESULTS

SITE	Pearson Crescent, Wombwell
JOB REF	S120313
CLIENT	Bernard William Associates
DATE	25/04/2011
TIME	09:00
VISIT NO	2 of 3
EQUIPMENT USED	GA2000 & GA5.3 Flow Pod
LAST CALIBRATED	September 2011
OPERATOR	S. J. Fisk

Weather Conditions: Overcast with showers
Ground Conditions: Wet
Ambient Atmospheric Pressure: 990mb
Regional Trend: Falling

Position	Flow (l/hr)	Atmospheric Pressure (mB)	CH ₄		CO ₂		O ₂ (%v/v)	CO (ppm)	H ₂ S (ppm)	Water Level (mbgl)	Depth to Base (mbgl)	Notes
			(%v/v)	GSV (l/hr)	(%v/v)	GSV (l/hr)						
Ambient	-	990	0.0	N/A	0.1	N/A	20.1	0	0	N/A	N/A	-
BH1	ND	990	0.0	0.0	1.3	0.0013	18.5	0	0	Dry	1.14	-
BH3	ND	990	0.0	0.0	0.4	0.0004	19.7	0	0	Dry	2.93	-
BH6	ND	990	0.0	0.0	0.5	0.0005	19.5	0	0	Dry	2.02	-

KEY

CH₄ = Methane, CO₂ = Carbon Dioxide, O₂ = Oxygen, CO = Carbon Monoxide, H₂S = Hydrogen Sulphide, GSV = Gas Screening Value (If no flow is recorded a value of 0.1 is assumed),
 ND = Not Detected, * = not measured, N/A = Not applicable, % = By volume, mbgl = m below ground level, ppm = parts per million

APPENDIX F
Solmek's Notes on Limitations and Contamination Guidance

Solmek conditions of offer, notes on limitations & basis for contract (ref: version1/2012)

These conditions accompany our tender and supercede any previous conditions issued. Solmek will prepare a report solely for the use of the Client (the party involved) and its agent(s). No reliance should be placed on the contents of this report, in whole or in part by 3rd parties. The report, its content and format and associated data are copyright, and the property of Solmek. Photocopying of part or all of the contents, transfer or reproduction of any kind is forbidden without written permission from Solmek. A charge may be levied against such approval, the same to be made at the discretion of Solmek. Solmek was a trading name of Hymas Geoenvironmental Ltd.

Solmek cannot be held liable and do not warrant, or otherwise guarantee the validity of information provided by third parties and subsequently used in our reports. Solmek are not responsible for the action negligent or otherwise of subcontractors or third parties.

Site investigation is a process of sampling. The scope and size of an investigation may be considered proportional to levels of confidence regarding the ground and groundwater conditions. The exploratory holes undertaken investigate only a small volume of the ground in relation to the overall size of the site, and can only provide a general indication of site conditions. The opinions provided and recommendations given in this report are based on the ground conditions as encountered within each of the exploratory holes. There may be different ground conditions elsewhere on the site which have not been identified by this investigation and which therefore have not been taken into account in this report. Reports are generally subject to the comments of the local authority and Environment Agency. The comments made on groundwater conditions are based on observations made at the time that site work was carried out. It should be noted that mobile contamination, ground gas levels and groundwater levels may vary owing to seasonal, tidal and/or weather related effects. Solmek cannot be held liable for any unrecorded or unforeseen obstructions between exploratory boreholes and trial pits. This includes instances where previous structures on the site (buried man made structures) or the presence of boulder clay (cobbles and/or boulder obstructions) have been anticipated. All types of piling operations should make allowance for obstructions within the construction budget to accommodate this. Unrecorded ancient mining may occur anywhere where seams that have been worked and influence the rock and soil above. Dissolution cavities can occur where gypsum or chalk is present. Rotary drilling is the recommended technique to prove the integrity of the rock.

Where the scope of the investigation is limited via access to information, time constraints, equipment limitations, testing, interpretation or by the client or his agents budgetary constraints, elements not set out in the proposal and excluded from the report are deemed to be omitted from the scope of the investigation.

Desk studies are generally prepared in accordance with RICS guidelines. Environmental site investigations are generally undertaken as 'exploratory investigations' in accordance with the definitions provided in paragraph 5.4 of BS 10175:2001 in order to confirm the conceptual assumptions. You are advised to familiarize yourself with the typical scope of such an investigation. No pumping of water will be undertaken unless a licence or facilities/equipment have been arranged by others.

Where the type, number or/and depth of exploratory hole is specified by others, Solmek cannot and will not be responsible for any subsequent shortfall or inadequacy in data, and any consequent shortfall in interpretation of environmental and geotechnical aspects which may be required at a later date in order to facilitate the design of permanent or temporary works.

All information acquired by Solmek in the course of investigation is the property of Solmek, and, only also becomes the joint property of the Client only on the complete settlement of all invoices relating to the project. Solmek reserve the right to use the information in commercial tendering and marketing, unless the Client expressly wishes otherwise in writing. The quoted rates do not include VAT, and payment terms are 30 days from dispatch of invoice from our offices. Quotes are subject to a site visit.

We have allowed for 1 mobilisation and normal working hours unless otherwise stated. The scope of the investigation may be reviewed following the desk study and/or fieldwork. The presence or otherwise of Japanese Knotweed or other invasive plants can be difficult to identify especially during winter months. If Japanese Knotweed or other invasive species are suspect, it should be confirmed by an ecologist. We have not allowed for acquiring services information, and cannot be responsible for damage to underground services or pipes not shown to us or not clearly shown on plans. Costs incurred will be passed on to you, and in commissioning Solmek you understand and accept that you/your agent have a contractual relationship with Solmek & you accept this. Our rates assume unobstructed, reasonably level and firm access to the exploratory positions and adequate clear working areas and headroom. We have priced on the basis that you or your client have the necessary permissions, wayleaves and approvals to access land. All boreholes and pits are backfilled with arisings except where gas monitoring pipes are installed with stopcock covers. Solmek are not responsible for any uneven surfaces as a result of siteworks and rutting and backfilled excavations may require re-levelling and/or making good by others after fieldwork is complete, and Solmek has not allowed for this. No price has been provided or requested for a return visit to remove pipework and covers. Hourly rates apply to consultancy only and do not include expenses unless otherwise shown. If warranties are required, legal costs incurred will be passed on to you assuming Solmek agree to complete such warranties, modified or otherwise and you understand and agree to pay all costs.

We reserve the right to pursue full payment of the invoice prior to release of any information including reports. We advise you/your client that we may elect to pursue our statutory rights under late payment legislation, and will apply 8% to the base rate for unreasonably late payments. Solmek are exempt from the CIS Scheme. Solmek offer to undertake work only in strict accordance with conditions covered by our current insurances, which are available for inspection. Solmek are not responsible for acts, negligent or otherwise of subcontractors and as a matter of policy cannot indemnify any other parties. Professional Indemnity Insurance is limited to ten times the invoice net total except where stated otherwise by Solmek. Solmek give notice that consequential loss as a direct or indirect result of Solmek's activities or omission of the same are excluded.

VEGETATION

Plants can be affected by soil contamination in a number of ways resulting in growth inhibition, nutrient deficiencies and yellowing of leaves. Contaminants are taken up by plants through the roots and through foliage. Contaminants identified as being highly phytotoxic include boron, cadmium, copper, lead, nickel, and zinc.

To establish if the levels of contaminants present on a site may pose a risk to vegetation the results of the contamination testing are compared to a series of threshold values published in 'Code of Good Agricultural Practice for the Protection of Soil'.

GROUNDWATER AND SURFACE WATER RECEPTORS

The principal pathway by which soil contamination may reach the water environment is through a slow seepage or leaching to groundwater or surface water. The potential for contaminants to migrate along such pathways is dependent on the chemical and physical characteristics of the contaminants and the local hydrogeology. Surface watercourses may also accumulate contamination as contaminated sediments are deposited within the water body.

Where the site investigated overlies major/principal aquifers (and in some cases minor/secondary aquifers depending on certain conditions), groundwater Source Protection Zones and areas in close proximity to groundwater abstractions, contamination test results have been compared with the Water Supply (Water Quality) Regulations 1989 and The Water Supply (Water Quality) Regulations 2000.

Should a surface water receptor, such as a fresh water environment (river, canal, stream, lake etc), or marine environment be considered sensitive in relation to a site, then test results are compared with DEFRA & SEPA Environmental Quality Standards (2004). Many of the Environmental Quality Standards are hardness (CaCO_3) depended. Where no hardness values are available, Solmek assume conservative values (of between 0 and 50mg/l).

In the absence of vulnerable ground and surface water environments, Solmek may compare any test results with the Environment Agency Leachate Quality Threshold Values.

DETAILED QUANTITATIVE RISK ASSESSMENT (DQRA)

In line with CLR 11- Model Procedures, a DQRA for groundwater/human health may be required following a Phase 2 investigation and before the preparation of a Phase 3 Remediation Strategy. For human health DQRA, a site specific assessment criteria is undertaken using CLEA Software Version 1.06. For groundwater DQRA, the Environment Agency Remedial Targets Worksheet Version 3.1 is used.

WASTE ACCEPTANCE CRITERIA

Waste Acceptance Criteria (WAC) testing accords with the Landfill (England and Wales) 2002 Regulations and the subsequent amendments set out in Schedule 1 of the Landfill (England and Wales)(Amendment) Regulations 2004. WAC testing was introduced into UK Practise to supplement the revised changes to the Hazardous Waste and Landfill regulations outlined in 2005. The WAC testing relates to materials that are to be exported from a site/development to landfill, and do not directly relate to human health specifically. The WAC test categorises materials as either inert waste, non-reactive hazardous waste, and hazardous waste. The testing results are generally presented as certificates which can be used by site owners/contractors etc, which should be presented to the accepting waste facility or waste contractor.

CONSTRUCTION MATERIALS

Materials at risk from possible soil contaminants include inorganic matrices such as cement and concrete and also organic material such as plastics and rubbers. Acid ground conditions and high levels of sulphates can accelerate the corrosion of building materials. Where pH and soluble sulphate analysis has been undertaken, Solmek compare the test results with the guidelines presented within BRE Special Digest 1, 2005 (3rd Edition) 'Concrete in Aggressive Ground'. Plastics and rubbers are generally used for piping and service ducts and are potentially attacked by a range of chemicals, most of which are organic, particularly petroleum based substances. Drinking water supplies can be tainted by substances that can penetrate piping and water companies enforce stringent threshold values.

REQUIREMENTS OF PARTIES WITHIN THE DEVELOPMENT PROCESS

Interested parties involved in the development process may use the data in different ways and there may be varying views and interpretation of the factual data. Local Authority staff may have a view on contamination and human health and the wider environment. The Environment Agency are concerned principally with the protection of Controlled waters. Building insurers, funders and purchasers may be primarily concerned with issues of potential commercial blight. Purchasers are also not always fully informed, and perceptions on issues associated with risk can affect the decision to purchase. Developers and construction organisations will focus on financial aspects of dealing with the contamination in the context of the development and construction programme.

RISKS & LIABILITIES FROM CONTAMINATION

In simple terms, risks associated with contamination may be considered in terms of 1) statutory risks and 2) development related risks. If contamination is severe or forms a potential hazard based on its potential to affect groundwater, surface water or human health, a statutory risk may be present, and as such, if the risk is not reduced, criminal proceedings may be instigated by a government body or local authority.

If the contamination is less severe or not considered to be mobile, it may be considered a commercial liability which could, in theory remain untreated, but which may at a later date affect the value of the property, or, with changing legislation, become a statutory risk. Commercial liabilities could give rise to civil proceedings by third parties if there are grounds for action.

UK BACKGROUND

A qualitative approach using the statutory definition of Contaminated land as defined with Section 78A (2) of Part 2A of the Environmental Protection Act has been adopted. This defines contaminated land (DEFRA 'Guidance on the Legal Definition of Contaminated Land', July 2008b) as:

"any land which appears to the local authority in whose area the land is situated to be in such a condition, by reason of substances in, on or under the land, that (a) significant harm is being caused or there is a significant possibility of such harm being caused; or (b) pollution of controlled waters is being, or is likely to be, caused"

"Harm" is defined as *harm to the health of living organisms or other interference within the ecological systems of which they form part, and in the case of man, includes harm to his property.*

The concept of "significant harm" is dealt with via the Government guidance DEFRA Circular 02/2000 Contaminated Land: "Implementation of Part IIA of the Environmental Protection Act 1990". The statutory guidance uses the concept of pollutant linkages set out in Section 2.4 of the circular. Before the Local Authority can make a judgement on whether "significant harm" and the significant possibility of harm is being caused they are required to identify a "significant pollution linkage". This means effectively that three elements (a **source** of contamination, a relevant **receptor** and a **pathway**) must be present. In statutory terms:

- ▲ A **source** is a substance that is in, on or under the land and has the potential to cause harm.
- ▲ A **receptor** is in general terms, is something that could be adversely affected by a contaminant, such as people.
- ▲ A **pathway** is a route or means by which a receptor can be exposed to, or affected by, a contaminant.

Without identification of all three elements together, land should not be regarded as "Contaminated" in the statutory sense. Solmek adopts the above measures in accordance with CLR 11 (2004) 'Model Procedures for the management of Land Contamination'.

HUMAN RECEPTORS

Human exposure to contaminants present in soils can occur via several pathways. Direct exposure pathways include dermal absorption after contact with contaminated ground, inhalation of soil or dust, inhalation of volatilised compounds, and inadvertent soil ingestion (or deliberate soil ingestion in the case of some children). Other indirect pathways include human ingestion of plants grown in contaminated soil or contaminated ground or surface water. Contaminants associated with wind blown dust can affect humans on surrounding sites.

DEFRA published the discussion paper 'Soil Guideline Values: the way forward' (2006). Following consultation, DEFRA released 'Improvements to Contaminated Land Guidance and Outcome of the Way Forward exercise on Soil Guideline Values' (2008b). From this review DEFRA and the Environment Agency had withdrawn documents CLR 7 to 10 since these no longer fully reflect the new UK approach, along with the associated Soil Guideline Values (SGV). The Environment Agency have revised and updated information presented in CLR 7 to 10 within two recently published CLEA Framework Reports: Human health toxicological assessment of contaminants in soil (Science Report Final SC050021/SR2) and updated technical background to the CLEA model (Science Report Final SC050021/SR3).

The Environment Agency released the updated CLEA Software Version 1.06 in May 2011 which accompanies the two CLEA Framework Reports and reflects the updated approach. Solmek uses the CLEA Software Version 1.06 to derive a series of Generic Assessment Criteria (GAC) threshold values based on a number of site and soil parameters. Solmek GAC values represent a level at which a risk to human health may exist and are primarily intended as a guide to site redevelopment. Various factors used within the CLEA software by Solmek are summarised below:

Land Use	Receptor	Building	Soil Type	pH and SOM
Residential with Homegrown Produce	Female (Age Class 1-6: Young Child)	Bungalow Small Terraced House	Clay Silty Clay	pH and SOM content values as presented from testing.
Residential without Homegrown Produce	Female (Age Class 1-6: Young Child)	Medium/large Terraced House Semi-detached House Detached House	Silty Clay Loam Clay Loam Sandy Lam Loam	
Allotments	Female (Age class 1-6: Young Child)	Assumes None	Silty Loam	
Parks			Sandy Loam	
Open spaces			Sandy Loam	
Playing fields	Female (Age class 4-11: Child)	Warehouse (pre 1970) Warehouse (post 1970) Office (pre 1970) Office (post 1970)	Sand	
Commercial	Female (Age Class 17-17: Working Adult)			
DERIVATION OF SOLMEK GAC THRESHOLD VALUES				

A number of specific exposure pathways are considered in addition to the above table when considering the generated GAC values. In some instances, the GAC generated value may be presented at the soil saturation limit if this has been exceeded. The choice of receptor may differ from the table above based on professional judgment (with justification).

Solmek adopts a pH value of 7, Soil Organic Matter (SOM) content of 1% and a sandy loam soil where this information is not available. These figures accord with the generic units presented within the CLEA Software. Where Solmek cannot generate specific GAC values, the Environment Agency's SGVs (where available), released from March 2009, and Atkins SSV's (derived using CLEA Software Version 1.04, May 2011) are adopted for comparison.