# New Lodge Crescent (Phase 2), Barnsley

# Site Investigation Report

# Yorkshire Housing Limited

**Solmek Report Number S110508/SI**

**August 2011**

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| | | | |

# New Lodge Crescent, Barnsley

# Site Investigation Report

## 1 INTRODUCTION AND SCOPE OF WORKS

At the request of Bernard Williams Associates acting on behalf of Yorkshire Housing Ltd, a ground investigation involving geotechnical and chemical testing was carried out on two portions of land at New Lodge Crescent in Barnsley. A plan showing the site locations is included in Appendix A, Figure 1.

### Scope of Works

The proposed development of the site is to involve constructing 38 new semi-detached houses with front and rear gardens.

A geotechnical and environmental investigation including gas risk assessment 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 (S110508, May 2011) 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 boreholes 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 preliminary site inspection, as recommended in BS 5930 and BS 10175, was undertaken on Tuesday 24th May 2011. The site is centred at the approximate Ordnance Survey Co-ordinates 434360E, 409200N and has an approximate area of 1.37Ha.

The site is divided into two separate plots of land positioned approximately 300m apart in the residential New Lodge area of Barnsley. The larger plot to the south, is located adjacent to New Lodge Crescent and Sherburn Road. The topography of this plot slopes from north west down towards the south east with an approximate drop in elevation of 5m. The plot is surfaced with bare earth and demolition rubble. A number of drainage covers and services were noted across the plot. Vegetation on the site is minimal with two semi-mature trees close to the southern tip of the site. Scrub vegetation is also present on some sections of the plot.

The plot of land in the north of the site comprises an irregular shaped parcel of land within a residential housing estate. The topography of the site is predominantly level with a gentle slope down at the north of the site with an approximate drop in elevation of 2-3m. The plot is surfaced with a mixture of bare earth and tall grass/scrub vegetation. No buildings were present however some rubble was noted where the previous houses have been demolished on the site.

Both plots are surrounded by residential housing. No visual signs of contamination were identified on the site. Numerous service covers and drainage covers were identified across both plots.

**Fieldwork**

The fieldwork was carried out on 10th and 13th June 2011. Seven small percussive boreholes (BH1 to BH7) were drilled to depths of 9.45m below ground level (bgl). Six machine excavated trial pits were dug to depths of between 1.95mbgl to supplement the borehole data and for the purposes of in-situ CBR testing and percolation trials. Three rotary boreholes (R1 to R3) were also drilled to depths of 20mbgl to investigate the possibility of any shallow mine workings present below the site.

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 four of the boreholes (BH's 1,3,4 & 7). The remaining boreholes and trial pits were backfilled with arisings and fully reinstated on completion of the works.

## 3 GROUND CONDITIONS

**Made Ground**

Made Ground was encountered within all of the percussive boreholes to depths ranging between 0.30mbgl and 0.80mbgl. The nature of the made ground across the sites generally comprises topsoil with granular sand and gravel deposits. Fragments of brick, concrete, wood and glass were noted within a number of the made ground samples.

**Natural Deposits**

The natural deposits within the percussive boreholes were variable across the site and predominantly comprised slightly clayey to clayey sand containing sandstone gravel. In BH5 brown clayey very sandy gravel was proven from 0.80mbgl which overlay highly weathered sandstone. In BH7 cohesive clay deposits were proven from 0.60mbgl to 1.70mbgl. Highly weathered sandstone was also proven to underlie the clay in BH7.

The borehole logs are presented in Appendix B.

**Rotary Boreholes**

Three rotary boreholes (R1 - R3) were drilled to a maximum depth of 20mbgl to investigate the possibility of shallow unrecorded coal workings beneath the site. R1 was drilled on the northern plot whilst R2 and R3 were drilled on the southern portion of the site in a triangular formation. In R1 drift deposits were recorded to a depth of 1.60mbgl which were proven to overlie sandstone strata to a maximum depth of 20mbgl. Within R2 and R3 on the southern plot drift deposits were recorded at 1.10mbgl and 0.90mbgl, respectively. Sandstone strata were proven in both boreholes to 20mbgl. A thin intact coal seam was encountered between 4.30 and 4.40mbgl in R2 and between 4.00 and 4.10mbgl in R3. 100% flush returns were recorded for all three of the boreholes indicating no voids present below the site. Logs of the rotary boreholes are presented in Appendix B.

**Groundwater**

No groundwater was recorded within any of the percussive/rotary boreholes or trial pits during the fieldwork. On the three subsequent monitoring visits to the site carried out during July and August 2011 all four of the monitoring installations were dry.

**Trial Pits**

The trial pits excavated in the south (TP1 – TP3) of the plot had made ground ranging between 0.25 to 1.15mbgl. Made ground in TP1 and TP2 comprised loose brown-grey sandy gravel fill containing brick fragments, concrete, ceramic, glass and sandstone. In TP3 clayey slightly gravelly sand fill was proven to 0.25mbgl. Made ground deposits were proven to overlie brown clayey slightly gravelly fine to coarse sand which in turn overlay medium to coarse grained weathered sandstone recovered as slightly clayey sand and gravel.

The trial pits excavated in the north of the site (TP4 – TP6) had made ground comprising sandy slightly gravelly topsoil (with brick fragments in TP6). Topsoil was proven to depths of between 0.30mbgl (TP4) and 0.50mbgl (TP6). Made ground in TP5 was proven to 0.70mbgl with brown slightly clayey gravelly fine to coarse sand present. Natural deposits in TP4 and TP6 comprised brown slightly clayey gravelly fine to coarse sand overlying yellow-brown medium to coarse grained weathered sandstone recovered as slightly clayey sand and gravel to a maximum depth of 1.95mbgl.

A plastic yellow gas main was exposed in TP5 at 0.70mbgl. Consequently, this trial pit was abandoned and backfilled once repairs to the main had been carried out.

## 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 (SPT's) were undertaken at regular intervals during drilling. Percolation trials were carried out in four of the trial pits to assess the suitability of the ground for land soakaways. The geotechnical results are presented in Appendix C.

### Percolation Trials

Soakaway tests were carried out within five trial pits TP1, TP2, TP3, TP4 and TP6. The results gave infiltration rates of between 31.57 and 82.301m/sec*10-6 in TP6 and TP4 respectively.

| Trial Pit | Test Number | Infiltration Rate ($m/sec^{10-6}$) | Classification (Based on BRE digest 365) |
|---|---|---|---|
| TP1 | SA1 | 56.67 | Acceptable |
| TP2 | SA2 | 50.00 | Acceptable |
| TP3 | SA3 | 47.98 | Acceptable |
| TP4 | SA4 | 82.30 | Acceptable |
| TP6 | SA5 | 31.57 | Acceptable |

**Table 1: Percolation Trial Results**

These results classify the strata as 'acceptable' for the use of land soakaways. The results are presented within Appendix B.

### 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 were between 4.9% and 26%.

### Atterberg Limit Determinations

Atterberg Limit Testing was carried out on one sample of cohesive material to determine the liquid and plastic limits and hence derive the plasticity index. The result when plotted on a Casagrande Chart shows the cohesive stratum to be classified as intermediate plasticity clay. The liquid limit of the sample was recorded at 41%. The moisture content was above the corresponding plastic limit. The results of the plasticity index test was 21 indicating the clay should be considered as having a **medium** shrinkage potential in accordance with NHBC Guidelines.

### Particle Size Distribution

Nine samples were subject to particle size distribution analysis tests in order to classify the deposits. These have been described on the borehole logs. Generally the deposits on the site comprise sand with varying quantities of clay and weathered sandstone gravel. Cohesive clay deposits were encountered within BH7 between 0.60mbgl and 1.70mbgl. The clay in BH7 was proven to overlie weathered sandstone.

### pH and Sulphate Results

Six samples of natural soil from the boreholes were tested for acidity and soluble sulphate content to assess whether the material may be potentially aggressive to building fabric. The result of the testing for pH ranged from 4.4 to 8.6 indicating a range of acidic and alkaline conditions. Soluble sulphates were recorded at levels ranging from 37mg/l to 268mg/l.

## 5 CONTAMINATION ANALYSIS AND RESULTS

The site is to be developed with 38 newly constructed semi-detached houses. The proposals include soft landscaping in the form of front and rear gardens with each of the proposed new houses. To provide information upon the possibility of ground contamination five samples of the made ground deposits from depths of between 0.20mbgl and 0.45mbgl were subject to 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 home grown produce. Solmek GAC were derived using the EA CLEA Software Version 1.06 (May 2011) 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 without home grown produce 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
- **Building Type:** Semi Detached House
- **Soil Type:** Sandy Clay Loam
- **Soil pH:** 5.6 (Lowest Recorded Value)
- **Soil Organic Matter:** 1.9% (Lowest Recorded Value)

The samples were subjected to a range of tests to detect the levels of various metals and organic determinands. In addition, the samples were subject to pH analysis. The results are provided in full in Appendix C and summarised in Table 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 | 1.0 | 5.17 | 0 |
| Chromium III | mg/kg | 5 | 5 | 8 | 30 | 3000 | 0 |
| Chromium VI | mg/kg | 5 | 0 | <1 | - | 4.25 | 0 |
| Copper | mg/kg | 5 | 5 | 7 | 44 | 2360 | 0 |
| Lead | mg/kg | 5 | 5 | 8 | 47 | 276* | 0 |
| Mercury (Inorganic) | mg/kg | 5 | 3 | <0.05 | 0.12 | 169 | 0 |
| Nickel | mg/kg | 5 | 5 | 9 | 15 | 127 | 0 |
| Zinc | mg/kg | 5 | 5 | 22 | 65 | 2860 | 0 |
| **Semi-Metals** | | | | | | | |
| Arsenic | mg/kg | 5 | 5 | 1.9 | 19 | 85 | 0 |
| Boron | Mg/kg | 5 | 5 | 0.9 | 2.1 | 10.3 | 0 |
| Selenium | mg/kg | 5 | 0 | <0.5 | - | 350 | 0 |
| **Inorganic chemicals** | | | | | | | |
| Cyanide (Total) | mg/kg | 5 | 5 | 0.1 | 0.9 | 1.49 | 0 |
| Sulphate (WS) | mg/l | 5 | 5 | 16 | 490 | 500** | 0 |
| Sulphide | mg/kg | 5 | 2 | <10 | 36 | 250*** | 0 |
| **Other** | | | | | | | |
| pH | pH | 5 | 5 | 5.6 | 10 | <5 | 0 |
| Phenol | mg/kg | 5 | 0 | <0.3 | - | 283 | 0 |

**TABLE 2: SUMMARY OF INORGANIC CHEMICAL CONTAMINATION TESTING RESULTS**

** Atkins SSV (GAC), CLEA Software Version 1.04*

*** BRE Special Digest 1, 2005 (3rd Edition) 'Concrete in Aggressive Ground'*

**** EA Lower Tier Threshold Values*

**Metals, Semi Metals and Inorganic Chemicals**

None of the five samples tested returned values which exceed the derived threshold values for metals or semi-metals.

Soluble sulphates (potentially aggressive to foundation concrete) were recorded between 16 and 490mg/l. Sulphide was detected in two of the five samples however the levels are significantly below the threshold of 250mg/kg. Cyanide was detected in all five of the samples tested at levels below the allowable threshold value.

**Asbestos Screening**

The five samples subject to chemical analysis were also screened for asbestos fibres. No asbestos fibres were detected in four of the five samples. The sample from BH6 at 0.40mbgl was shown to contain fibres of Chrysotile (white) asbestos.

**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 F 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 in boreholes proven to depths of up to 0.80mbgl and comprised topsoil and sand/gravel fill. Brick, wood and glass present in some locations on the site.<br><br>Site former location of housing.<br><br>Demolition wastes present in the shallow made ground including bricks and concrete.<br><br>No areas of obvious contamination on ground surface.<br><br>One thin intact coal band (0.15m thick) encountered 4mbgl in rotary boreholes R2 and R3. 100% flush returns noted indicating no voids below the site.<br><br>No significant levels of contamination in made ground on the site.<br><br>Basic radon protection measures not required.<br><br>Chrysotile detected in BH6 at 0.40mbgl. | Dermal absorption<br>Inhalation of soil/volatised compounds<br>Ingestion of soil<br>Contact with contaminated groundwater | **Users of site** – Adults and children receptors.<br><br>Soft landscaped gardens proposed in final development. |
| | Dermal absorption<br>Inhalation of soil/volatised compounds<br>Ingestion of soil<br>Contact with contaminated groundwater | **Construction Workers** – Users of the site during construction phase of development. |
| | Dermal absorption<br>Inhalation of soil/volatised compounds<br>Ingestion of soil | **Users of surrounding sites** – Residential housing. |
| | Taken up through roots and foliage<br>Direct contact | **Vegetation** – Proposed development includes front and back gardens with each new house. |
| | Slow seepage or leaching of contaminants | **Groundwater** – 'Secondary A' Aquifer.<br>No groundwater encountered in any of the boreholes or trial pits during the fieldwork. |
| | Slow seepage or leaching of contaminants and accumulation of contaminated sediments | **Surface water** – located 216m to the south west of the site. |
| | 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**

The users of the site are likely to be exposed to contaminants present in the soils beneath the site, as soft landscaping is proposed in the final development. **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 contamination testing have been compared to a series of Solmek Generic Assessment Criteria (GAC) thresholds based on a residential land use with homegrown produce. The results indicate that the levels of contamination within the made ground are below the threshold values for long term risk to human health.

It should be noted that in one of the five samples screened for asbestos fibres was shown to contain fibres of Chrysotile (white) asbestos. The Chrysotile was found within the shallow made ground in BH6 at 0.40mbgl.

It is therefore considered that the levels of contamination on site are unlikely to pose a risk to the current and future users of the site, and remediation is not required beneath proposed hardstanding areas or the proposed building footprint.

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 waste involves the categorization of materials into inert waste, non reactive hazardous wastes and hazardous wastes. The determination of the category depends on DEFRA landfill directive waste acceptance criteria (WAC) testing. Material taken off site may be subject to WAC by the appropriate waste disposal company.

**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 pH and sulphide falling into the contaminated category. Levels of boron within two of the samples classify the material as slightly contaminated. 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 work when handling made ground.

**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 determinands zinc, copper, cadmium, lead, chromium, nickel, arsenic, selenium and mercury were all below the corresponding thresholds.

The available topsoil on the site should be stripped, screened of deleterious material such as ash, glass and brick rubble then stockpiled. The deleterious material can be placed beneath areas of hardcover. The topsoil stockpile should be tested to determine its suitability for reuse before placement. The proposed soft landscaping should comprise at least 200mm of screened, clean topsoil over existing natural sand, gravel and clay subsoil. The above measures act to block any pollution pathway to human receptors. In the event that there is insufficient topsoil available to provide adequate cover on the site, clean topsoil should be imported to the site with verification of its suitability.

**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.

The site does not lie within a Source Protection Zone and the solid geology is classified as a 'Secondary A' Aquifer. There are no surface water bodies within 200m of the site. No groundwater was encountered in any of the boreholes or trial pits during the fieldwork. It should also be noted that groundwater levels vary with rainfall, time of year and in proximity to local abstractions and dewatering activities.

Given the low contamination profile of the ground, distance to a watercourse and lack of groundwater the risk to controlled waters appears relatively low.

**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 pH and sulphate tests fall into Class DS-1, ACEC (Class AC-3z) requirements for concrete protection. This assumes 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"*. Based on the contamination test results three of the determinands were above the accepted thresholds. Levels of Arsenic were present in levels exceeding the threshold values, whilst pH levels were shown to be raised in one of the five samples tested. Prior to laying any new services consultation with the utility providers is recommended. As a minimum services should be placed within clean service trenches.

## 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. Three visits have been carried out between July 2011 and August 2011 to assess the potential risks posed by ground gases.

The gas was monitored by measuring emissions from monitoring points installed into BH1, BH3, BH4 and BH7 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 1002 and 1026 millibars during the surveys. Falling and rising atmospheric pressure regional trends were noted during the survey. This is considered to be a good range of conditions for the time of year.

Carbon dioxide concentrations were recorded between 0.0 and 1.3% volume, and oxygen levels were between 19.1 and 20.7%. 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.

A Characteristic Situation ranking of between 1 and 6 is given based on the ground gas monitoring results coupled with the gas flow rate. These combined produce a Gas Screening Value (GSV). Where no flow is recorded a flow rate of 0.1l/hr is assumed. The GSV and risk classification define the characteristic situation, which are comparable to Table 4 below, taken from CIRIA C665, and derived from CIRIA R149.

| CHARACTERISTIC SITUATION (CS) | RISK CLASSIFICATION | GAS SCREENING VALUE $CH_4$ OR $CO_2$ (l/hr) | ADDITIONAL FACTORS |
|---|---|---|---|
| 1 | Very Low Risk | <0.07 | *CS1 where $CH_4$ is <1% and/or $CO_2$ is <5%, Otherwise increase to CS2* |
| 2 | Low Risk | <0.7 | |
| 3 | Moderate Risk | <3.5 | |
| 4 | Moderate to High Risk | <15 | |
| 5 | High Risk | <70 | |
| 6 | Very High Risk | >70 | |

**TABLE 4: CIRIA R149 Gas Regimes**

The gas screening values from the monitoring visits would place the site in **Characteristic Situation (CS) 1 – Very Low Risk**. A list of recommended gas protection measures is included in Appendix F.

Basic 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 5) collates the salient aspects of the site to form a model. This model identifies the potential pollution linkages that may influence the proposed development and the relevant geological considerations.

The risk ratings are based on the outcome **after** mitigating action has taken place.

| SOURCES | PATHWAYS | RECEPTORS | MITIGATION/DETAILS | RISK RATING |
|---|---|---|---|---|
| Made ground proven to depths of up to 0.80mbgl on the site.<br><br>Site formerly occupied by residential houses. No significant industrial activities noted in the close proximity to the site.<br><br>No areas of obvious contamination on ground surface.<br><br>No worked coal seams or voids present below the site.<br><br>Low contamination profile of shallow made ground.<br><br>Basic radon protection measures required. | Dermal absorption<br><br>Inhalation of soil/volatised compounds<br><br>Ingestion of soil<br><br>Contact with contaminated groundwater | **Human**<br><br>Residents are likely to include adults and children.<br><br>Areas of soft landscaping proposed as gardens with houses. | Soft landscaping is proposed in front and rear gardens of houses.<br><br>Levels of contamination are unlikely to pose a risk to the current and future users of the site and remediation is not required beneath hardstanding or the building footprints. | **LOW** |
| | Ground gas migration.<br><br>Made ground over low permeable clays. | | Characteristic Situation 1 – Very Low Risk.<br><br>Basic Radon Protection required. | **LOW** |
| | Dermal absorption<br><br>Inhalation of soil/volatised compounds (dust)<br><br>Ingestion of soil<br><br>Contact with contaminated groundwater | **Construction workers** | Made ground on site classed as contaminated. pH and sulphide fall within contaminated category. Boron levels in 2 samples 'slightly contaminated'<br><br>Appropriate PPE should be employed as a matter of course. Gloves should be worn when in contact with made ground.<br><br>Limit dust during ground works. | **MOD** |
| | Dermal absorption<br><br>Inhalation of soil/volatised compounds (dust)<br><br>Ingestion of soil | **Surrounding areas**<br><br>Streets of residential housing. | Damping down of site in dry/windy conditions and limit access by the public. | **LOW** |
| | Uptake via roots and leaf surfaces | **Vegetation/ Human**<br><br>Soft landscaping proposed.<br><br>Children and adults in area. | Topsoil should be stripped, screened and stockpiled. The stockpile should be tested prior to re-placement.<br><br>Cover to comprise at least 200mm topsoil onto existing natural subsoil. | **LOW** |
| | Seepage or leaching of contaminants.<br><br>Accumulation of contaminated sediments in water body. | **Surface Water**<br><br>No surface water features within 200m of site. | Site to be partially capped by the proposed development.<br><br>Low soil contamination results, no groundwater encountered. | **LOW** |
| | | **Groundwater**<br><br>No groundwater encountered during site works. | | **LOW** |

| | | | | |
|---|---|---|---|---|
| | | 'Secondary A' Aquifer<br><br>Not in a Source Protection Zone. | | |
| | Contact with contaminated soil/deleterious material. | **Construction Materials and service fabrics** | Class DS-1, AC-3z<br><br>pH raised.<br><br>Consultation with utility providers recommended. | **MOD** |
| **TABLE 5: CONCEPTUAL MODEL AND RISK ASSESSMENT** | | | | |

## 8 CONCLUSIONS

A site investigation was required for a split site in the vicinity of New Lodge Crescent in Barnsley where it is proposed to build a number of semi-detached houses.

### Extent of investigation

The extent of the investigation was to provide geotechnical and environmental information based on the drilling of seven percussive boreholes (BH1-BH7), three rotary boreholes (R1-R6) and six machine excavated trial pits (TP1-TP6). In-situ SPTs were carried out in the underlying strata during drilling and selected samples were subject to geotechnical and chemical contamination laboratory testing.

Ground gas monitoring standpipes were installed in four of the boreholes (BH1, BH3, BH4 & BH7) and three ground gas and water monitoring visits were carried out in the weeks immediately following the site work.

### Summary of Ground Conditions

Made Ground was encountered within all of the percussive boreholes to depths ranging between 0.30mbgl and 0.80mbgl. The nature of the made ground across the site generally comprises topsoil with granular sand and gravel deposits. Fragments of brick, concrete, wood and glass were noted within a number of the made ground samples.

The natural deposits within the percussive boreholes were variable across the sites and predominantly comprised slightly clayey to clayey sand containing sandstone gravel. In BH5 brown clayey very sandy gravel was proven from 0.80mbgl which overlay highly weathered sandstone. In BH7 cohesive clay deposits were proven from 0.60mbgl to 1.70mbgl. Highly weathered sandstone was also proven to underlie the clay in BH7.

### Foundations

The ground conditions prove that strip footings will be acceptable for the proposed housing.

Both cohesive and granular deposits were proven at approximate foundation depth. Where cohesive deposits are encountered, an allowable bearing pressure of 188kN/$m^2$ has been calculated. This is based upon 0.6m wide strip footings at 0.9m depth using a shear strength of 75kN/$m^2$.

Where granular sandy deposits are present at foundation depth the predicted settlement has been calculated as less than 25mm based upon 0.60m wide strips at 0.75mbgl. This assumes an SPT N-value of 48.

Should foundations span both cohesive and granular deposits, the foundations should be stepped and reinforcement should be used in the concrete to reduce the risk of differential settlement. The foundations may require deepening should any areas of deeper made ground be exposed when excavating foundations.

Prior to placing any foundation concrete all exposed formations should be well compacted and any obvious soft or loose spots should be removed and replaced with hardcore. Furthermore, all excavations should be inspected to ensure that they fully penetrate any areas of disturbed ground.

Atterberg Limit testing on clay from BH7 indicates the fine grained soils at foundation depths have a **medium** shrinkage potential.

**Percolation Trials**

Soakaway tests were carried out within five trial pits TP1, TP2, TP3, TP4 and TP6. The results gave infiltration rates of between 31.57 and 82.301m/sec*10-6 in TP6 and TP4 respectively.

These results classify the strata as 'acceptable' for the use of land soakaways. The results are presented within Appendix B.

**Equilibrium CBR**

Within the trial pits (TP 1 – TP6) made ground was proven to depths of between 0.25 to 1.15mbgl. In-situ CBR measurements were taken within each of the trial pits at depths of 0.30 and 0.60mbgl. CBR results at 0.30mbgl ranged from 3.0% to 6.0% giving an average of 4.58%. CBR results at 0.60mbgl ranged from 5.0% to 8.5% giving an average of 6.66%. Due to the depth and nature of the made ground it is recommended that where made ground is encountered a conservative equilibrium CBR 2% should therefore be adopted. In natural sand deposits it is recommended that an equilibrium CBR value of 5% should be adopted.

**Excavation**

From the evidence of the investigation, excavations in the made ground should be easily achieved by means of a normal excavator. A breaker may be required if relict foundations are encountered. Stability of excavations will be poor to moderate in the made ground and will also likely be poor in sand/gravel. 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 in any of the boreholes or trial pits during the field work. On subsequent visits to the site all of the monitoring points were dry on all three occasions. It is therefore unlikely that groundwater will be encountered within shallow excavations. If excavations are to be left open for long periods of time or during inclement weather some allowances 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, none of the metals, semi/non-metals or speciated PAH determinants exceeded the derived threshold. Consequently, the made ground on site should be classified as "contaminated" with regards to construction workers and it is recommended that gloves are always worn when handling made ground. It is recommended that utility companies are consulted due to the arsenic levels and raised pH within the made ground.

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 land use with home grown produce.

The results indicate that the levels of contamination across the site are generally low, and unlikely to pose a long term risk to human health. Remediation is not required beneath hardstanding areas or the proposed building footprints. The available topsoil on the site should be stripped, screened of deleterious material such as ash and brick rubble then stockpiled. The deleterious material can be placed beneath areas of hardcover. The topsoil stockpile should be tested to determine its suitability for use before placement. The proposed soft landscaping should comprise at least 200mm of screened, clean topsoil over existing natural sand/clay subsoil. The above measures act to block any pollution pathway to human receptors.

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 determinands zinc, copper, cadmium, lead, chromium, nickel, arsenic, selenium and mercury were all below the corresponding thresholds.

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 waste involves the categorization of materials into inert waste, non reactive hazardous wastes and hazardous wastes. The determination of the category depends on DEFRA landfill directive waste

acceptance criteria (WAC). Material taken off site may be subject to WAC testing by the appropriate waste disposal company.

**Asbestos**

The five samples subject to chemical analysis were also screened for asbestos fibres. The sample from BH6 at 0.4mbgl was shown to contain fibres of Chrysotile (white) asbestos. Care should be taken when excavating around BH6 and it would be prudent for asbestos specialists to screen the made ground in this area.

**Sulphate results**

BRE Special Digest One (2005: 3rd Edition): *"Concrete in Aggressive Ground"* 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 pH and sulphate tests on the made ground from the chemical analysis results, fall into Class DS-1, ACEC (Class AC-3z) requirements for concrete protection assuming mobile groundwater conditions.

**Ground Gas Assessment**

The gas screening values from the monitoring visits would place the site in **Characteristic Situation (CS) 1 – Very Low Risk**. A list of recommended gas protection measures is included in Appendix B.

Basic 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

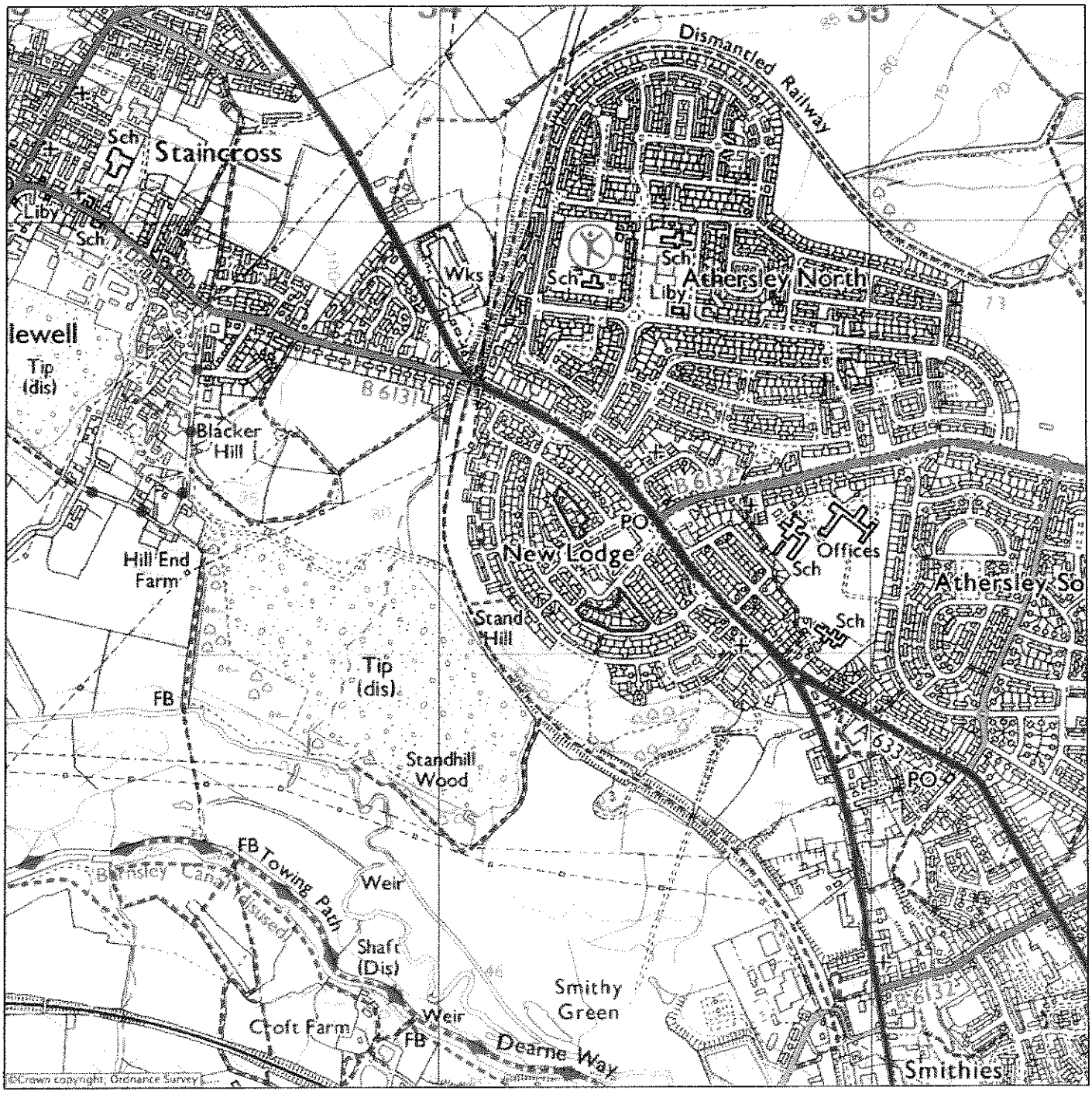



**Figure 1: Site Location Plan**

| | | |
|---|---|---|
| **Client:** | Yorkshire Housing Ltd | |
| **Project:** | New Lodge Crescent (Phase 2), Barnsley | |
| **Title:** | Site Location Plan | |
| **Drawing No:** | Figure 1 | **Scale:** NTS |
| **Date** | August 2011 | |

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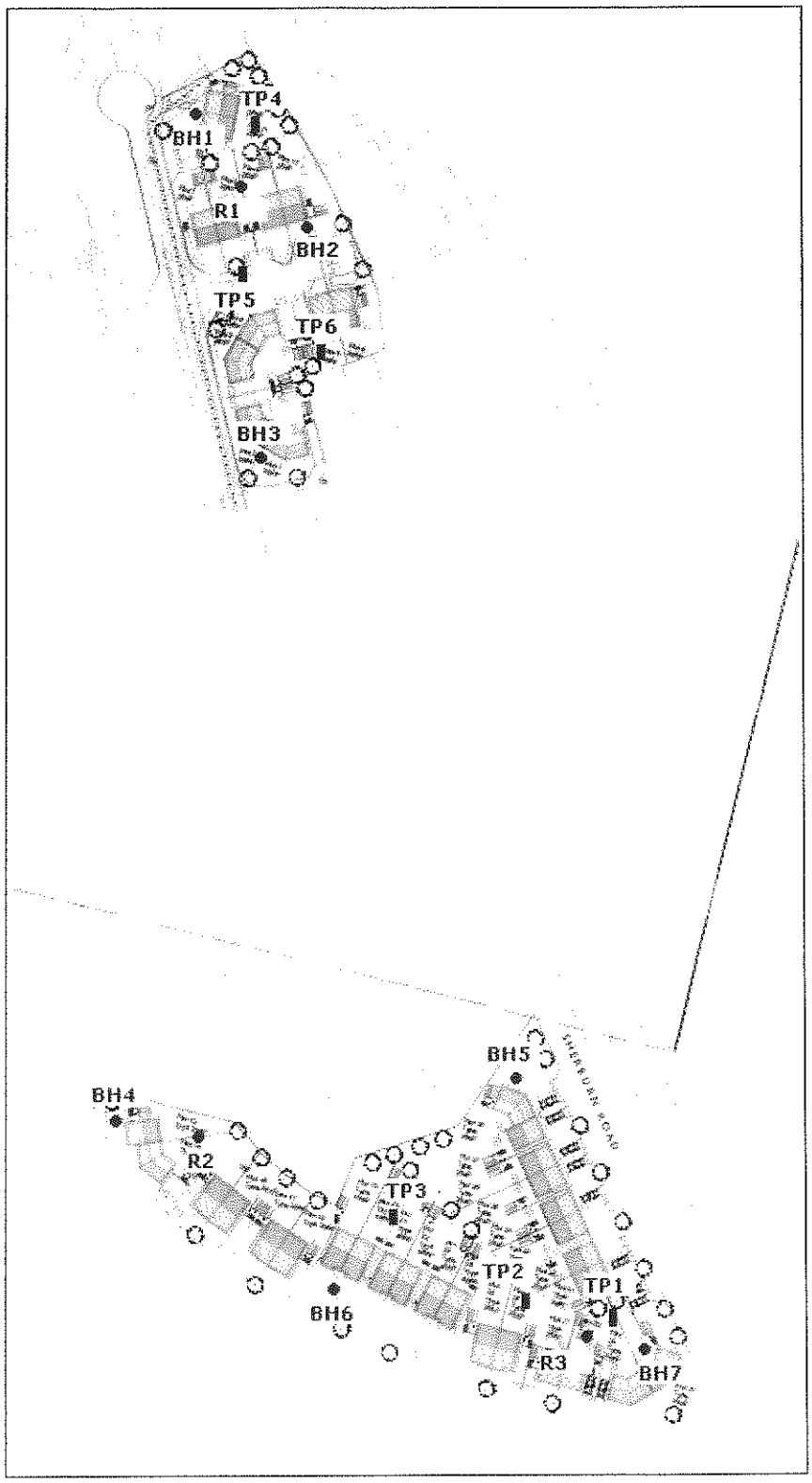



**Figure 2: Borehole & Trial Pit Location Plan**

| | | |
|---|---|---|
| **Client:** | Yorkshire Housing Ltd | |
| **Project:** | New Lodge Crescent (Phase 2), Barnsley | |
| **Title:** | Borehole & Trial Pit Location Plan | |
| **Drawing No:** | Figure 2 | **Scale:** NTS |
| **Date** | August 2011 | |

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# APPENDIX B:
# Borehole, Trial Pit Logs
# & Soakaway Test Results

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# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | BH1 |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet |
| | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Geology | Instrument/ Backfill |
|---|---|---|---|---|---|---|---|---|---|
| Depth | Type No | Test Result | | Reduced Level | Legend | Depth (Thick-ness) | DESCRIPTION | | |
| | | | | | | (0.30) 0.30 | MADE GROUND: Dark grey very gravelly topsoil. | | |
| 0.30 | B | | | | | (0.35) 0.65 | Dark brown slightly clayey very sandy GRAVEL. | | |
| 0.65 | B | | | | | (0.55) 1.20 | Light brown very clayey gravelly SAND. | | |
| 1.20 | J | | | | | (0.60) 1.80 | Yellow-brown SAND with much weathered sandstone inclusions. | | |
| 1.52 | SPT | N=43 | | | | | | | |
| 1.80 | B | | | | | (0.20) 2.00 | Highly weathered yellow SANDSTONE. | | |
| | J | | | | | | | | |
| | SPT | N=50+ | | | | | | | |
| | | | | | | | End of borehole. | | |

| 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 1:18.75 | Client Yorkshire housing Limited | Method/ Plant Used Mini Rig | Logged By TJ |
|---|---|---|---|

GRD_BOREHOLE_LOG S110508.GPJ AGS3_ALL.GDT 27/07/11

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# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | BH2 |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet |
| | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Geology | Instrument/ Backfill |
|---|---|---|---|---|---|---|---|---|---|
| Depth | Type No | Test Result | | Reduced Level | Legend | Depth (Thick-ness) | DESCRIPTION | | |
| | | | | | | (0.30) 0.30 | MADE GROUND: Compact dark grey sandy gravelly topsoil. Much brick inclusions. | | |
| | | | | | | (0.30) 0.60 | Highly weathered yellowish brown SANDSTONE. | | |
| | | | | | | | 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 1:18.75 | Client Yorkshire housing Limited | Method/ Plant Used Mini Rig | Logged By TJ |
|---|---|---|---|

GRD_BOREHOLE_LOG S110508.GPJ AGS3_ALL.GDT 15/06/11

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# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | **BH3** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Geology | Instrument/ Backfill |
|---|---|---|---|---|---|---|---|---|---|
| Depth | Type No | Test Result | | Reduced Level | Legend | Depth (Thick-ness) | DESCRIPTION | | |
| | | | | | | (0.30) 0.30 | MADE GROUND: Compact grey gravelly topsoil. | | |
| 0.30 | B | | | | | (0.30) 0.60 | Brown slightly gravelly SAND. | | |
| 0.60 | B | | | | | (1.00) 1.60 | Brown very clayey gravelly SAND. Gravel is fine to coarse sub angular weathered sandstone. | | |
| 1.20-1.65 | B J | | | | | 1.70 | Highly weathered light yellowish brown SANDSTONE. | | |
| 1.20 | SPT | N=50+ | | | | | | | |
| 1.70 | B J | | | | | | End of borehole. | | |
| | SPT | N=50+ | | | | | | | |

| 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 1:18.75 | Client Yorkshire housing Limited | Method/ Plant Used Mini Rig | Logged By TJ |
|---|---|---|---|

GRD_BOREHOLE_LOG S110508.GPJ AGS3_ALL.GDT 27/07/11

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# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | **BH4** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet |
| | | | | 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Geology | Instrument/ Backfill |
|---|---|---|---|---|---|---|---|---|---|
| Depth | Type No | Test Result | | Reduced Level | Legend | Depth (Thick-ness) | DESCRIPTION | | |
| | | | | | | (0.55) 0.55 | MADE GROUND: Compact brown slightly gravelly sand. | | |
| 0.30 | B | | | | | (0.15) 0.70 | Yellowish brown SAND with much weathered sandstone pieces. | | |
| 0.80 | B | | | | | (0.80) 1.50 | Yellow brown clayey very gravelly SAND. Gravel is fine to coarse of weathered sandstone. | | |
| 1.20-1.65 | B J | | | | | | | | |
| 1.20 | SPT | N=50+ | | | | | | | |
| | | | | | | | End of borehole. | | |

| 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 1:18.75 | Client Yorkshire housing Limited | Method/ Plant Used Mini Rig | Logged By TJ |
|---|---|---|---|

GRD_BOREHOLE_LOG S110508.GPJ AGS3 ALL.GDT 27/07/11

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# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | **BH5** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Geology | Instrument/ Backfill |
|---|---|---|---|---|---|---|---|---|---|
| Depth | Type No | Test Result | | Reduced Level | Legend | Depth (Thick-ness) | DESCRIPTION | | |
| | | | | | | (0.20) 0.20 | MADE GROUND: Compact grey very gravelly topsoil, much brick inclusions. | | |
| 0.20 | B | | | | | (0.60) 0.80 | Possible MADE GROUND: dark brown slightly gravelly sand. | | |
| 0.80 | B | | | | | (0.60) 1.40 | Brown clayey very sandy GRAVEL. Gravel is fine to coarse of sub angular weathered sandstone. | | |
| 1.20 | B J SPT | N=50+ | | | | (0.30) 1.70 | Yellow-brown highly weathered SANDSTONE. | | |
| 1.70 | B J SPT | N=50+ | | | | | End of borehole. | | |

| 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 1:18.75 | Client Yorkshire housing Limited | Method/ Plant Used Mini Rig | Logged By TJ |
|---|---|---|---|

GRD_BOREHOLE_LOG S110508.GPJ AGS3_ALL.GDT 27/07/11

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# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | **BH6** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Geology | Instrument/ Backfill |
|---|---|---|---|---|---|---|---|---|---|
| Depth | Type No | Test Result | | Reduced Level | Legend | Depth (Thick-ness) | DESCRIPTION | | |
| | | | | | | (0.60) | MADE GROUND: Grey very sandy topsoil, much brick, wood and glass inclusions. | | |
| 0.40 | B | | | | | 0.60 | | | |
| | | | | | | (0.20) | Possible MADE GROUND: Yellowish brown sand. | | |
| 0.70 | B | | | | | 0.80 | | | |
| | | | | | | (0.80) | Yellow-brown very clayey very gravelly SAND. Gravel is fine to coarse of sub angular weathered sandstone. | | |
| 1.20-1.60 | B | | | | | | | | |
| 1.20 | J SPT | N=50+ | | | | 1.60 | | | |
| | | | | | | | End of borehole. | | |

| 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 1:18.75 | Client Yorkshire housing Limited | Method/ Plant Used Mini Rig | Logged By TJ |
|---|---|---|---|

GRD_BOREHOLE_LOG S110508.GPJ AGS3_ALL.GDT 27/07/11

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# BOREHOLE LOG

| Project | | | | BOREHOLE No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | BH7 |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | | Geology | Instrument/ Backfill |
|---|---|---|---|---|---|---|---|---|---|
| Depth | Type No | Test Result | | Reduced Level | Legend | Depth (Thick-ness) | DESCRIPTION | | |
| 0.20 | B | | | | | (0.60) | MADE GROUND: Compact grey gravelly topsoil, much brick and wood pieces. | | |
| 0.50 | B | | | | | 0.60 | | | |
| 0.70 | B | | | | | (0.35) | Stiff light brown CLAY. | | |
| | | | | | | 0.95 | | | |
| 1.20 | B<br>J<br>SPT | N=28 | | | | (0.75) | Light brown slightly sandy slightly gravelly CLAY. | | |
| | | | | | | 1.70 | | | |
| 1.70 | J<br>SPT | N=50+ | | | | (0.15)<br>1.85 | Brown highly weathered SANDSTONE. | | |
| | | | | | | | End of borehole. | | |

| 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<br>Scale 1:18.75 | Client Yorkshire housing Limited | Method/ Plant Used Mini Rig | Logged By TJ |
|---|---|---|---|

GRD_BOREHOLE_LOG S110508.GPJ AGS3_ALL.GDT 27/07/11

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# DRILLHOLE LOG

| Project | | | | DRILLHOLE No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | R1 |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 13-06-11 | | | |
| Contractor | | | | Sheet 1 of 1 |

| RUN DETAILS | | | STRATA | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Depth / Date | TCR (SCR) RQD | (SPT) Fracture Spacing | Red'cd Level | Legend | Depth (Thick-ness) | DESCRIPTION: Discontinuities | Detail | Main | Geology | Instrument/ Backfill |
| | | | | | 0.20 | | | MADE GROUND: Soil. | | |
| | | | | | (1.40) | | | Sandy CLAY. | | |
| | | | | | 1.60 | | | Yellow SANDSTONE. | | |
| | | | | | (4.20) | | | | | |
| | | | | | 5.80 | | | Grey SANDSTONE. | | |
| | | | | | (1.40) | | | | | |
| | | | | | 7.20 | | | Yellow SANDSTONE. | | |
| | | | | | (5.20) | | | | | |
| | | | | | 12.40 | | | Grey SANDSTONE. | | |
| | | | | | (5.70) | | | | | |
| | | | | | 18.10 | | | Yellow SANDSTONE. | | |
| | | | | | (1.90) | | | | | |
| | | | | | 20.00 | | | | | |

| Drilling Progress and Water Observations | | | | | | |
|---|---|---|---|---|---|---|
| Date | Time | Depth | Casing | Core Dia mm | Water Strike | Water Standing |
| | | | | | | |

| Rotary Flush | | | |
|---|---|---|---|
| From | To | Type | Returns |
| | | | |

**GENERAL REMARKS**

100% flush returns

| All dimensions in metres Scale 1:125.625 | Client Yorkshire housing Limited | Method/ Plant Used | Logged By TJ |
|---|---|---|---|

GRD_ROTARY_LOG S110508.GPJ AGS3_ALL.GDT 22/06/11

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# DRILLHOLE LOG

| Project | | | | DRILLHOLE No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | R2 |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 13-06-11 | | | |
| Contractor | | | | Sheet 1 of 1 |

| RUN DETAILS | | | STRATA | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Depth / Date | TCR (SCR) RQD | (SPT) Fracture Spacing | Red'cd Level | Legend | Depth (Thick-ness) | DESCRIPTION: Discontinuities | Detail | Main | Geology | Instrument/ Backfill |
| | | | | | 0.20 | | | MADE GROUND: Soil. | | |
| | | | | | 1.10 | | | Sandy CLAY. | | |
| | | | | | (3.20) | | | Yellow SANDSTONE. | | |
| | | | | | 4.30 | | | | | |
| | | | | | 4.45 | | | COAL. | | |
| | | | | | 5.10 | | | Grey MUDSTONE. | | |
| | | | | | (4.10) | | | Yellow SANDSTONE. | | |
| | | | | | 9.20 | | | | | |
| | | | | | (4.50) | | | Grey SANDSTONE. | | |
| | | | | | 13.70 | | | | | |
| | | | | | (6.30) | | | Yellow SANDSTONE. | | |
| | | | | | 20.00 | | | | | |

| Drilling Progress and Water Observations | | | | | | | Rotary Flush | | | | GENERAL REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Depth | Casing | Core Dia mm | Water Strike | Water Standing | From | To | Type | Returns | 100% flush returns |
| | | | | | | | | | | | |

| All dimensions in metres Scale 1:125.625 | Client Yorkshire housing Limited | Method/ Plant Used | Logged By TJ |
|---|---|---|---|

GRD_ROTARY_LOG S110508.GPJ AGS3_ALL.GDT 22/06/11

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# DRILLHOLE LOG

| Project | | | | DRILLHOLE No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | R3 |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 13-06-11 | | | |
| Contractor | | | | Sheet 1 of 1 |

| RUN DETAILS | | | STRATA | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Depth / Date | TCR (SCR) RQD | (SPT) Fracture Spacing | Red'cd Level | Legend | Depth (Thick-ness) | DESCRIPTION: Discontinuities | Detail | Main | Geology | Instrument/ Backfill |
| | | | | | 0.20 | | | MADE GROUND: Soil. | | |
| | | | | | 0.90 | | | Sandy CLAY. | | |
| | | | | | (3.10) | | | Yellow SANDSTONE. | | |
| | | | | | 4.00 | | | | | |
| | | | | | 4.10 | | | COAL. | | |
| | | | | | 4.60 | | | Grey MUDSTONE | | |
| | | | | | (3.50) | | | Yellow SANDSTONE. | | |
| | | | | | 8.10 | | | | | |
| | | | | | (4.70) | | | Grey SANDSTONE. | | |
| | | | | | 17.30 | | | | | |
| | | | | | (2.70) | | | Yellow SANDSTONE. | | |
| | | | | | 20.00 | | | | | |

| Drilling Progress and Water Observations | | | | | | | Rotary Flush | | | | GENERAL REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Time | Depth | Casing | Core Dia mm | Water Strike | Water Standing | From | To | Type | Returns | 100% flush returns |
| | | | | | | | | | | | |

| All dimensions in metres Scale 1:125.625 | Client Yorkshire housing Limited | Method/ Plant Used | Logged By TJ |
|---|---|---|---|

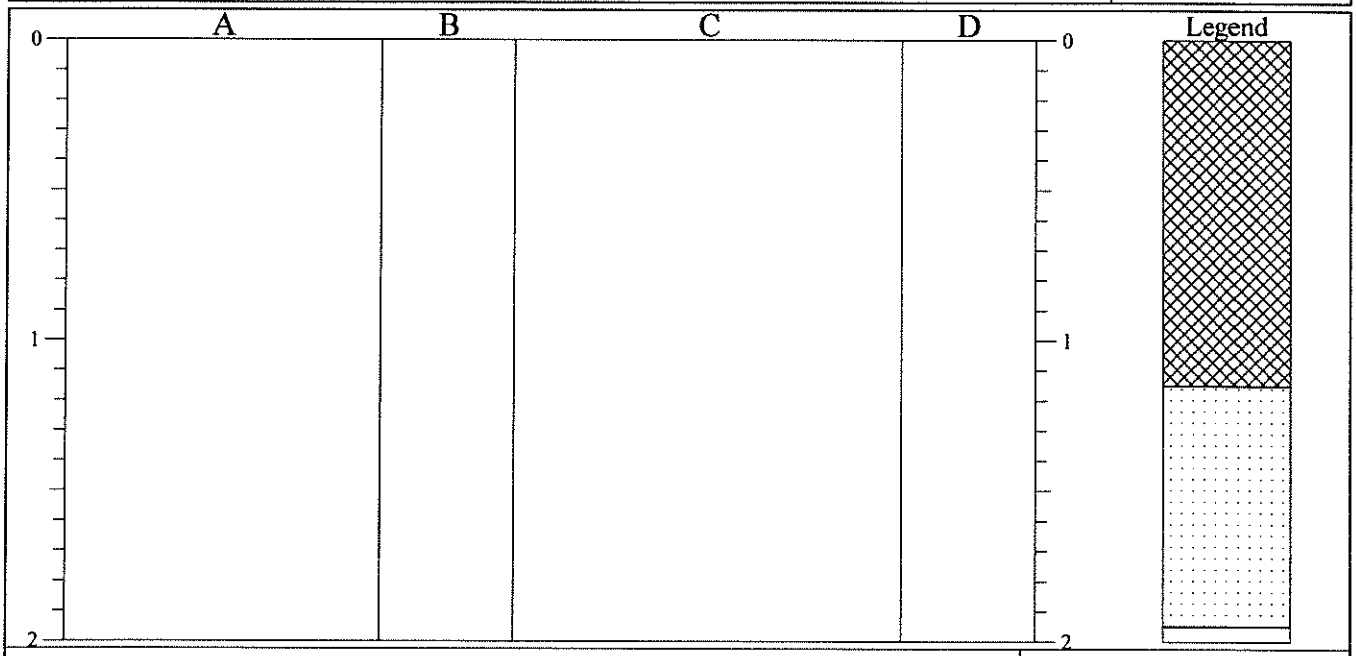
GRD_ROTARY_LOG S110508.GPJ AGS3_ALL.GDT 22/06/11

**Solmek/Hymas Geo**
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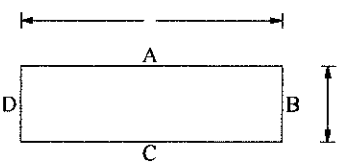
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | **TP1** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet |
| | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-1.15 | | MADE GROUND: Loose brown-grey sandy gravel fill containing brick fragments, concrete, ceramic, glass and sandstone. (large concrete block recovered from 0.60mbgl. Possibly relict foundation). | 0.30 | CBR | =5.0% |
| | | | 0.60 | CBR | =5.0% |
| 1.15-1.95 | | Yellow-brown medium to coarse grained weathered SANDSTONE recovered as slightly clayey sand and gravel. Gravel is fine to coarse of sub angular sandstone. Occasional sub angular sandstone cobbles noted. | | | |

Shoring/Support:
Stability:




**GENERAL REMARKS**

No groundwater encountered.
Pit walls unstable in places.

| All dimensions in metres Scale 1:25 | Client Yorkshire housing Limited | Method/ Plant Used Mini Excavator. | Logged By TJ |
|---|---|---|---|

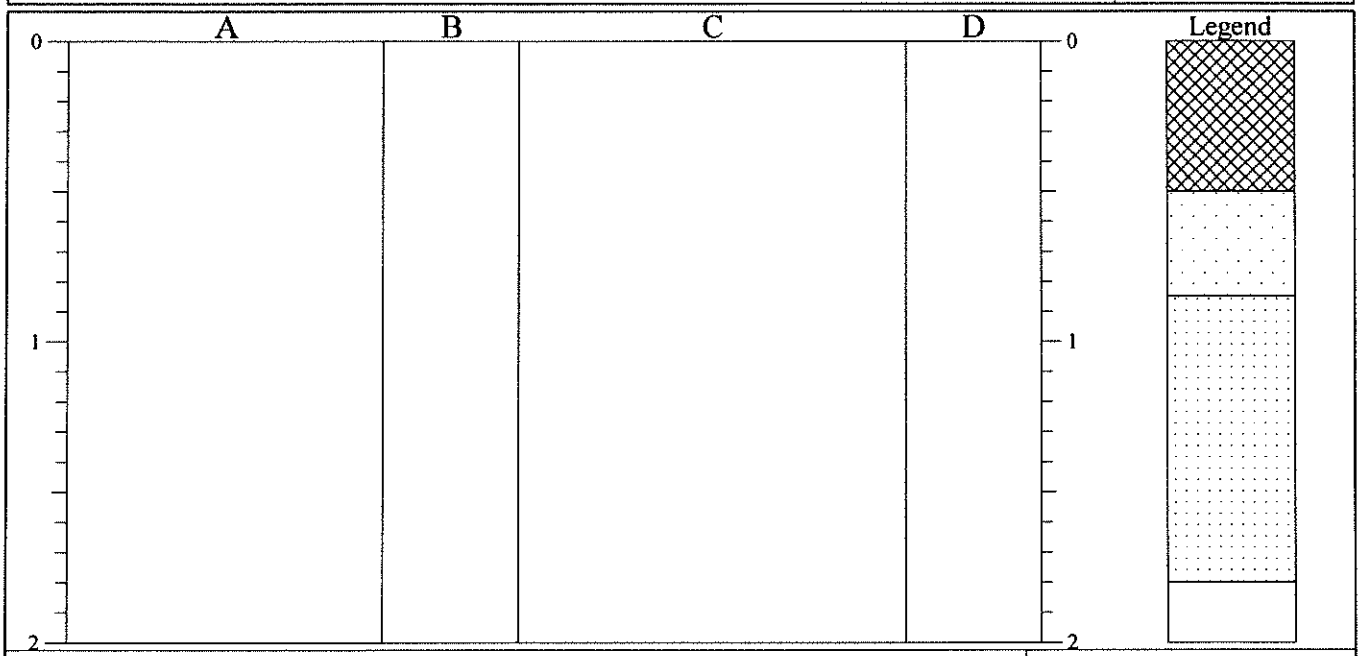
GRD_TRIAL_PIT_LOG_S110508.GPJ AGS3_ALL.GDT 13/06/11

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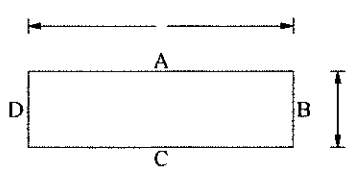
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | **TP2** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet |
| | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-0.50 | | MADE GROUND: Loose brown-grey sandy gravel fill containing brick fragments, concrete, ceramic and sandstone. | 0.30 | CBR | =6.0% |
| 0.50-0.85 | | Brown slightly clayey slightly gravelly fine to coarse SAND. Gravel is fine to coarse sub angular sandstone. | 0.60 | CBR | =8.5% |
| 0.85-1.80 | | Yellow-brown medium to coarse grained weathered SANDSTONE recovered as slightly clayey sand and gravel. Gravel is fine to coarse of sub angular sandstone. Occasional sub angular sandstone cobbles noted. | | | |

Shoring/Support:
Stability:




**GENERAL REMARKS**

No groundwater encountered.
Pit walls unstable in places.

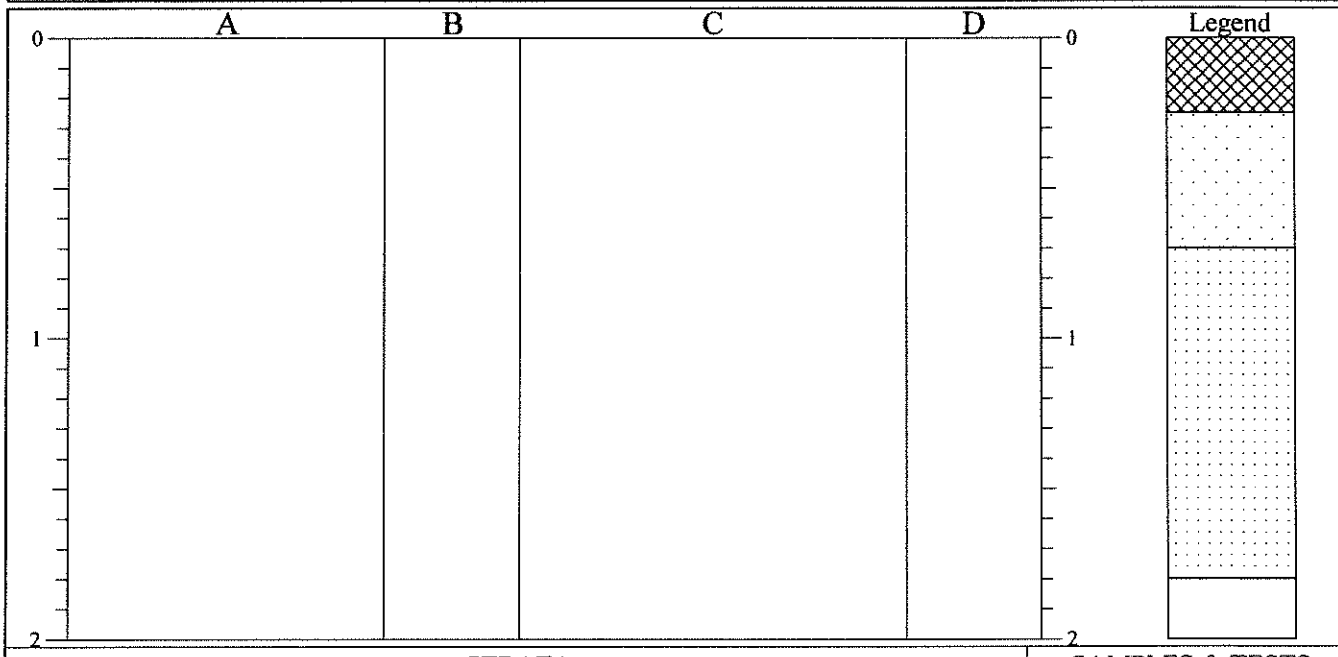
| All dimensions in metres Scale 1:25 | Client Yorkshire housing Limited | Method/ Plant Used Mini Excavator. | Logged By TJ |
|---|---|---|---|

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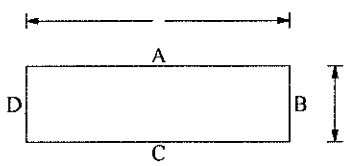
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | **TP3** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet |
| | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-0.25 | | MADE GROUND: Patchy grass over clayey slightly gravelly sand fill. | | | |
| 0.25-0.70 | | Brown slightly clayey slightly gravelly fine to coarse SAND. Gravel is fine to coarse sub angular sandstone. | 0.30 | CBR | =5.0% |
| | | | 0.60 | CBR | =7.0% |
| 0.70-1.80 | | Yellow-brown medium to coarse grained weathered SANDSTONE recovered as slightly clayey sand and gravel. Gravel is fine to coarse of sub angular sandstone. Occasional sub angular sandstone cobbles noted. | | | |

Shoring/Support:
Stability:




**GENERAL REMARKS**

No groundwater encountered.
Pit walls unstable.
Parial collapse.

| All dimensions in metres Scale 1:25 | Client Yorkshire housing Limited | Method/ Plant Used Mini Excavator. | Logged By TJ |
|---|---|---|---|

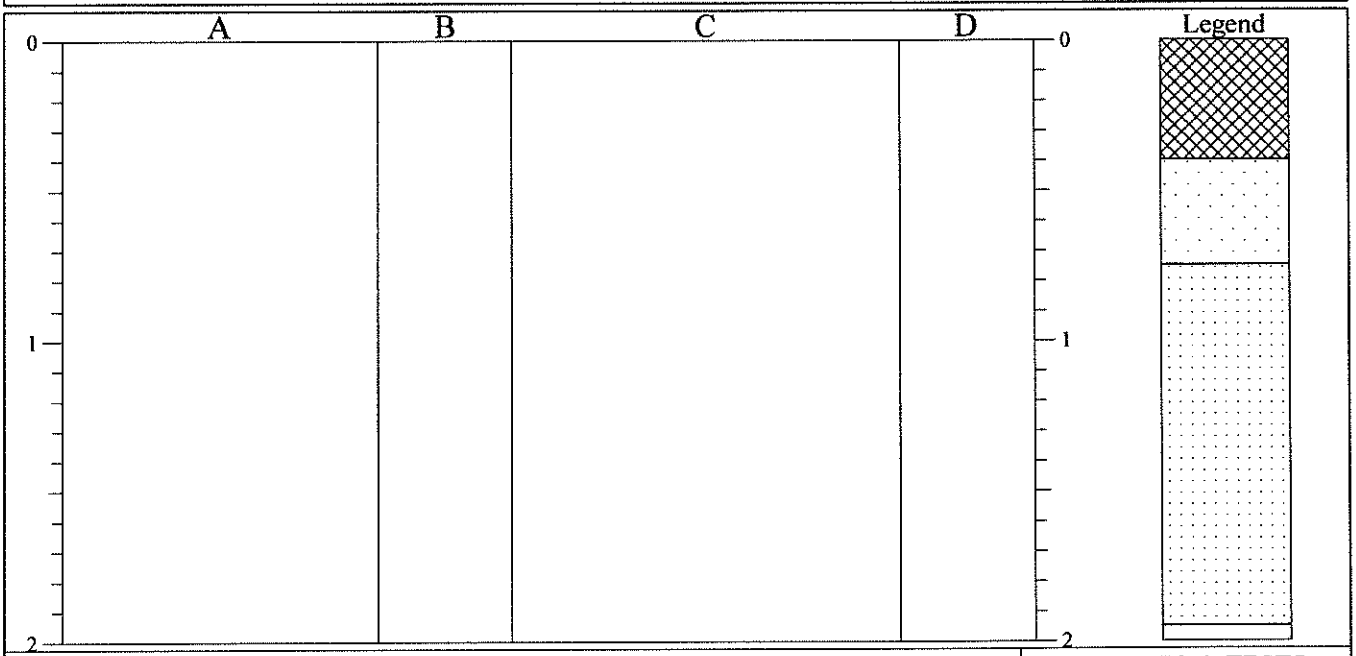
GRD_TRIAL_PIT_LOG S110508.GPJ AGS3_ALL.GDT 13/06/11

**Solmek/Hymas Geo**
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Tel 01642 607083
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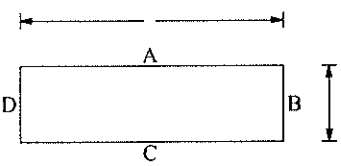
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | **TP4** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet |
| | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-0.40 | | MADE GROUND: Tall grass over sandy slightly gravelly topsoil. | | | |
| | | | 0.30 | CBR | =3.0% |
| 0.40-0.75 | | Brown slightly clayey slightly gravelly fine to coarse SAND. Gravel is fine to coarse sub angular sandstone. | | | |
| | | | 0.60 | CBR | =7.0% |
| 0.75-1.95 | | Yellow-brown medium to coarse grained weathered SANDSTONE recovered as slightly clayey sand and gravel. Gravel is fine to coarse of sub angular sandstone. Occasional sub angular sandstone cobbles noted. | | | |

Shoring/Support:
Stability:




**GENERAL REMARKS**

No groundwater encountered.
Pit walls unstable.

| All dimensions in metres Scale 1:25 | Client Yorkshire housing Limited | Method/ Plant Used Mini Excavator. | Logged By TJ |
|---|---|---|---|

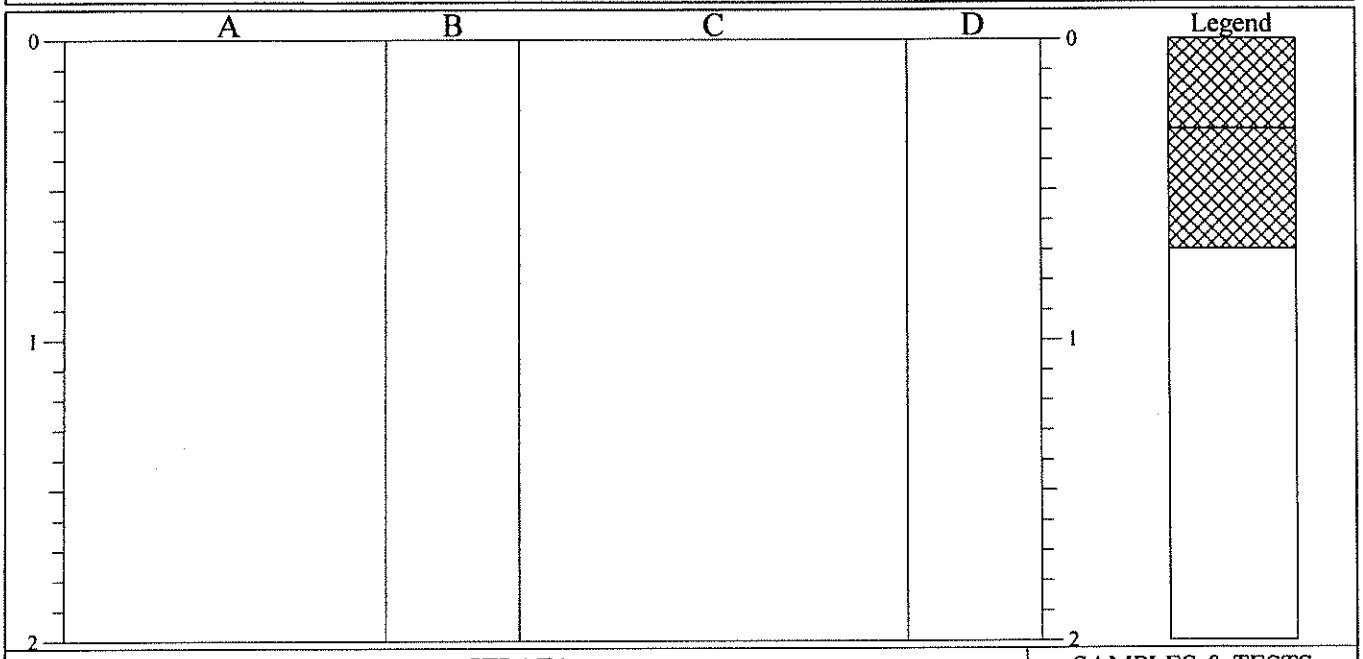
GRD_TRIAL_PIT_LOG S110508.GPJ AGS3_ALL.GDT 13/06/11

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Tel 01642 607083
Fax 01642 612355

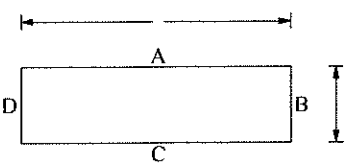
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | **TP5** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet |
| | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-0.30 | | MADE GROUND: Grass over sandy slightly gravelly topsoil. | | | |
| 0.30-0.70 | | MADE GROUND: Brown slightly clayey slightly gravelly fine to coarse sand. Gravel is fine to coarse sub angular sandstone.<br><br>Yellow plastic gas pipe encountered at 0.70mbgl. Trial pit abandoned and backfilled. | 0.30 | CBR | =5.5% |
| | | | 0.60 | CBR | =7.5% |

Shoring/Support:
Stability:




**GENERAL REMARKS**

No groundwater encountered.
Pit walls relatively stable.

| All dimensions in metres<br>Scale 1:25 | Client Yorkshire housing Limited | Method/ Plant Used Mini Excavator. | Logged By TJ |
|---|---|---|---|

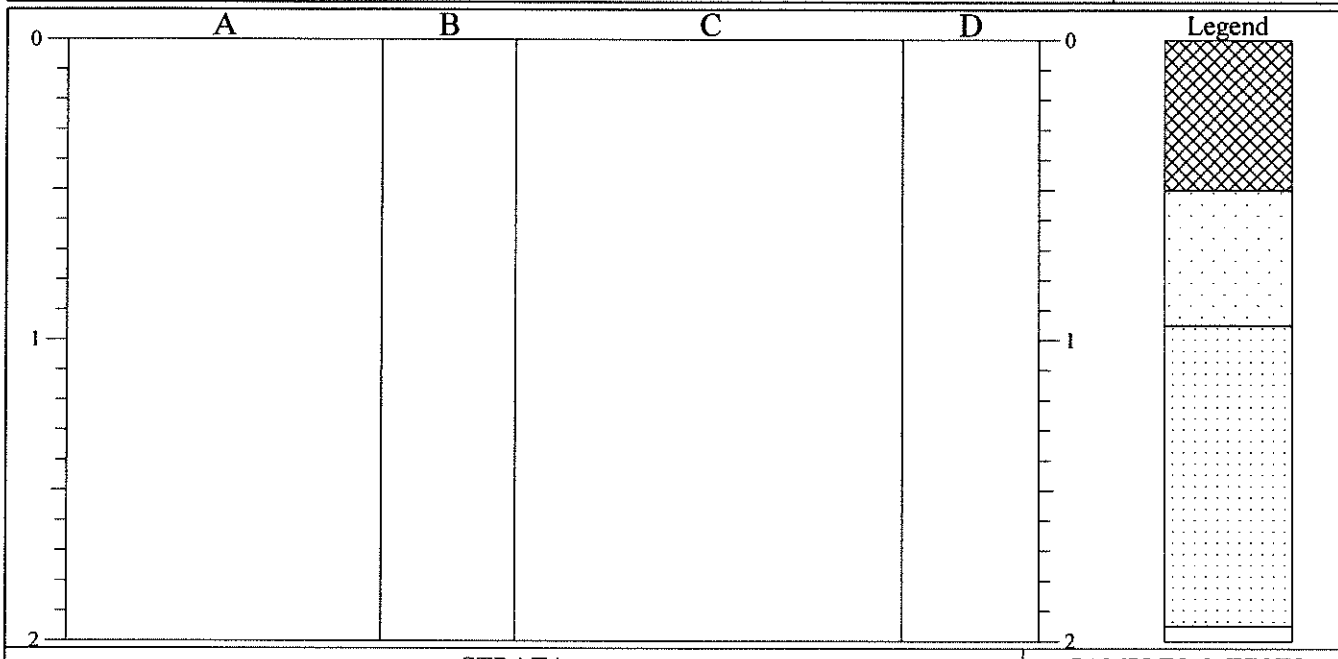
GRD_TRIAL_PIT_LOG_S110508.GPJ_AGS3_ALL.GDT 13/06/11

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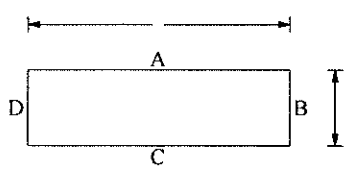
# TRIAL PIT LOG

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| New Lodge Crescent, Barnsley | | | | **TP6** |
| Job No | Date | Ground Level (m) | Co-Ordinates () | |
| S110508 | 10-06-11 | | | |
| Contractor | | | | Sheet |
| | | | | 1 of 1 |




| STRATA | | | SAMPLES & TESTS | | |
|---|---|---|---|---|---|
| Depth | No | DESCRIPTION | Depth | No | Remarks/Tests |
| 0.00-0.50 | | MADE GROUND: Grass over sandy slightly gravelly topsoil fill containing brick fragments. | 0.30 | CBR | =3.0% |
| 0.50-0.95 | | Brown slightly clayey slightly gravelly fine to coarse SAND. Gravel is fine to coarse sub angular sandstone. | 0.60 | CBR | =5.0% |
| 0.95-1.95 | | Yellow-brown medium to coarse grained weathered SANDSTONE recovered as clayey sand and gravel. Gravel is fine to coarse of sub angular sandstone. Occasional sub angular sandstone cobbles noted. | | | |

Shoring/Support:
Stability:




**GENERAL REMARKS**

No groundwater encountered.
Pit walls relatively stable.

| All dimensions in metres Scale 1:25 | Client Yorkshire housing Limited | Method/ Plant Used Mini Excavator. | Logged By TJ |
|---|---|---|---|

GRD_TRIAL_PIT_LOG S110508.GPJ AGS3_ALL.GDT 13/06/11

# Soakaway Test Results

**SA1 in TP1**

**Job No:** S110508
**Project:** New Lodge Crescent, Barnsley
**Client:** Yorkshire Housing Association
**Date:** 10th June 2011

SOLMEK

**Soakaway Test Number = SA1**

| Time | Depth to Water |
|---|---|
| 0 | 1280 |
| 1 | 1310 |
| 2 | 1350 |
| 5 | 1390 |
| 10 | 1440 |
| 15 | 1510 |
| 30 | 1660 |
| 60 | 1950 |
| 120 | |
| 180 | |

Test Pit Dimensions
Length = 1100 mm (Plan area = 0.44 m2 )
Width = 400 mm
Depth = 1950 mm (Total depth)

Initial parameters
Depth to water = 1280 mm
Start time = 0 min

Average water depth = 335 mm

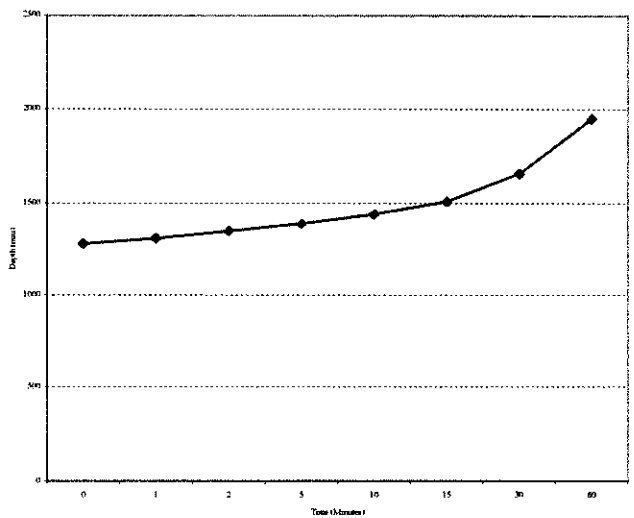
Change in water depth = 670 mm

Final parameters
Depth to water = 1950 mm
End time = 60 min

Time interval = 60 min

Average Soakaway Rate = 81.89 m3/sec*10-6
Average soakaway area = 1.45 m2 (sides + base)

**Infiltration Rate = 56.67 m/sec*10-6**



**GROUND CONDITIONS**

| Depth (m) | Strata Description |
|---|---|
| 0.00-1.15 | Made Ground: Loose brown-grey sandy gravel fill containing brick fragments, concrete, ceramic, glass and sandstone. |
| 1.15-1.95 | Yellow-brown medium to coarse grained weathered SANDSTONE recovered as slightly clayey sand and gravel. Gravel is fine to coarse of sub-angular sandstone. |

*(based on BRE Digest 365)*

# Soakaway Test Results

**SA2 in TP2**

**Job No:** S110508
**Project:** New Lodge Crescent, Barnsley
**Client:** Yorkshire Housing Association
**Date:** 10th June 2011

SOLMEK

**Soakaway Test Number = SA2**

| Time | Depth to Water |
|---|---|
| 0 | 1350 |
| 1 | 1370 |
| 2 | 1400 |
| 5 | 1450 |
| 10 | 1520 |
| 15 | 1610 |
| 30 | 1710 |
| 60 | 1800 |
| 120 | |
| 180 | |

Test Pit Dimensions
Length = 1200 mm (Plan area = 0.48 m2 )
Width = 400 mm
Depth = 1800 mm (Total depth)

Initial parameters
Depth to water = 1350 mm
Start time = 0 min

Average water depth = 225 mm

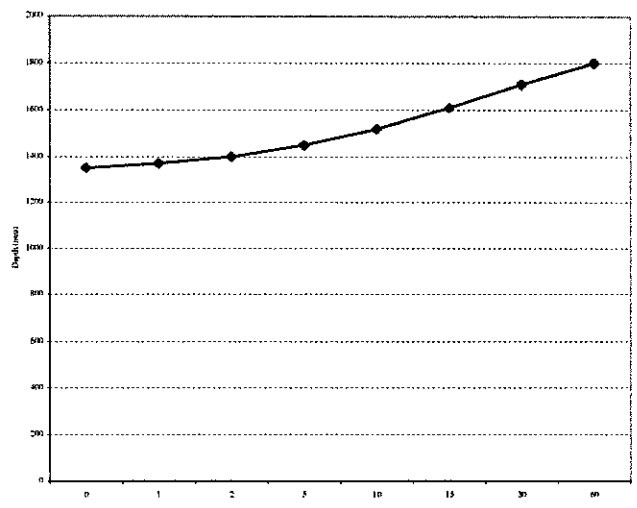
Change in water depth = 450 mm

Final parameters
Depth to water = 1800 mm
End time = 60 min

Time interval = 60 min

Average Soakaway Rate = 60.00 m3/sec*10-6
Average soakaway area = 1.20 m2 (sides + base)

**Infiltration Rate = 50.00 m/sec*10-6**



*(based on BRE Digest 365)*

**GROUND CONDITIONS**

| Depth (m) | Strata Description |
|---|---|
| 0.00-0.50 | Made Ground: Loose brown-grey sandy gravel fill containing brick fragments, concrete, ceramic and sandstone. |
| 0.50-0.85 | Brown slightly clayey slightly gravelly fine to coarse SAND. Gravel is fine to coarse of sub angular sandstone. |
| 0.85-1.80 | Yellow-brown medium to coarse grained weathered SANDSTONE recovered as slightly clayey sand and gravel. Gravel is fine to coarse of sub-angular sandstone. |

# Soakaway Test Results

**SA3 in TP3**

**Job No:** S110508
**Project:** New Lodge Crescent, Barnsley
**Client:** Yorkshire Housing Association
**Date:** 10th June 2011

SOLMEK

**Soakaway Test Number = SA3**

| Time | Depth to Water |
|---|---|
| 0 | 1380 |
| 1 | 1390 |
| 2 | 1410 |
| 5 | 1460 |
| 10 | 1520 |
| 15 | 1630 |
| 30 | 1720 |
| 60 | 1800 |
| 120 | |
| 180 | |

Test Pit Dimensions
Length = 1100 mm (Plan area = 0.44 m2 )
Width = 400 mm
Depth = 1800 mm (Total depth)

Initial parameters
Depth to water = 1380 mm
Start time = 0 min

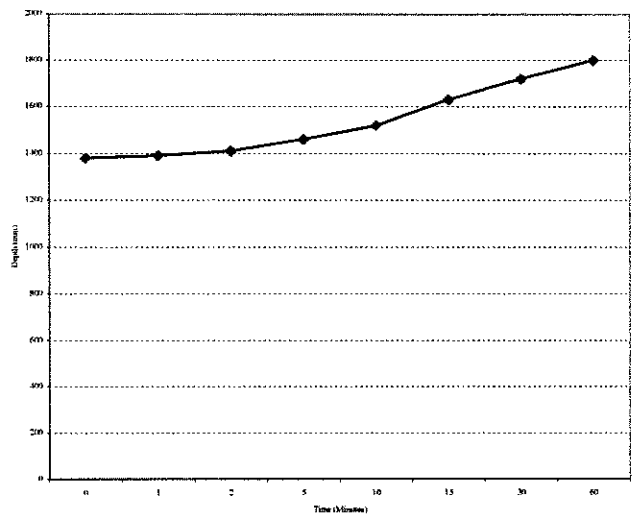
Average water depth = 210 mm
Change in water depth = 420 mm

Final parameters
Depth to water = 1800 mm
End time = 60 min

Time interval = 60 min

Average Soakaway Rate = 51.33 m3/sec*10-6
Average soakaway area = 1.07 m2 (sides + base)

**Infiltration Rate = 47.98 m/sec*10-6**



*(based on BRE Digest 365)*

**GROUND CONDITIONS**

| Depth (m) | Strata Description |
|---|---|
| 0.00-0.25 | Made Ground: Patchy grass over clayey slightly gravelly sand fill. |
| 0.25-0.70 | Brown slightly clayey slightly gravelly fine to coarse SAND. Gravel is fine to coarse of sub angular sandstone. |
| 0.70-1.80 | Yellow-brown medium to coarse grained weathered SANDSTONE recovered as slightly clayey sand and gravel. Gravel is fine to coarse of sub-angular sandstone. |

# Soakaway Test Results

**SA4 in TP4**

**Job No:** S110508
**Project:** New Lodge Crescent, Barnsley
**Client:** Yorkshire Housing Association
**Date:** 10th June 2011

**Soakaway Test Number = SA4**

| Time | Depth to Water |
|---|---|
| 0 | 1280 |
| 1 | 1300 |
| 2 | 1330 |
| 5 | 1400 |
| 10 | 1470 |
| 15 | 1560 |
| 30 | 1700 |
| 60 | 1950 |
| 120 | |
| 180 | |

Test Pit Dimensions

Length = 1100 mm (Plan area = 0.44 m2 )
Width = 400 mm
Depth = 1800 mm (Total depth)

Initial parameters

Depth to water = 1280 mm
Start time = 0 min

Average water depth = 185 mm

Change in water depth = 670 mm

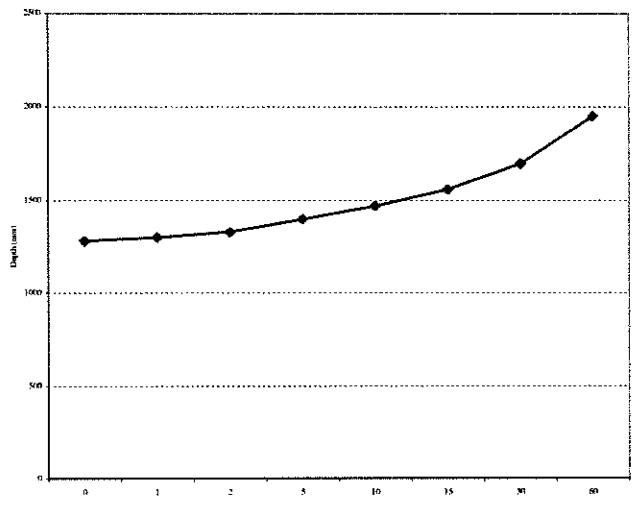
Final parameters

Depth to water = 1950 mm
End time = 60 min

Time interval = 60 min

Average Soakaway Rate = 81.89 m3/sec*10-6
Average soakaway area = 1.00 m2 (sides + base)

**Infiltration Rate = 82.30 m/sec*10-6**



*(based on BRE Digest 365)*

**GROUND CONDITIONS**

| Depth (m) | Strata Description |
|---|---|
| 0.00-0.25 | Made Ground: Patchy grass over clayey slightly gravelly sand fill. |
| 0.25-0.70 | Brown slightly clayey slightly gravelly fine to coarse SAND. Gravel is fine to coarse of sub angular sandstone. |
| 0.70-1.80 | Yellow-brown medium to coarse grained weathered SANDSTONE recovered as slightly clayey sand and gravel. Gravel is fine to coarse of sub-angular sandstone. |

# Soakaway Test Results

**SA5 in TP6**

**Job No:** S110508
**Project:** New Lodge Crescent, Barnsley
**Client:** Yorkshire Housing Association
**Date:** 10th June 2011

**Soakaway Test Number = SA5**

| Time | Depth to Water |
|---|---|
| 0 | 940 |
| 1 | 950 |
| 2 | 950 |
| 5 | 970 |
| 10 | 1040 |
| 15 | 1100 |
| 30 | 1200 |
| 60 | 1500 |
| 120 | 1950 |
| 180 | |

Test Pit Dimensions
Length = 1100 mm (Plan area = 0.44 m2 )
Width = 400 mm
Depth = 1950 mm (Total depth)

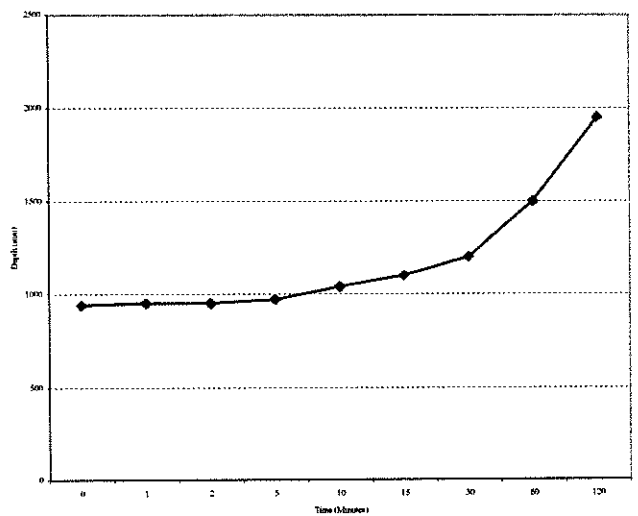
Initial parameters
Depth to water = 940 mm
Start time = 0 min

Final parameters
Depth to water = 1950 mm
End time = 120 min

Average water depth = 505 mm
Change in water depth = 1010 mm
Time interval = 120 min

Average Soakaway Rate = 61.72 m3/sec*10-6
Average soakaway area = 1.96 m2 (sides + base)

**Infiltration Rate = 31.57 m/sec*10-6**




*(based on BRE Digest 365)*

**GROUND CONDITIONS**

| Depth (m) | Strata Description |
|---|---|
| 0.00-0.50 | Made Ground: Tall grass over sandy slightly gravelly topsoil. |
| 0.50-0.95 | Brown slightly clayey slightly gravelly fine to coarse SAND. Gravel is fine to coarse of sub angular sandstone. |
| 0.95-1.95 | Yellow-brown medium to coarse grained weathered SANDSTONE recovered as slightly clayey sand and gravel. Gravel is fine to coarse of sub-angular sandstone. |

# APPENDIX C:
# Laboratory Geotechnical Test Results

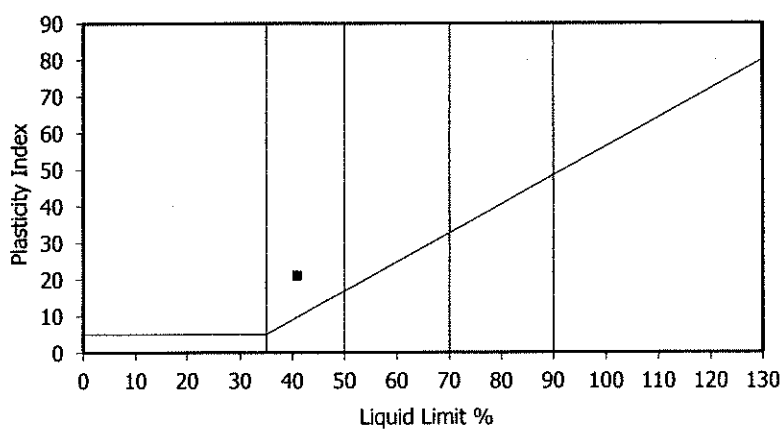
SUMMARY OF SOIL CLASSIFICATION TESTS
(BS1377-2:1990+A1:1996)

NEW LODGE CRESCENT, BARNSLEY
S110508

SOLMEK



| Hole | Depth m | Type | Moisture Content % | Liquid Limit % | Plastic Limit % | Plasticity Index | Plasticity | % Passing 425µm | pH | $SO_4$ Content mg/L | Chloride Content mg/L | Organic Matter Content % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BH1 | 0.65 | B | 15 | | | | | | 6.4 | 54 | | |
| BH1 | 1.20 | J | 12 | | | | NP | | | | | |
| BH3 | 0.60 | B | 19 | | | | | | 5.5 | 37 | | |
| BH3 | 1.20 | B | 13 | | | | | | 4.4 | 58 | | |
| BH4 | 0.80 | B | 4.9 | | | | | | | | | |
| BH5 | 0.80 | B | 6.1 | | | | | | 6.4 | 78 | | |
| BH5 | 1.20 | B | 8.1 | | | | | | | | | |
| BH6 | 0.70 | B | 7.2 | | | | | | 8.6 | 268 | | |
| BH7 | 0.70 | B | 21 | 41 | 20 | 21 | CI | | | | | |
| BH7 | 1.20 | B | 26 | | | | | | 4.9 | 49 | | |




Liquid Limit

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

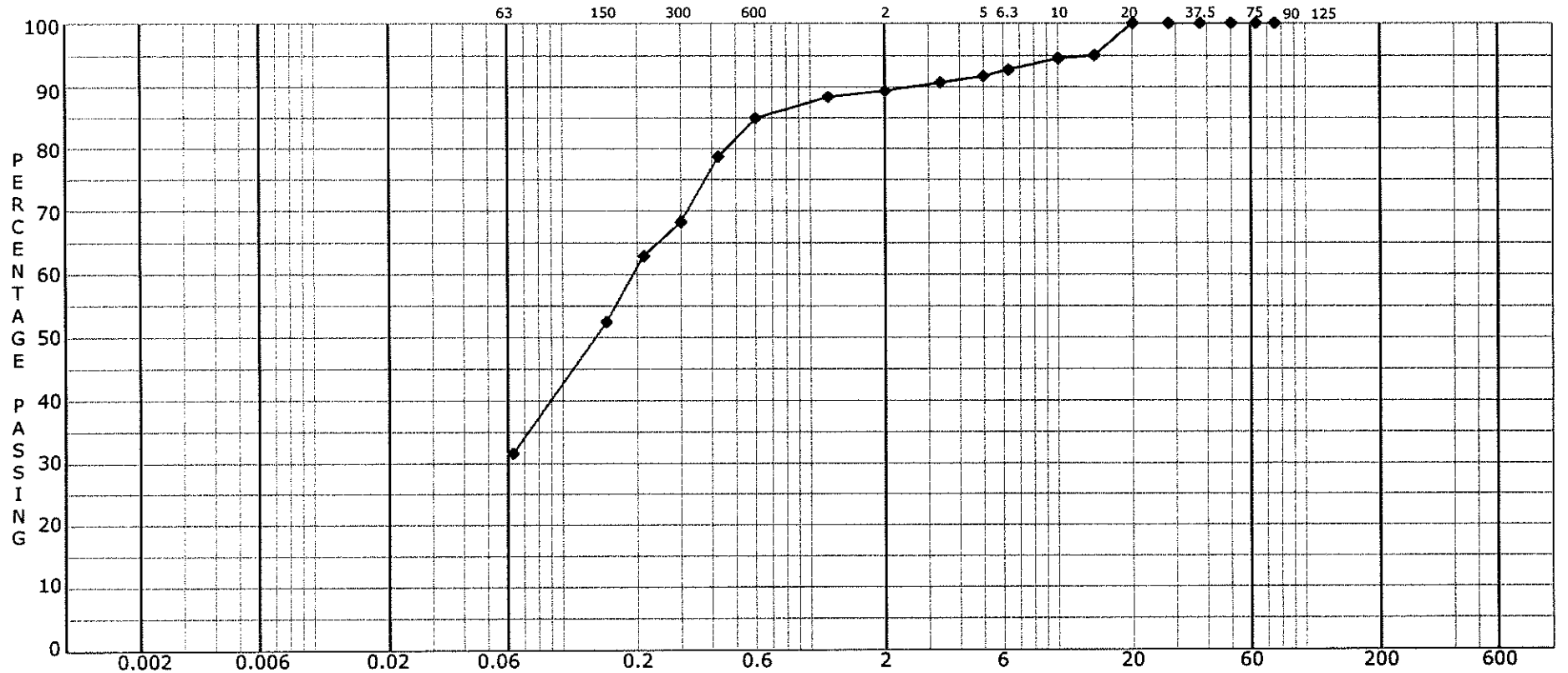
Comments

Prepared: Date: 28/7/11

Checked: Date: 28-7-11.

Approved: Date: 4/8/11

BS Test Sieves In mm and microns




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

| | BH No. | Depth | MC | $C_u$ | $C_z$ | D100 | D60 | D30 | D10 | %GRAVEL | %SAND | %SILT and/or %CLAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ◆ | 1 | 0.65 - 0.75 | 15.1 | | | 20.0000 | 0.1948 | | | 11 | 57 | 32 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

Scheme : New Lodge Crescent, Barnsley
Client :

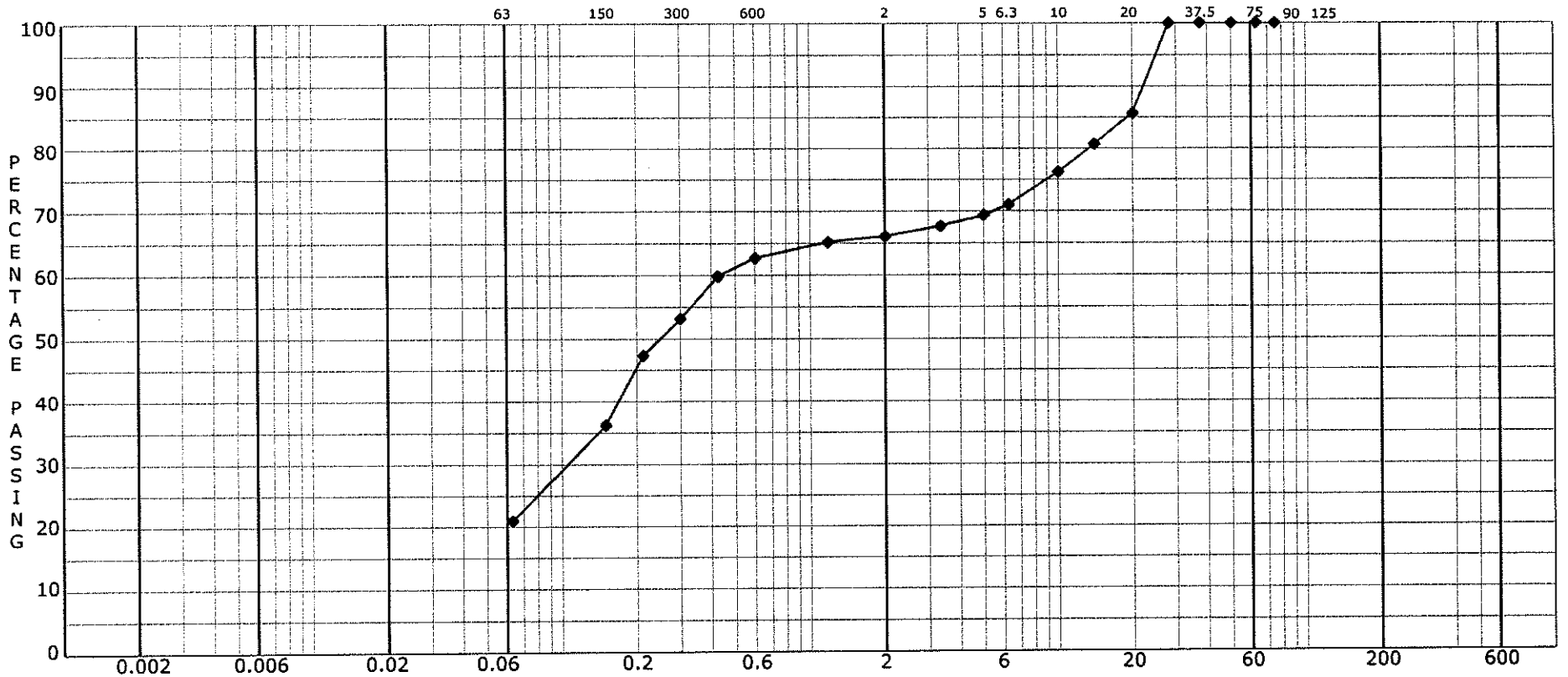
SOLMEK
12 Yarm Road
Stockton-on-Tees
TS18 3NA
01642 607083

Form No. 4AR Rev 2

Particle Size Distribution
Test Method BS 1377 : Part 2 : 1990 : Method 9
Deviations from test method - None

Report. S110508
Revision 0 Amd-

BS Test Sieves In mm and microns




PARTICLE SIZE IN MILLIMETRES

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

| | BH No. | Depth | MC | $C_u$ | $C_z$ | D100 | D60 | D30 | D10 | %GRAVEL | %SAND | %SILT and/or %CLAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ◆ | 1 | 1.20 - 1.65 | 11.7 | | | 28.0000 | 0.4363 | 0.1145 | | 34 | 45 | 21 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
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Scheme : New Lodge Crescent, Barnsley
Client :

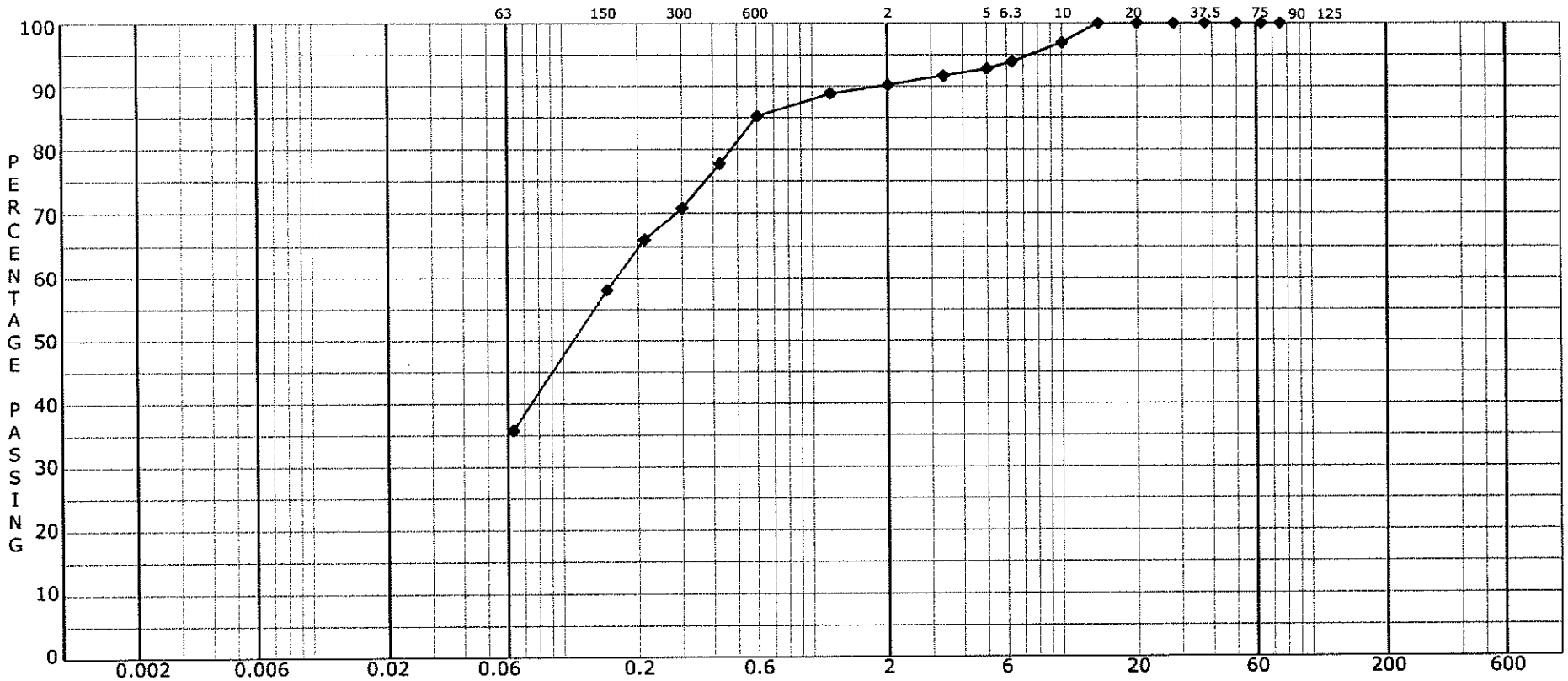
SOLMEK
12 Yarm Road
Stockton-on-Tees
TS18 3NA
01642 607083

Form No. 4AR Rev 2

Particle Size Distribution
Test Method BS 1377 : Part 2 : 1990 : Method 9
Deviations from test method - None

Report. S110508
Revision 0 Amd-

BS Test Sieves In mm and microns




PARTICLE SIZE IN MILLIMETRES

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

| | BH No. | Depth | MC | $C_u$ | $C_z$ | D100 | D60 | D30 | D10 | %GRAVEL | %SAND | %SILT and/or %CLAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ◆ | 3 | 0.60 - 0.70 | 19.4 | | | 14.0000 | 0.1649 | | | 10 | 54 | 36 |
| | | | | | | | | | | | | |
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Form No. 4AR Rev 2

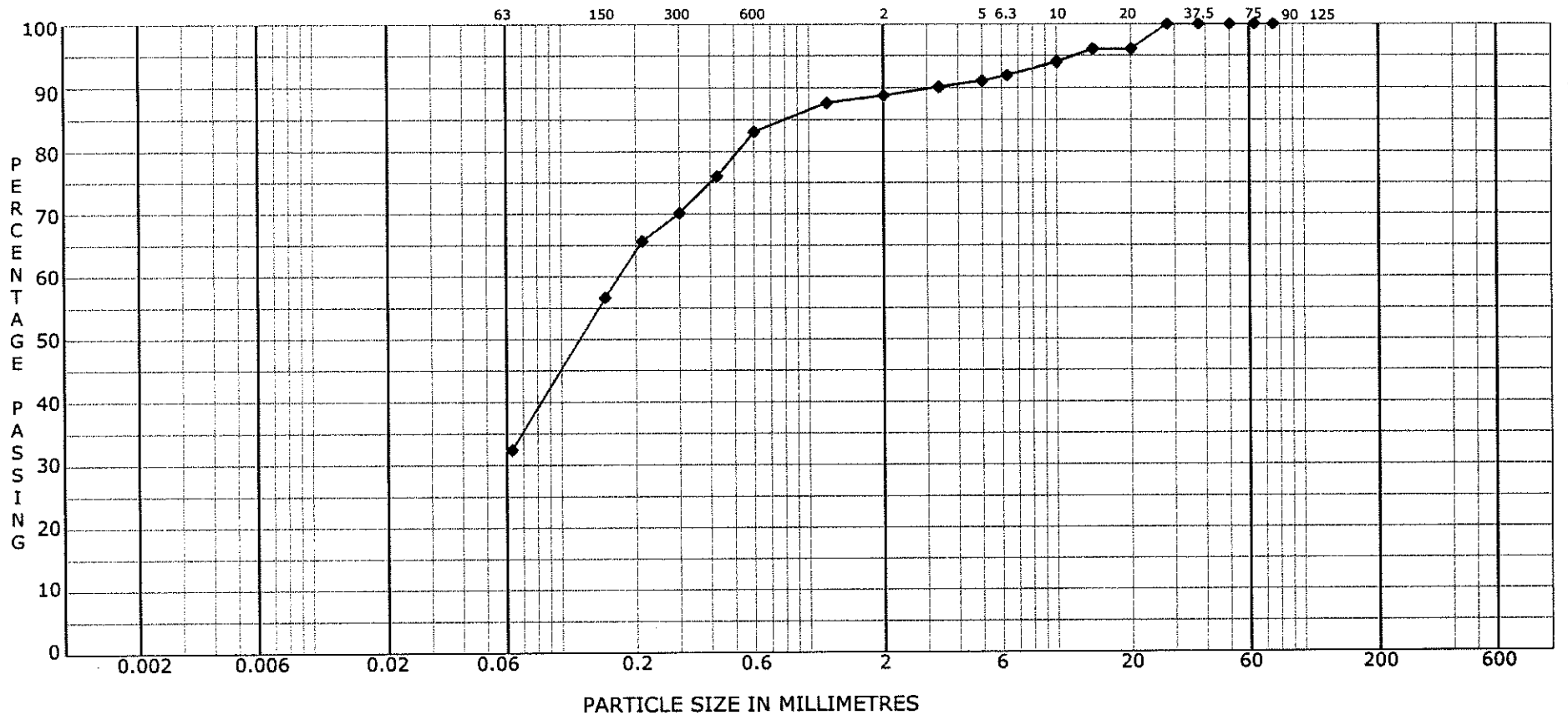
Particle Size Distribution
Test Method BS 1377 : Part 2 : 1990 : Method 9
Deviations from test method - None

Report. S110508
Revision 0 Amd-
Page 1 of 1

Scheme : New Lodge Crescent, Barnsley
Client :

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

BS Test Sieves In mm and microns




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

| | BH No. | Depth | MC | $C_u$ | $C_z$ | D100 | D60 | D30 | D10 | %GRAVEL | %SAND | %SILT and/or %CLAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ◆ | 3 | 1.20 - 1.65 | 13.1 | | | 28.0000 | 0.1733 | | | 11 | 57 | 32 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
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Form No. 4AR Rev 2

Particle Size Distribution
Test Method BS 1377 : Part 2 : 1990 : Method 9
Deviations from test method - None

Report. S110508
Revision 0 Amd-
Page 1 of 1

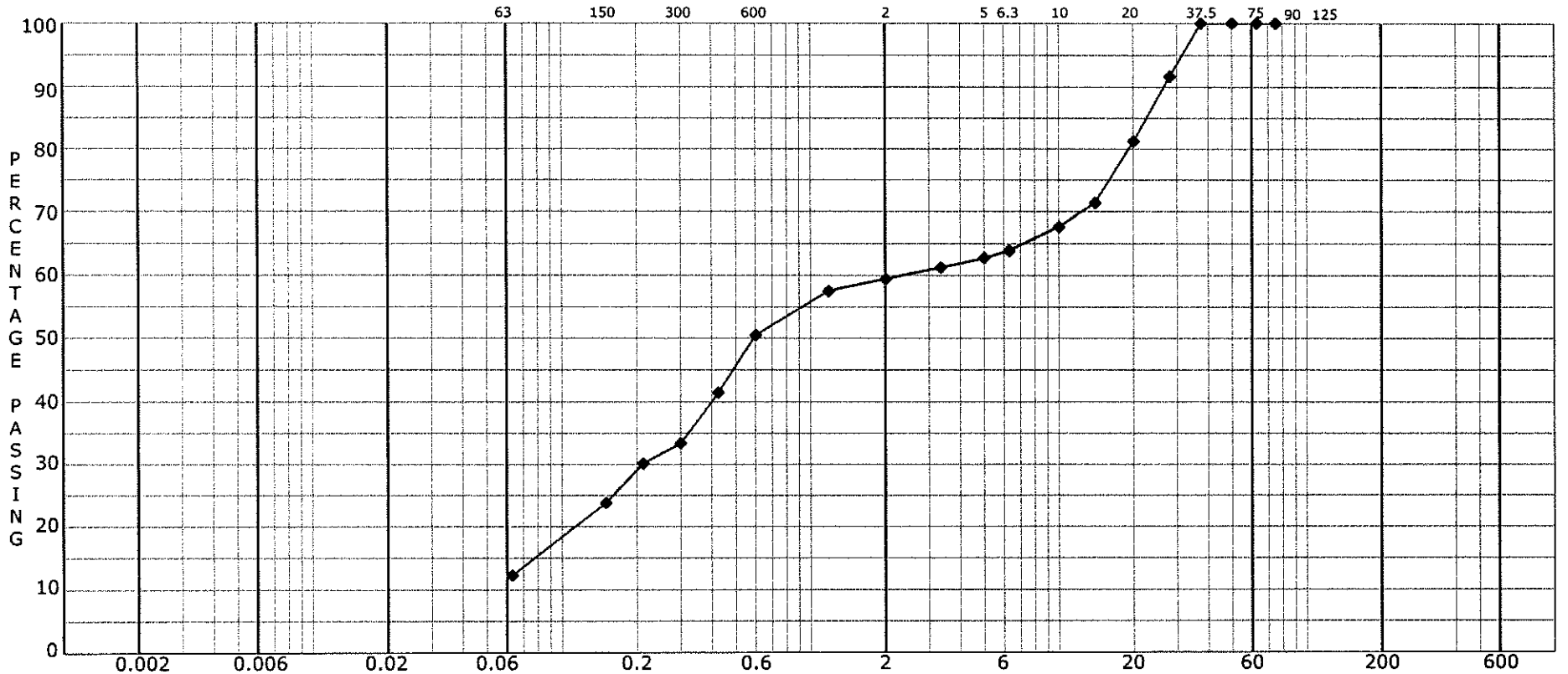
Scheme : New Lodge Crescent, Barnsley
Client :

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

Form No. 4AR Rev 2

Particle Size Distribution
Test Method BS 1377 : Part 2 : 1990 : Method 9
Deviations from test method - None

BS Test Sieves In mm and microns




PARTICLE SIZE IN MILLIMETRES

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

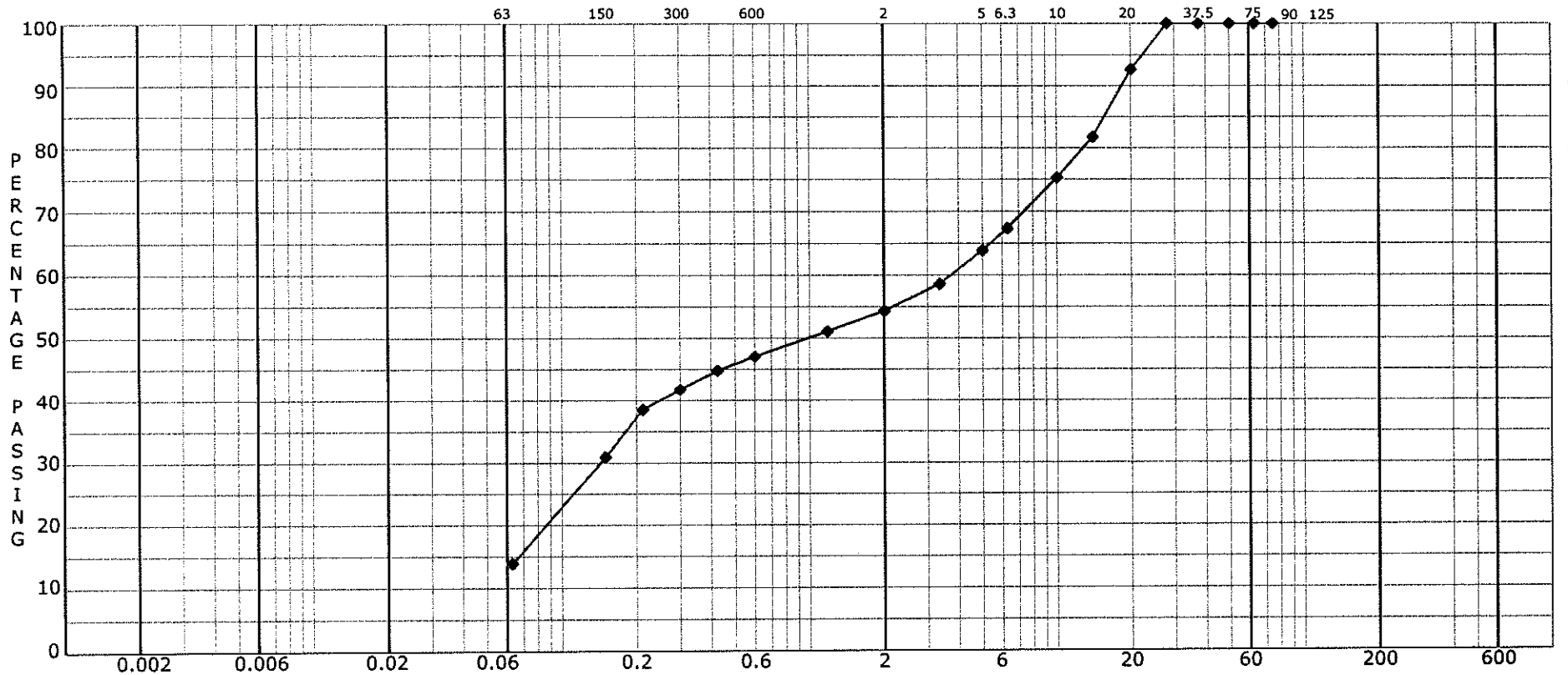
| | BH No. | Depth | MC | $C_U$ | $C_Z$ | D100 | D60 | D30 | D10 | %GRAVEL | %SAND | %SILT and/or %CLAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ◆ | 4 | 0.80 - 0.90 | 4.9 | | | 37.5000 | 2.4326 | 0.2109 | | 41 | 47 | 12 |
| | | | | | | | | | | | | |
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Report. S110508
Revision 0 Amd-
Page 1 of 1

Scheme : New Lodge Crescent, Barnsley
Client :

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

BS Test Sieves In mm and microns




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

| | BH No. | Depth | MC | $C_u$ | $C_z$ | D100 | D60 | D30 | D10 | %GRAVEL | %SAND | %SILT and/or %CLAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ◆ | 5 | 0.80 - 0.90 | 6.1 | | | 28.0000 | 3.7921 | 0.1453 | | 46 | 40 | 14 |
| | | | | | | | | | | | | |
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Form No. 4AR Rev 2

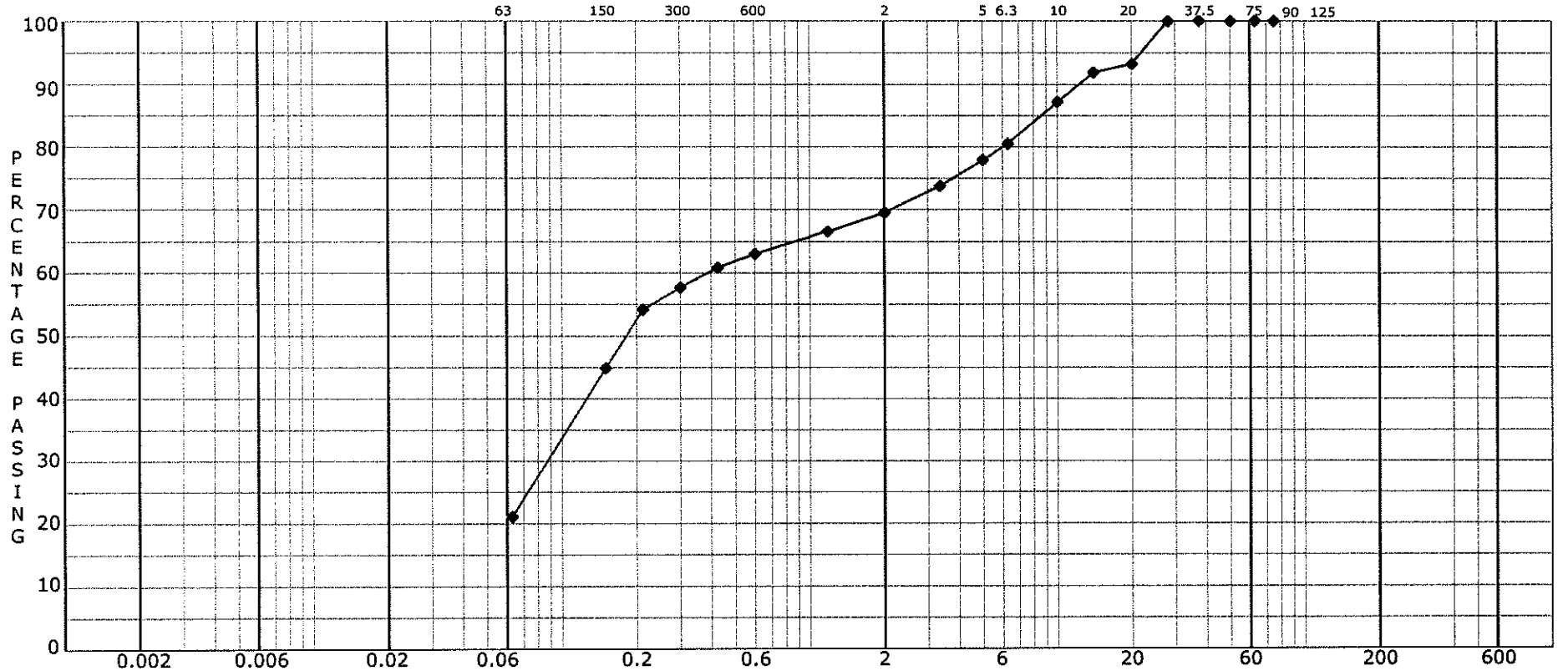
Particle Size Distribution
Test Method BS 1377 : Part 2 : 1990 : Method 9
Deviations from test method - None

Report. S110508
Revision 0 Amd-
Page 1 of 1

Scheme : New Lodge Crescent, Barnsley
Client :

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

BS Test Sieves In mm and microns




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

| | BH No. | Depth | MC | $C_U$ | $C_Z$ | D100 | D60 | D30 | D10 | %GRAVEL | %SAND | %SILT and/or %CLAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ◆ | 5 | 1.20 - 1.65 | 8.1 | | | 28.0000 | 0.3922 | 0.0956 | | 30 | 49 | 21 |
| | | | | | | | | | | | | |
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| | | | | | | | | | | | | |

Form No. 4AR Rev 2

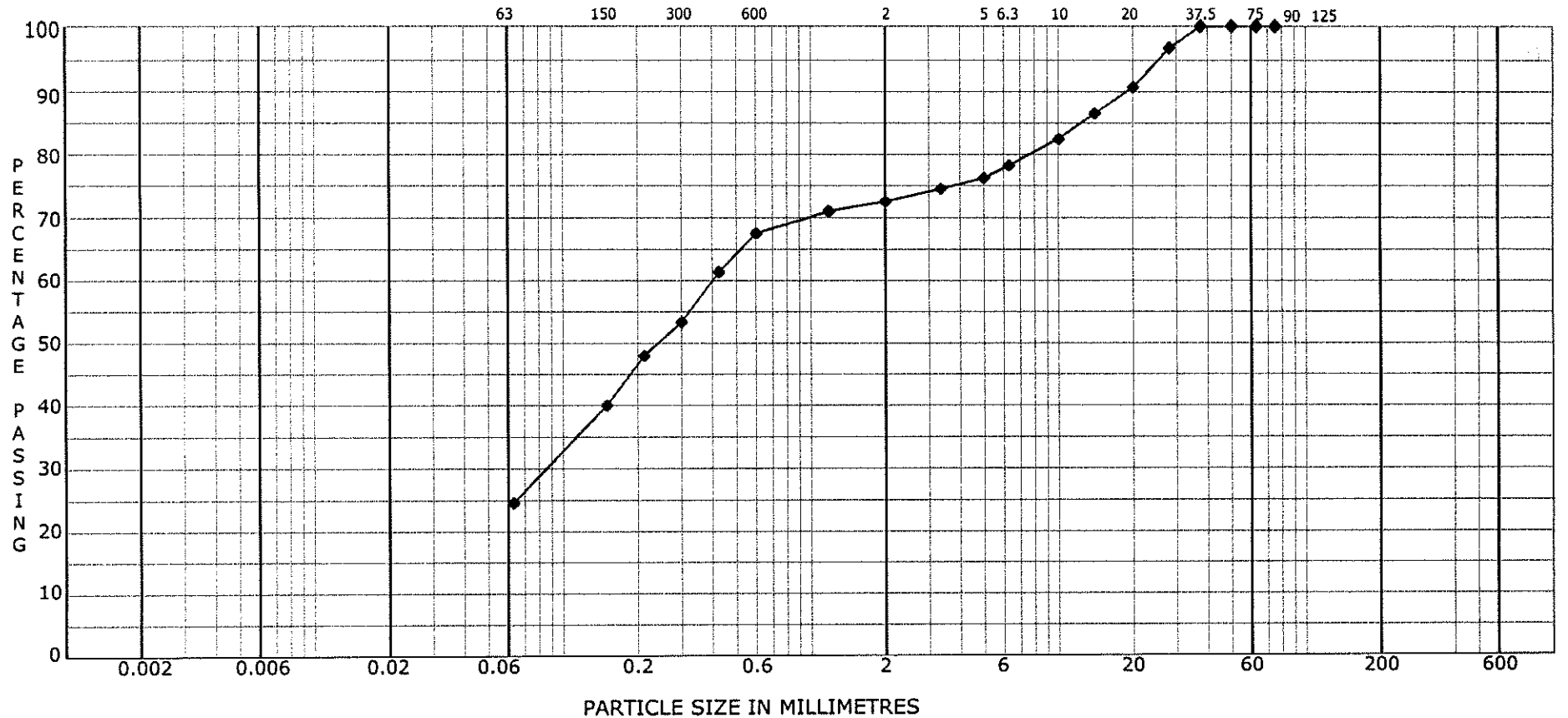
Particle Size Distribution
Test Method BS 1377 : Part 2 : 1990 : Method 9
Deviations from test method - None

Report. S110508
Revision 0 Amd-
Page 1 of 1

Scheme : New Lodge Crescent, Barnsley
Client :

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

BS Test Sieves In mm and microns




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

| | BH No. | Depth | MC | $C_U$ | $C_z$ | D100 | D60 | D30 | D10 | %GRAVEL | %SAND | %SILT and/or %CLAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ◆ | 6 | 0.70 - 0.80 | 7.2 | | | 37.5000 | 0.4035 | 0.0935 | | 28 | 47 | 25 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

Form No. 4AR Rev 2

Particle Size Distribution
Test Method BS 1377 : Part 2 : 1990 : Method 9
Deviations from test method - None

Report. S110508
Revision 0 Amd-
Page 1 of 1

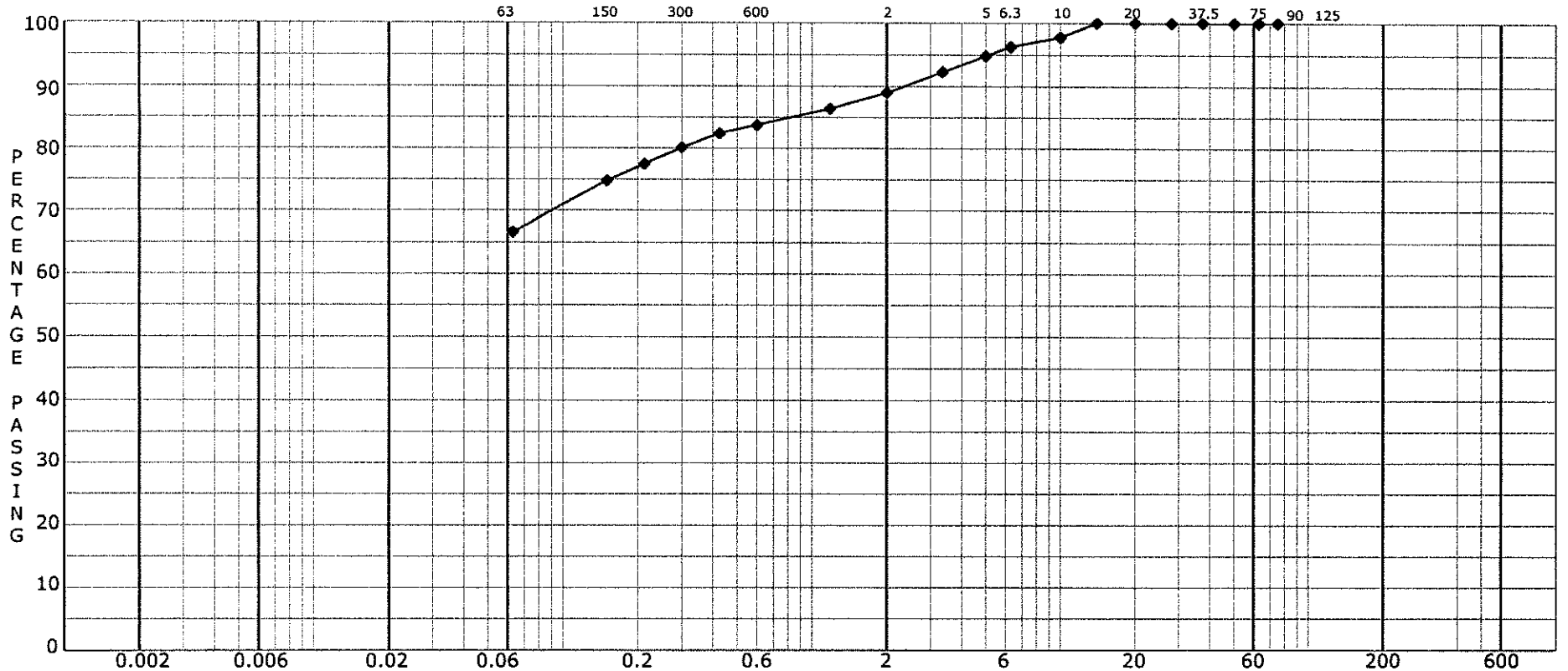
Scheme : New Lodge Crescent, Barnsley
Client :

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

Form No. 4AR Rev 2

Particle Size Distribution
Test Method BS 1377 : Part 2 : 1990 : Method 9
Deviations from test method - None

BS Test Sieves In mm and microns




PARTICLE SIZE IN MILLIMETRES

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

| | BH No. | Depth | MC | $C_u$ | $C_z$ | D100 | D60 | D30 | D10 | %GRAVEL | %SAND | %SILT and/or %CLAY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ◆ | 7 | 1.20 - 1.65 | 25.8 | | | 14.0000 | | | | 11 | 22 | 67 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
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Report. S110508
Revision 0 Amd-
Page 1 of 1

Scheme : New Lodge Crescent, Barnsley
Client :

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

# APPENDIX D:
# Chemical Test Results and CLEA Model Output

Derwentside Environmental Testing Services

2139

# Certificate of Analysis

Date: 07/07/2011

Certificate Number: 11-51149

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

Our Reference: 11-51149

Client Reference: S110508

Contract Title: New Lodge Crescent, Barnsley

Description: 5 soil samples

Date Received: 28/06/2011

Date Started: 29/06/2011

Date Completed: 07/07/2011

Test Procedures: Identified by prefix DETSn, details available upon request.

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

Approved By: Mark Hughes, Contracts 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 |

## Deviating Samples

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 is based upon the UKAS note "Guidance on Deviating Samples".

***Key***

| | |
|---|---|
| ! | Denotes sample may be deviating due to one or more of the following |
| 1 | Sample not received in appropriate containers |
| 2 | Sample exceeded holding times |
| 3 | Sample received without a Date Sampled |
| 4 | Sample received without a Time Sampled (Waters only) |
| n/a | Denotes sample is not deviating |

## 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: 11-51149
Client Ref: S110508
Contract Title: New Lodge Crescent, Barnsley

| | | Lab No. | 339143 | 339144 | 339145 | 339146 | 339147 |
|---|---|---|---|---|---|---|---|
| | | Sample ID | BH1 | BH2 | BH4 | BH6 | BH7 |
| | | Depth | 0.20-0.30 | 0.20-0.30 | 0.30 | 0.40 | 0.45 |
| | | Sample Ref | | | | | |
| | | Sample Type | | | | | |
| | | Sampling Date | 10/06/2011 | 10/06/2011 | 10/06/2011 | 10/06/2011 | 10/06/2011 |
| | | Sample Time | | | | | |
| **Test** | **Units** | **DETSxx** | | | | | |
| Deviating Sample | | | !,1 | !,1 | !,1 | !,1 | !,1 |
| Arsenic | mg/kg | DETS 042# | 11 | 19 | 1.9 | 8.2 | 9.1 |
| Cadmium | mg/kg | DETS 042# | 0.7 | 1 | 0.4 | 0.9 | 0.8 |
| Chromium | mg/kg | DETS 042# | 22 | 16 | 8 | 30 | 17 |
| Hexavalent Chromium | mg/kg | DETSC2204* | < 1 | < 1 | < 1 | < 1 | < 1 |
| Copper | mg/kg | DETS 042# | 21 | 29 | 7 | 36 | 44 |
| Lead | mg/kg | DETS 042# | 44 | 47 | 8 | 26 | 39 |
| Mercury | mg/kg | DETS 081# | 0.12 | 0.09 | < 0.05 | < 0.05 | 0.05 |
| Nickel | mg/kg | DETS 042# | 12 | 14 | 9 | 14 | 15 |
| Selenium | mg/kg | DETS 042# | < 0.5 | < 0.5 | < 0.5 | < 0.5 | < 0.5 |
| Zinc | mg/kg | DETS 042# | 40 | 62 | 22 | 57 | 65 |
| Boron (water soluble) | mg/kg | DETS 020# | 1.4 | 1.4 | 0.9 | 2.1 | 2.1 |
| Calcium Carbonate (as CaCO3) | % | DETS 005* | < 1.0 | < 1.0 | < 1.0 | 23 | < 1.0 |
| Cyanide total | mg/kg | DETS 067# | 0.3 | 0.9 | 0.1 | 0.2 | 0.3 |
| Organic matter | % | DETS 002# | 2.2 | 4.8 | 1.9 | 3.8 | 2.3 |
| Sulphide | mg/kg | DETS 024# | < 10 | < 10 | < 10 | 36 | 12 |
| Sulphate Aqueous Extract as SO4 | mg/l | DETS 076# | 59 | 16 | 47 | 490 | 470 |
| pH | | DETS 008# | 6.8 | 5.6 | 6.1 | 10 | 7.8 |
| Phenol - Monohydric | mg/kg | DETS 067# | < 0.3 | < 0.3 | < 0.3 | < 0.3 | < 0.3 |

## Summary of Asbestos Analysis
## Soil Samples

Our Ref: 11-51149
Client Ref: S110508
Contract Title: New Lodge Crescent, Barnsley

| Lab No | Sample Ref | Depth | Other Ref | Material | Result |
|---|---|---|---|---|---|
| 339143 | BH1 | 0.20-0.30 | | SOIL | NAD |
| 339144 | BH2 | 0.20-0.30 | | SOIL | NAD |
| 339145 | BH4 | 0.30 | | SOIL | NAD |
| 339146 | BH6 | 0.40 | | SOIL | Chrysotile |
| 339147 | BH7 | 0.45 | | SOIL | NAD |

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

CLEA Software Version 1.06 

| | |
|---|---|
| Report generated | 26-Jul-11 |
| Report title | New Lodge Crescent, Barnsley |
| Created by | TJ at Solmek |

Environment Agency

**RESULTS**

Environment Agency

| | | Assessment Criterion (mg kg$^{-1}$) | | | Ratio of ADE to HCV | | | Saturation Limit (mg kg$^{-1}$) | 50% rule? | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | oral | inhalation | combined | oral | inhalation | combined | | Oral | Inhal |
| 1 | Cadmium | 5.45E+00 | 2.97E+01 | 5.17E+00 | 0.91 | 0.10 | 1.00 | NR | Yes | Yes |
| 2 | Chromium III | 1.95E+04 | 3.55E+03 | 3.00E+03 | 0.15 | 0.85 | 1.00 | NR | No | No |
| 3 | Chromium VI | NR | 4.25E+00 | NR | 0.00 | 1.00 | NR | NR | Yes | No |
| 4 | Copper | 2.70E+03 | 1.04E+04 | 2.36E+03 | 0.77 | 0.23 | 1.00 | NR | Yes | No |
| 5 | Mercury, inorganic | 1.81E+02 | 2.55E+03 | 1.69E+02 | 0.93 | 0.07 | 1.00 | NR | No | No |
| 6 | Nickel | 5.31E+02 | 1.27E+02 | NR | 0.14 | 1.00 | NR | NR | Yes | Yes |
| 7 | Zinc | 3.74E+03 | 7.49E+03 | 2.86E+03 | 0.62 | 0.38 | 1.00 | NR | Yes | No |
| 8 | Arsenic | 3.24E+01 | 8.50E+01 | NR | 1.00 | 0.38 | NR | NR | No | No |
| 9 | Boron | 2.91E+02 | 1.05E+01 | 1.03E+01 | 0.02 | 0.98 | 1.00 | NR | Yes | No |
| 10 | Selenium | 3.50E+02 | NR | NR | 1.00 | NR | NR | NR | Yes | No |
| 11 | Cyanide | 1.07E+01 | 1.60E+00 | 1.49E+00 | 0.07 | 0.93 | 1.00 | NR | Yes | No |
| 12 | Phenol | 7.62E+02 | 4.51E+02 | 2.83E+02 | 0.37 | 0.63 | 1.00 | 6.75E+04 (vap) | No | No |
| 13 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 15 | | | | | | | | | | |
| 16 | | | | | | | | | | |
| 17 | | | | | | | | | | |
| 18 | | | | | | | | | | |
| 19 | | | | | | | | | | |
| 20 | | | | | | | | | | |

Environment Agency

| | Assessment Criterion (mg kg$^{-1}$) | | | Ratio of ADE to HCV | | | Saturation Limit (mg kg$^{-1}$) | 50% rule? | |
|---|---|---|---|---|---|---|---|---|---|
| | oral | inhalation | combined | oral | inhalation | combined | | Oral | Inhal |
| 21 | | | | | | | | | |
| 22 | | | | | | | | | |
| 23 | | | | | | | | | |
| 24 | | | | | | | | | |
| 25 | | | | | | | | | |
| 26 | | | | | | | | | |
| 27 | | | | | | | | | |
| 28 | | | | | | | | | |
| 29 | | | | | | | | | |
| 30 | | | | | | | | | |

Environment Agency

| | | Soil Distribution | | | | Media Concentrations | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Sorbed | Dissolved | Vapour | Total | Soil | Soil gas | Indoor Dust | Outdoor dust at 0.8m | Outdoor dust at 1.6m | Indoor Vapour | Outdoor vapour at 0.8m | Outdoor vapour at 1.6m | Green vegetables | Root vegetables | Tuber vegetables | Herbaceous fruit | Shrub fruit | Tree fruit |
| | | % | % | % | % | mg kg$^{-1}$ | mg m$^{-3}$ | mg kg$^{-1}$ | mg m$^{-3}$ | mg m$^{-3}$ | mg m$^{-3}$ | mg m$^{-3}$ | mg m$^{-3}$ | mg kg$^{-1}$ FW | mg kg$^{-1}$ FW | mg kg$^{-1}$ FW | mg kg$^{-1}$ FW | mg kg$^{-1}$ FW | mg kg$^{-1}$ FW |
| 1 | Cadmium | 99.7 | 0.3 | 0.0 | 100.0 | 5.17E+00 | NR | 2.59E+00 | 2.20E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.69E-01 | 1.50E-01 | 1.60E-01 | 8.28E-02 | 1.60E-02 | 7.24E-03 |
| 2 | Chromium III | 100.0 | 0.0 | 0.0 | 100.0 | 3.00E+03 | NR | 1.50E+03 | 1.28E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.01E-02 | 9.01E-02 | 9.01E-02 | 9.01E-02 | 9.01E-02 | 9.01E-02 |
| 3 | Chromium VI | 98.3 | 1.7 | 0.0 | 100.0 | 4.25E+00 | NR | 2.12E+00 | 1.81E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.50E-04 | 4.25E-04 | 4.25E-04 | 3.82E-01 | 1.27E-03 | 3.82E-01 |
| 4 | Copper | 99.7 | 0.3 | 0.0 | 100.0 | 2.36E+03 | NR | 1.18E+03 | 1.00E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.85E+01 | 4.85E+01 | 4.85E+01 | 4.85E+01 | 4.85E+01 | 4.85E+01 |
| 5 | Mercury, inorganic | 99.9 | 0.1 | 0.0 | 100.0 | 1.69E+02 | NR | 8.43E+01 | 7.18E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.41E-01 | 1.16E+00 | 7.25E-01 | 1.69E-01 | 1.86E-01 | 1.69E-01 |
| 6 | Nickel | 99.9 | 0.1 | 0.0 | 100.0 | 1.27E+02 | NR | 6.37E+01 | 5.42E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.84E-01 | 5.48E-01 | 2.42E-01 | 3.19E-01 | 3.19E-01 | 4.33E-01 |
| 7 | Zinc | 99.2 | 0.8 | 0.0 | 100.0 | 2.86E+03 | NR | 1.43E+03 | 1.22E-06 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.54E+02 | 1.54E+02 | 1.54E+02 | 4.09E+02 | 1.54E+02 | 1.54E+02 |
| 8 | Arsenic | 99.9 | 0.1 | 0.0 | 100.0 | 3.24E+01 | NR | 1.62E+01 | 1.38E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.39E-02 | 1.30E-02 | 7.45E-03 | 1.07E-02 | 6.48E-03 | 3.56E-02 |
| 9 | Boron | 96.9 | 3.1 | 0.0 | 100.0 | 1.03E+01 | NR | 5.14E+00 | 4.38E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.11E+00 | 2.06E+00 | 2.06E+00 | 2.06E+00 | 2.06E+00 | 2.06E+00 |
| 10 | Selenium | 99.4 | 0.6 | 0.0 | 100.0 | 3.50E+02 | NR | 1.75E+02 | 1.49E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.78E+00 | 1.27E+00 | 2.91E-01 | 9.49E-01 | 1.05E+00 | 1.05E+00 |
| 11 | Cyanide | -208.3 | 308.3 | 0.0 | 100.0 | 1.49E+00 | NR | 7.43E-01 | 6.32E-10 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.58E-01 | 7.58E-01 | 7.58E-01 | 7.58E-01 | 7.58E-01 | 7.58E-01 |
| 12 | Phenol | 74.8 | 25.2 | 0.0 | 100.0 | 2.83E+02 | 1.93E+00 | 1.42E+02 | 1.20E-07 | 0.00E+00 | 1.64E-03 | 8.73E-05 | 0.00E+00 | 1.83E+02 | 3.58E+02 | 1.97E+02 | 0.00E+00 | 0.00E+00 | 3.74E+02 |
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Environment Agency

| | Soil Distribution | | | | Media Concentrations | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sorbed | Dissolved | Vapour | Total | Soil | Soil gas | Indoor Dust | Outdoor dust at 0.8m | Outdoor dust at 1.6m | Indoor Vapour | Outdoor vapour at 0.8m | Outdoor vapour at 1.6m | Green vegetables | Root vegetables | Tuber vegetables | Herbaceous fruit | Shrub fruit | Tree fruit |
| | % | % | % | % | mg $kg^{-1}$ | mg $m^{-3}$ | mg $kg^{-1}$ | mg $m^{-3}$ | mg $m^{-3}$ | mg $m^{-3}$ | mg $m^{-3}$ | mg $m^{-3}$ | mg $kg^{-1}$ FW | mg $kg^{-1}$ FW | mg $kg^{-1}$ FW | mg $kg^{-1}$ FW | mg $kg^{-1}$ FW | mg $kg^{-1}$ FW |
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Environment Agency

| | | Average Daily Exposure (mg kg$^{-1}$ bw day$^{-1}$) | | | | | | | Distribution by Pathway (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Direct soil ingestion | Consumption of homegrown produce and attached soil | Dermal contact with soil and dust | Inhalation of dust | Inhalation of vapour | Background (oral) | Background (inhalation) | Direct soil ingestion | Consumption of homegrown produce and attached soil | Dermal contact with soil and dust | Inhalation of dust | Inhalation of vapour (indoor) | Inhalation of vapour (outdoor) | Background (oral) | Background (inhalation) |
| 1 | Cadmium | 3.84E-05 | 1.32E-04 | 1.97E-07 | 1.22E-07 | 0.00E+00 | 7.54E-04 | 1.21E-06 | 11.21 | 38.70 | 0.06 | 0.04 | 0.00 | 0.00 | 49.96 | 0.04 |
| 2 | Chromium III | 2.23E-02 | 3.53E-04 | 0.00E+00 | 7.07E-05 | 0.00E+00 | 3.39E-03 | 1.64E-05 | 85.34 | 1.35 | 0.00 | 0.27 | 0.00 | 0.00 | 12.97 | 0.06 |
| 3 | Chromium VI | 3.15E-05 | 1.82E-04 | 0.00E+00 | 1.00E-07 | 0.00E+00 | 3.77E-04 | 0.00E+00 | 0.00 | 0.00 | 0.00 | 100.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4 | Copper | 1.75E-02 | 5.23E-02 | 0.00E+00 | 5.55E-05 | 0.00E+00 | 3.94E-01 | 4.12E-05 | 12.52 | 37.44 | 0.00 | 0.04 | 0.00 | 0.00 | 49.97 | 0.03 |
| 5 | Mercury, inorganic | 1.25E-03 | 5.64E-04 | 0.00E+00 | 3.97E-06 | 0.00E+00 | 5.63E-05 | 0.00E+00 | 66.71 | 30.08 | 0.00 | 0.21 | 0.00 | 0.00 | 3.00 | 0.00 |
| 6 | Nickel | 9.45E-04 | 4.66E-04 | 2.43E-05 | 3.00E-06 | 0.00E+00 | 7.31E-03 | 3.64E-06 | 32.77 | 16.18 | 0.84 | 0.10 | 0.00 | 0.00 | 49.90 | 0.10 |
| 7 | Zinc | 2.12E-02 | 2.08E-01 | 0.00E+00 | 6.73E-05 | 0.00E+00 | 1.52E+00 | 1.45E-04 | 3.09 | 30.23 | 0.00 | 0.01 | 0.00 | 0.00 | 33.33 | 0.02 |
| 8 | Arsenic | 2.40E-04 | 2.27E-05 | 3.70E-05 | 7.62E-07 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 79.89 | 7.54 | 12.31 | 0.25 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | Boron | 7.63E-05 | 2.75E-03 | 0.00E+00 | 2.42E-07 | 0.00E+00 | 2.08E-01 | 2.41E-05 | 0.90 | 32.34 | 0.00 | 0.00 | 0.00 | 0.00 | 33.24 | 0.28 |
| 10 | Selenium | 2.60E-03 | 1.82E-03 | 0.00E+00 | 8.24E-06 | 0.00E+00 | 1.97E-03 | 3.64E-06 | 40.59 | 28.46 | 0.00 | 0.13 | 0.00 | 0.00 | 30.82 | 0.00 |
| 11 | Cyanide | 1.10E-05 | 8.13E-04 | 5.66E-06 | 3.50E-08 | 0.00E+00 | 1.69E-02 | 3.64E-06 | 0.44 | 32.61 | 0.23 | 0.00 | 0.00 | 0.00 | 33.28 | 0.15 |
| 12 | Phenol | 2.10E-03 | 2.51E-01 | 3.24E-03 | 6.66E-06 | 1.52E-03 | 1.97E-02 | 2.42E-03 | 0.75 | 89.64 | 1.16 | 0.00 | 0.54 | 0.00 | 7.04 | 0.87 |
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Environment Agency

| | Average Daily Exposure (mg kg$^{-1}$ bw day$^{-1}$) | | | | | | | Distribution by Pathway (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Direct soil ingestion | Consumption of homegrown produce and attached soil | Dermal contact with soil and dust | Inhalation of dust | Inhalation of vapour | Background (oral) | Background (inhalation) | Direct soil ingestion | Consumption of homegrown produce | Dermal contact with soil and dust | Inhalation of dust | Inhalation of vapour (indoor) | Inhalation of vapour (outdoor) | Background (oral) | Background (inhalation) |
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Environment Agency

| | | Oral Health Criteria Value ($\mu g\ kg^{-1}\ BW\ day^{-1}$) | | Inhalation Health Criteria Value ($\mu g\ kg^{-1}\ BW\ day^{-1}$) | | Oral Mean Daily Intake ($\mu g\ day^{-1}$) | Inhalation Mean Daily Intake ($\mu g\ day^{-1}$) | Air-water partition coefficient ($K_{aw}$) ($cm^3\ cm^{-3}$) | Coefficient of Diffusion in Air ($m^2\ s^{-1}$) | Coefficient of Diffusion in Water ($m^2\ s^{-1}$) | log $K_{oc}$ ($cm^3\ g^{-1}$) | log $K_{ow}$ (dimensionless) | Dermal Absorption Fraction (dimensionless) | Soil-to-dust transport factor ($g\ g^{-1}$ DW) | Sub-surface soil to indoor air correction factor (dimensionless) | Relative bioavailability via soil ingestion (unitless) | Relative bioavailability via dust inhalation (unitless) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Cadmium | TDI | 0.36 | TDI | 0.0014 | 13.4 | 0.02 | NR | NR | NR | NR | NR | 0.001 | 0.5 | 1 | 1 | 1 |
| 2 | Chromium III | TDI | 150 | TDI | 0.1 | 60.2 | 0.27 | NR | NR | NR | NR | NR | 0 | 0.5 | 1 | 1 | 1 |
| 3 | Chromium VI | TDI | 1 | ID | 0.0001 | 6.7 | NR | NR | NR | NR | NR | NR | 0 | 0.5 | 1 | 1 | 1 |
| 4 | Copper | TDI | 160 | TDI | 0.286 | 7000 | 0.68 | NR | NR | NR | NR | NR | 0 | 0.5 | 1 | 1 | 1 |
| 5 | Mercury, inorganic | TDI | 2 | TDI | 0.06 | 1 | 0 | NR | NR | NR | NR | NR | 0 | 0.5 | 1 | 1 | 1 |
| 6 | Nickel | TDI | 12 | TDI | 0.006 | 130 | 0.06 | NR | NR | NR | NR | NR | 0.005 | 0.5 | 1 | 1 | 1 |
| 7 | Zinc | TDI | 600 | TDI | 600 | 27000 | 2.4 | NR | NR | NR | NR | NR | 0 | 0.5 | 1 | 1 | 1 |
| 8 | Arsenic | ID | 0.3 | ID | 0.002 | NR | NR | NR | NR | NR | NR | NR | 0.03 | 0.5 | 1 | 1 | 1 |
| 9 | Boron | TDI | 160 | TDI | 2.9 | 3700 | 0.398 | NR | NR | NR | NR | NR | 0 | 0.5 | 1 | 1 | 1 |
| 10 | Selenium | TDI | 6.4 | NR | 0 | 35 | 0.06 | NR | NR | NR | NR | NR | 0 | 0.5 | 1 | 1 | 1 |
| 11 | Cyanide | TDI | 12 | TDI | 0.9 | 300 | 0.06 | NR | NR | NR | NR | NR | 0.1 | 0.5 | 1 | 1 | 1 |
| 12 | Phenol | TDI | 700 | TDI | 10 | 350 | 40 | 8.35E-06 | 7.90E-06 | 6.36E-10 | 1.92 | 1.48 | 0.3 | 0.5 | 1 | 1 | 1 |
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Environment Agency

| | Oral Health Criteria Value (µg $kg^{-1}$ BW $day^{-1}$) | | Inhalation Health Criteria Value (µg $kg^{-1}$ BW $day^{-1}$) | | Oral Mean Daily Intake (µg $day^{-1}$) | Inhalation Mean Daily Intake (µg $day^{-1}$) | Air-water partition coefficient ($K_{aw}$) ($cm^3$ $cm^{-3}$) | Coefficient of Diffusion in Air ($m^2$ $s^{-1}$) | Coefficient of Diffusion in Water ($m^2$ $s^{-1}$) | log $K_{oc}$ ($cm^3$ $g^{-1}$) | log $K_{ow}$ (dimensionless) | Dermal Absorption Fraction (dimensionless) | Soil-to-dust transport factor (g $g^{-1}$ DW) | Sub-surface soil to indoor air correction factor (dimensionless) | Relative bioavailability via soil ingestion (unitless) | Relative bioavailability via dust inhalation (unitless) |
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Environment Agency

| | | Soil-to-water partition coefficient ($cm^3 g^{-1}$) | Vapour pressure (Pa) | Water solubility (mg $L^{-1}$) | Soil-to-plant concentration factor for green vegetables (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) | Soil-to-plant concentration factor for root vegetables (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) | Soil-to-plant concentration factor for tuber vegetables (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) | Soil-to-plant concentration factor for herbaceous fruit (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) | Soil-to-plant concentration factor for shrub fruit (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) | Soil-to-plant concentration factor for tree fruit (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Cadmium | 1.00E+02 | NR | 1.62E+06 | 0.052 fw | 0.029 fw | 0.031 fw | 0.016 fw | 0.0031 fw | 0.0014 fw |
| 2 | Chromium III | 4.80E+03 | NR | 5.85E+05 | 0.00003 fw | 0.00003 fw | 0.00003 fw | 0.00003 fw | 0.00003 fw | 0.00003 fw |
| 3 | Chromium VI | 1.80E+01 | NR | 2.30E+06 | 0.0002 fw | 0.0001 fw | 0.0001 fw | 0.09 fw | 0.0003 fw | 0.09 fw |
| 4 | Copper | 1.00E+02 | NR | 1.38E+06 | 0.0206 fw | 0.0206 fw | 0.0206 fw | 0.0206 fw | 0.0206 fw | 0.0206 fw |
| 5 | Mercury, inorganic | 5.00E+02 | NR | 7.40E+04 | 0.0038 fw | 0.0069 fw | 0.0043 fw | 0.001 fw | 0.0011 fw | 0.001 fw |
| 6 | Nickel | 5.00E+02 | NR | 2.50E+06 | 0.0038 fw | 0.0043 fw | 0.0019 fw | 0.0025 fw | 0.0025 fw | 0.0034 fw |
| 7 | Zinc | 3.80E+01 | NR | 4.32E+06 | 0.054 fw | 0.054 fw | 0.054 fw | 0.143 fw | 0.054 fw | 0.054 fw |
| 8 | Arsenic | 5.00E+02 | NR | 1.25E+06 | 0.00043 fw | 0.0004 fw | 0.00023 fw | 0.00033 fw | 0.0002 fw | 0.0011 fw |
| 9 | Boron | 1.00E+01 | NR | 6.35E+04 | 0.4 fw | 0.2 fw | 0.2 fw | 0.2 fw | 0.2 fw | 0.2 fw |
| 10 | Selenium | 5.00E+01 | NR | 2.17E+06 | 0.0108 fw | 0.00364 fw | 0.00083 fw | 0.00271 fw | 0.003 fw | 0.003 fw |
| 11 | Cyanide | 1.00E-01 | NR | 1.00E+05 | model | model | model | model | model | model |
| 12 | Phenol | 9.17E-01 | 1.15E+01 | 8.41E+04 | model | model | model | 0.00E+00 | 0.00E+00 | model |
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Environment Agency

| | Soil-to-water partition coefficient ($cm^3 g^{-1}$) | Vapour pressure (Pa) | Water solubility ($mg L^{-1}$) | Soil-to-plant concentration factor for green vegetables (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) | Soil-to-plant concentration factor for root vegetables (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) | Soil-to-plant concentration factor for tuber vegetables (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) | Soil-to-plant concentration factor for herbaceous fruit (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) | Soil-to-plant concentration factor for shrub fruit (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) | Soil-to-plant concentration factor for tree fruit (mg $g^{-1}$ plant DW or FW basis over mg $g^{-1}$ DW soil) |
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# APPENDIX E:
# Gas & Groundwater Monitoring Results

SOLMEK

12 Yarm Road
Stockton on Tees
Cleveland
TS18 3NA
Tel 01642 607 083 fax. 01642 612 355
Email: south@solmek.com
**www.solmek.com**

| | | |
|---|---|---|
| TEST | : | GAS SURVEY |
| CONDITIONS | : | WEATHER – CLEAR, SUNNY<br>GROUND – DRY |
| ATMOSPHERIC PRESSURE | : | 1026mb |
| REGIONAL TREND | : | FALLING |
| CLIENT | : | YORKSHIRE HOUSING LTD |
| LOCATION | : | NEW LODGE CRESCENT, BARNSLEY |
| DATE | : | 01/07/2011 |
| VISIT | : | 1 OF 3 |
| OPERATOR | : | TJ |
| EQUIPMENT | : | LAND SURVEYOR |

**RESULTS**

| Position | $CH_4$ | | $CO_2$ | | $O_2$ (%v/v) | VOC ppm | Flow Litres/hr | Groundwater level (mbgl) |
|---|---|---|---|---|---|---|---|---|
| | (%v/v) | GSV (l/hr) | (%v/v) | GSV (l/hr) | | | | |
| BH1 | ND | 0.0 | 1.2 | 0.0012 | 19.9 | * | ND | DRY |
| BH3 | ND | 0.0 | 1.2 | 0.0012 | 20.0 | * | ND | DRY |
| BH4 | ND | 0.0 | 0.0 | 0.0 | 20.7 | * | ND | DRY |
| BH7 | ND | 0.0 | 0.0 | 0.0 | 20.7 | * | ND | DRY |

## KEY

**$CH_4$** = Methane, **$CO_2$** = Carbon Dioxide, **$O_2$** = Oxygen, **GSV** = Gas Screening Value

**ND** = Not Detected, * = not measured, **N/A** = Not applicable, **%** = By volume, **mbgl** = m below ground level, **VOC** = Volatile Organic Compounds (measured using a PID meter)

SOLMEK

12 Yarm Road
Stockton on Tees
Cleveland
TS18 3NA
Tel 01642 607 083 fax. 01642 612 355
Email: south@solmek.com
**www.solmek.com**

TEST : GAS SURVEY

CONDITIONS : WEATHER – CLEAR, SUNNY
GROUND – DRY

ATMOSPHERIC PRESSURE : 1013mb

REGIONAL TREND : FALLING

CLIENT : YORKSHIRE HOUSING LTD

LOCATION : NEW LODGE CRESCENT, BARNSLEY

DATE : 27/07/2011

VISIT : 2 OF 3

OPERATOR : PF

EQUIPMENT : GA2000

**RESULTS**

| Position | $CH_4$ | | $CO_2$ | | $O_2$ (%v/v) | VOC ppm | Flow Litres/hr | Groundwater level (mbgl) |
|---|---|---|---|---|---|---|---|---|
| | (%v/v) | GSV (l/hr) | (%v/v) | GSV (l/hr) | | | | |
| BH1 | ND | 0.0 | 0.8 | 0.0008 | 19.9 | * | ND | DRY |
| BH3 | ND | 0.0 | 0.8 | 0.0008 | 19.8 | * | ND | DRY |
| BH4 | ND | 0.0 | 0.0 | 0.0 | 20.4 | * | ND | DRY |
| BH7 | ND | 0.0 | 1.1 | 0.0 | 19.6 | * | ND | DRY |

## KEY

**$CH_4$** = Methane, **$CO_2$** = Carbon Dioxide, **$O_2$** = Oxygen, **GSV** = Gas Screening Value

**ND** = Not Detected, * = not measured, **N/A** = Not applicable, **%** = By volume, **mbgl** = m below ground level, **VOC** = Volatile Organic Compounds (measured using a PID meter)

SOLMEK

12 Yarm Road
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Cleveland
TS18 3NA
Tel 01642 607 083 fax. 01642 612 355
Email: south@solmek.com
**www.solmek.com**

TEST : GAS SURVEY

CONDITIONS : WEATHER – PARTLY CLOUDY, WARM
GROUND – DRY

ATMOSPHERIC PRESSURE : 1002mb

REGIONAL TREND : RISING

CLIENT : YORKSHIRE HOUSING LTD

LOCATION : NEW LODGE CRESCENT, BARNSLEY

DATE : 02/08/2011

VISIT : 3 OF 3

OPERATOR : TJ

EQUIPMENT : GA2000

RESULTS

| Position | $CH_4$ | | $CO_2$ | | $O_2$ (%v/v) | VOC ppm | Flow Litres/hr | Groundwater level (mbgl) |
|---|---|---|---|---|---|---|---|---|
| | (%v/v) | GSV (l/hr) | (%v/v) | GSV (l/hr) | | | | |
| BH1 | ND | 0.0 | 0.9 | 0.0009 | 19.6 | * | ND | DRY |
| BH3 | ND | 0.0 | 0.9 | 0.0009 | 19.5 | * | ND | DRY |
| BH4 | ND | 0.0 | 0.1 | 0.0001 | 20.2 | * | ND | DRY |
| BH7 | ND | 0.0 | 1.3 | 0.0013 | 19.1 | * | ND | DRY |

## KEY

**$CH_4$** = Methane, **$CO_2$** = Carbon Dioxide, **$O_2$** = Oxygen, **GSV** = Gas Screening Value

**ND** = Not Detected, * = not measured, **N/A** = Not applicable, **%** = By volume, **mbgl** = m below ground level, **VOC** = Volatile Organic Compounds (measured using a PID meter)

# APPENDIX F:
# Notes on Limitations & Contamination Guidance

## Solmek conditions of offer, notes on limitations & basis for contract (ref: version1/2011)

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 invoiced) 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 of 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.

# SOLMEK NOTES ON CONTAMINATION GUIDANCE(REF: VERSION 1/2011)

## 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 relavent **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 volatised 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 Guidelines 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:

<table>
<tr><th>Land Use</th><th>Receptor</th><th>Building</th><th>Soil Type</th><th>pH and SOM</th></tr>
<tr><td>Residential with Homegrown Produce</td><td>Female (Age Class 1-6: Young Child)</td><td rowspan="2">Bungalow<br>Small Terraced House<br>Medium/large Terraced House<br>Semi-detached House<br>Detached House</td><td rowspan="6">Clay<br>Silty Clay<br>Silty Clay Loam<br>Clay Loam<br>Sandy Lam<br>Loam<br>Silty Loam<br>Sandy Loam<br>Sandy Loam<br>Sand</td><td rowspan="6">pH and SOM content values as presented from testing.</td></tr>
<tr><td>Residential without Homegrown Produce</td><td>Female (Age Class 1-6: Young Child)</td></tr>
<tr><td>Allotments</td><td rowspan="3">Female (Age class 1-6: Young Child)</td><td rowspan="3">Assumes None</td></tr>
<tr><td>Parks</td></tr>
<tr><td>Open spaces</td></tr>
<tr><td>Playing fields</td><td>Female (Age class 4-11: Child)</td></tr>
<tr><td>Commercial</td><td>Female (Age Class 17-17: Working Adult)</td><td>Warehouse (pre 1970)<br>Warehouse (post 1970)<br>Office (pre 1970)<br>Office (post 1970)</td></tr>
<tr><td colspan="5">DERIVATION OF SOLMEK GAC THRESHOLD VALUES</td></tr>
</table>

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.

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.

## Gas Protection Measures - Residential Development

| Characteristic Situation | Membrane | Floor Slab | Sub-floor ventilation | External ventilation | Additional measures to reduce gas concentrations in the ground |
|---|---|---|---|---|---|
| 1 | No special precautions | | | | |
| 2 (equivalent to basic radon) | Waterproof DPM (see note below) | well constructed suspended floor or raft foundation<br>well constructed suspended floor or raft foundation | Beam & block floors: **open void** min. 150mm depth<br><br>Suspended in-situ concrete floors: **proprietary void former**:<br>• expanded polystyrene shuttering with equivalent clear void depth of 22mm *or*<br>• geocomposite drainage blanket<br><br>or 20mm single size gravel blanket (min. 300mm thick)<br><br>Rafts: **granular blanket** min. 300mm thick (not suitable on sites with high water table) | Area of side ventilation >2,000 $mm^2$/m run of wall<br>Vents on at least 2 opposite sides of ventilation layer (usually via air bricks)<br>Area of side ventilation >2,000 $mm^2$/m run of wall<br>Vents on at least 2 opposite sides of ventilation layer (usually via air bricks) | None required |
| 3 (equivalent to full radon) | Gas resistant membrane (basic) | | | | None required |
| 4 | Gas resistant membrane (with aluminium foil) | well constructed suspended floor (raft foundation unsuitable)<br>well constructed suspended floor (raft foundation unsuitable) | Beam & block floors: **open void** min. 150mm depth<br><br>Suspended in-situ concrete floors: **proprietary void former**:<br>• expanded polystyrene shuttering with equivalent clear void depth of 22mm (structures <7.5m wide only) *or*<br>• expanded polystyrene shuttering with equivalent clear void depth of 100mm (structures >7.5m wide) *or*<br>• geocomposite drainage blanket (structures <7.5m wide only) | Area of side ventilation >4500 $mm^2$/m run of wall<br>Vents on at least 2 opposite sides of ventilation layer (usually via air bricks)<br>Design of ventilation layer should be checked by calculation.<br>Area of side ventilation >4500 $mm^2$/m run of wall<br>Vents on at least 2 opposite sides of ventilation layer (usually via air bricks) | In-ground barrier / in ground venting layer / trenches / wells (see CIRIA 149) |
| 5 | | | Beam & block floors with **open void** min. 150mm depth | | In-ground barrier / in ground venting layer / trenches / wells (see CIRIA 149).<br>**Probabilistic QRA required.** |

Note: DPM should be 2000 g where beam & block floors are used; 1200 g is suitable for cast *in situ* floor slabs