09/5514

GEOENVIRONMENTAL SITE INVESTIGATION FOR SITE AT ST MICHAELS SCHOOL BARNSLEY

FOR

BARNSLEY MBC

JULY 2009

CC GEOTECHNICAL

CC Geotechnical

Consulting Geotechnical & Geoenvironmental Engineers

Essex House, Bridle Road, BOOTLE, Merseyside. L30 4UE.

Telephone: (0151) 523 0202 **Fax: (0151) 523 0252**

CC Geotechnical

Document Control Form

Client:	Barnsley MBC
Project Title:	Geoenvironmental site investigation at St Michaels school Barnsley
Reference Number:	09/5514
Main Author:	Carl Highton BSc (Hons)
Signature:	
Reviewed by:	Chris Bolan CEng MICE CEnv
Signature:	
Approved for Issue by:	Chris Bolan CEng MICE CEnv
Signature	

For and behalf of CC GEOTECHNICAL LTD

Date:	July 2009
Revision Number:	0
Comments:	
Status:	
Distribution:	Barnsley MBC

This document has been prepared by ***CC GEOTECHNICAL LTD*** within the terms of the Contract, scope of work, and resources agreed in writing with the client.

This document is intended for the sole use of the client indicated above and ***CC GEOTECHNICAL LTD*** *accepts no responsibility of whatever* nature to third parties to whom this document or any part of this document is made known. Any such party relies upon that information at their own risk.

Additional information, improved practices, new guidance, changes in legislation or provision of detailed layout design proposals will necessitate this report having to be reviewed in whole or in part after that date.

The findings and opinions provided in this document are made in good faith and are subject to the limitations imposed by employing site assessment methods and techniques, appropriate to the time of investigation and within the limitations and constraints defined in this document. The findings and opinions are relevant to the dates when the assessment was undertaken, but should not necessarily be relied upon to represent conditions at a substantially later date. In particular, seasonal groundwater levels, with the effects of precipitation, may affect the conditions found during the investigation.

Factual data has largely been obtained from enquiries with third parties, the results of which are relied on unless indicated to be inaccurate by contradictory information. Further assessment, investigation, construction activities, could not have been taken into account in the preparation of the report. Where such information might impact upon stated opinions, ***CC GEOTECHNICAL LTD*** reserve the right to modify such opinions expressed herein.

The findings and opinions conveyed, via this report, are based on information obtained from a variety of sources as detailed in this report, and which ***CC GEOTECHNICAL LTD*** assumes to be reliable, but has not been independently confirmed. Therefore ***CC GEOTECHNICAL LTD*** cannot and does not guarantee the authenticity or reliability of third party information it has relied upon.

Where opinions expressed in this report are based on current available guidance and legislation, no liability can be accepted by ***CC GEOTECHNICAL LTD*** for the effects of any future changes to such guidelines and legislation.

The limitations of liability of ***CC GEOTECHNICAL LTD*** for the contents of this document have been agreed with the Client, as set out in the terms and conditions of offer and related contract documentation.

CC GEOTECHNICAL LTD possess a non-exclusive and non-transferable Ordnance Survey Licence, but do not possess any right to sub-license any of the rights granted by this licence to any party. Under the terms of ***CC GEOTECHNICAL LTD*** Ordnance Survey Licence, copying of figures containing Ordnance Survey data or using figures for any purpose other than as part of this report is not permitted.

1.0 INTRODUCTION

1.1 Background Information

CC GEOTECHNICAL LTD is providing consultancy services to Barnsley MBC, in connection with the proposed redevelopment at St Michaels School, Barnsley.

It is proposed that the site be redeveloped by the demolition of St Michael's and St Dominic's schools on Carlton Road, Barnsley. These schools will be replaced by a new Advanced Learning Centre with associated car parking areas, sports pitches, and landscaped areas. The new ALC building will be on an area to the north of the demolished schools on land that formerly formed part of the Edward Sheering School.

The proposed area of development was extensively investigated in 2006, the investigation reported under ***CC GEOTECHNICAL LTD*** Report No 3908/2. A further stage of intrusive investigation was required on an area not investigated in the 2006 investigation.

This report summarises the findings of the additional investigation and has been devised to generally comply with the relevant principles and requirements of a wide range of guidance including BS5930:1999 as amended 2007 Code of Practice for Site Investigations, BS10175:2001 Investigation of Potentially Contaminated Sites - Code of Practice, and the DEFRA/Environment Agency Report CLR11 Model Procedures for the Management of Land Contamination.

The report should be read in conjunction with the Notes on Limitations presented in Appendix A.

1.2 Purpose and Aims of Intrusive Investigation

The primary purposes of the Phase 2 Intrusive Investigation were:

- To undertake an intrusive investigation with associated sampling and testing for potential contaminants in the area of redevelopment
- To carry out a qualitative / semi quantitative contamination risk assessment to identify and potential risks to human or environmental receptors
- To undertake landfill gas monitoring and prepare a gas risk assessment
- To prepare a conceptual model according to the findings of the intrusive investigation
- To identify feasible remediation measures (if any) to develop the site for its intended

use as school

2.0 SITE DATA

2.1 Site Location

The site is located off Carlton Road, Barnsley, approximately 3km north of Barnsley centre, as shown on Drawing 5514/1 and Plate 5514/2.

The National Grid reference for the approximate site centre is 436040E, 409090N

The property/site is located within the administrative jurisdiction of Barnsley Metropolitan Borough Council.

2.2 Site Description Reconnaissance Visit

A walkover survey was undertaken in May 2009 on completion of a review of relevant historical and environmental data. The information obtained from the walkover is summarised in Table 1 hereunder:

Table 1: Summary of Walkover Survey

SUBJECT MATTER		OBSERVATION
Current use and site context		Two primary schools with shared playing areas
Site surface		Hardstanding and grassed areas
Site access		No access issues found.
Current building layout & other structures		Three main buildings present surrounding a concrete
Storage tanks		None visible
What defines the *boundaries of the* site?	North	Edward Sheering secondary school
	East	*Edward Sheering secondary school playing fields*
	South	Playing Fields
	West	Houses
Evidence of potential on site contamination		None

Photographs of the site are presented in Appendix B.

3.0 ENVIRONMENTAL SETTING

3.1 Phase I Data Summary

The environmental background data (geology, hydrology, hydrogeology etc) in the previous *reports are summarised hereunder. The information in the following table represents the* base data used to formulate the conceptual ground model.

Table 2: Summary of environmental and geological data

Data Type	Data Source	Data Summary
Geology	BGS Solid and Drift map of Barnsley Sheet 87	The maps indicate that the solid geology is Middle Coal Meaures of Upper carboniferous age. There is no drift geology identified on the Map
Site History	Previous reports on immediately surrounding area of site	The earliest maps available show the site to be agricultural fields with isolated farms and dwellings. The settlements of Carlton and Monk Bretton are shown approximately 1km north and south respectively. There is an area of woodland (Spring Wood) some 300m to the south, a small gravel pit. An old sandstone quarry to the south (800m). The land use changed little prior to 1974. However, the surrounding land use changed more rapidly with the introduction of Wharncliffe Woodmoor Colliery, associated railways and a small school to the north and carlton reservoir to the west as shown on the 1984 OS map. Between 1966 and 1974 St Michaels and St Helens (now known as Edward Sheering) schools were constructed, together with surrounding playing fields. Warehouses were built to the east of the site together with the closure of Wharncliffe Woodmoor Colliery and dismantling of its associated railways. Houses were built alongside the western site boundary on Carlton road and Carlton Industrial Estate developed to the east of the site prior to 1984 continually expanding until the most recent maps published.
Site Walkover	Site walkover	The site currently comprises of St Michaels School and St Dominic's school. The Edward Sheering school is located adjacent to the north.
Mining & Quarrying	SYMAS Report	Records indicate that the area lies mainly on Wooley Edge Rock Sandstone of the middle coal measures, which may be fissured both naturally and mining induced. The major St.Helen's Geological Fault (approximate downthrow of 30m to the south-east) crosses the playing fields to the south east. The south of this area lies shales and mudstones. There are two areas of fill to the south of the site these may have been formed during cut and operations when the site was developed. Mining operations have taken place beneath this area in nine coal seams at depths ranging between 70m and 380m. The latest being in the Kents Thick Seam (Depth 125m, thickness 915mm) in 1959. All subsidence movement from these workings will have ceasedsome 45 years ago as the site now lies remote from the active coalfield it will not be affected in the future. The Relevant OS maps show the area to be open land with no former industrial land uses affecting the area.
	Previous Reports	The published geological map covering the Site BGS Sheet 87 shows the site located on Middle coal measures of Upper Carboniferous age. No drift deposits are shown other than a small area to the north of glacially derived sand and gravels. Superficial deposits would be expected to be thin, consisting in situ weathered material.
	Previous reports Coal Authority Mining Report	The Coal Authority mining report states that the site is within the likely zone of influence on the surface from workings in nine seams of coal between depths of 50 to 400m, the last date of working being 1958. It also states that ground movement from these workings should now have ceased. The site is not within the zone of likely physical influence on the surface from present underground coal workings and is not within a geographical area for which a licence to extract coal by underground methods is pending or has been granted. The site is in an area where reserves of coal exist which could be worked at some time in the future subject to appropriate licences. The report also states that their records show no mine entries on site, or within 20m of, the boundary of the property. No records of subsidence within the property are held.
Contamination status	Previous SI for area surrounding the site	The soils surrounding the site appear to be generally clean, however there was a hotspot of contamination of Benzo(a)Pyrene around TP6. However these were not considered high enough to warrant remediation.
Radon Potential	Building Research Establishment, 2007, BR211 ' Radon: Guidance on protective measures for new dwellings'	The property is not in a Radon Affected area, as less than 1% of the properties are above the action level. No radon protective measures are necessary.

3.4 Additional Hydrogeological, Hydrological and Flooding Information

Further information linked to regional hydrology obtained from the desk study report and the environment agency website is presented in Appendix C, and summarised hereunder:

Table 3: Summary of Hydrology, Hydrogeology and Flooding Data from EA Website

HYDROLOGY & HYDROGEOLOGY DATA	
Water abstractions	Eight within 2km, the closest 1120m SE concerned with abstraction of water for cooling.
Discharge consents within 1km	Five. The closest is 125m North concerned with sewage and storm effluent discharge
Nearest surface water feature	Less than 250m away
Pollution incidents to controlled waters	Twenty two incidents within 2km of the site. The closest 201m SE minor incident –unknown oils. Others occurred between 251m to 2km 62% minor and 38% significant incidents.
Source Protection Zones	The site is not located in an Groundwater Source Protection Zone.

FLOODING DATA	
Environment Agency indicative Zone 2 floodplains	*None within 250m*
Environment Agency indicative Zone 3 floodplains	None within 250m

The geological succession underlying the site may be regarded as a series of discrete units in terms of their hydrogeological significance, as illustrated hereunder:

Table 4: Hydrogeological Interpretation

UNIT	PROPERTIES	HYDROGEOLOGICAL DESIGNATION
Made Ground	Likely to be generally granular and permeable and will permit vertical and lateral transmission of groundwater. Where underlain by an aquiclude perched groundwater may be present in depressions at the interface	N/A
Middle Coal Measures	Locally important source of water, and important for the recharge for rivers. Variably permeable, these can be fractured or potentially fractured rocks, which do not have a high primary permeability, or other formations of variable permeability including unconsolidated deposits. Though not producing large quantities of water for abstraction	Minor Aquifer

4.0 SUMMARY OF 2006 DESK STUDY FINDINGS

The desk study forming part of the 2006 study, identified a number of potentially contaminative land uses within 250m of the site, and/or natural geological sources of contamination, and a number of plausible pollution linkages, as summarised hereunder.

Table 5: Summary of Potential Contaminants of Concern

Source	Location	Metals	Non Metals	Organics	Gases	Others
Made Ground	On site	Ba, Be, Cd, Cr, Cu, Pb, Hg, Ni, V, Zn	As, B, Se, S°, CN^-, SO_4^{2-}. SO_3^{2-}	Hydrocarbons PAH's	CO_2 H_2S CH_4 CO	Asbestos Acidic/alkaline soils
Summary Suite		*Ba, Be, Cd, Cr, Cu,* Pb, Hg, Ni, V, Zn	*As, B, Se, S°,* CN^-, SO_4^{2-}. SO_3^{2-}	*Hydrocarbons* PAH's	CO_2 H_2S CH_4 CO	*Asbestos* Acidic/alkaline soils

Table 6: Plausible Pollution Linkages

Source	Receptor	Pathway
Made Ground	Construction workers	Ingestion of soil / soil dust Inhalation of soil dust Dermal contact with soil / soil dust Indoor and outdoor inhalation of soil / groundwater vapours Indoor inhalation of ground gases Explosion of gas/air mixtures
	Workers / pupils within the completed facility	Ingestion of soil / soil dust Inhalation of soil dust Dermal contact with soil / soil dust Indoor and outdoor inhalation of soil / groundwater vapours Indoor inhalation of ground gases Explosion of gas/air mixtures
	Controlled waters – perched groundwater / deep groundwater	Dissolution of soluble contamination in rainwater infiltration and vertical (downward) migration
	Building structure and services	Direct contact between soil / perched water / groundwater and buildings materials and services

On the basis of the foregoing an intrusive investigation was undertaken.

5.0 FIELDWORK

The fieldwork intrusive investigation was undertaken in May 2009. The scope of the fieldwork comprised:

- The drilling of nine dynamic sampling boreholes
- The performance of appropriate insitu testing
- The installation of standpipes.
- The performance of falling head tests in three of the boreholes.
- The determination of CBR values using dynamic cone penetrometer equipment.

The layout of the investigation is illustrated on Drawing 5514/3.

The fieldwork was planned in accordance with BS10175: 2001, and carried out in accordance with BS10175: 2001 and BS5930: 1999, and the sampling and monitoring protocols employed by ***CC GEOTECHNICAL LTD*** *as presented in Appendix D, insofar as they related* to the scope of the investigation.

5.1 Dynamic Sampling Boreholes

Nine boreholes were drilled by light dynamic methods using a Dando Terrier dynamic sampling rig on the area of the playing field.

In this method of investigation, samples of subsoils are recovered by driving and extracting a series of reducing diameter 1m long steel tubes. The method recovers relatively "undisturbed" soil profiles in Perspex tubes, which are used to line the steel tubes. The Perspex liners are removed from the steel tube, and split and logged on site. The exposures are scanned by a PID. Subsamples are removed at appropriate positions from the profile, and transferred to chilled amber glass jars. Counterparts of the subsamples are subjected to headspace analyses.

In this investigation Standard Penetration Tests were carried out at 1m centres throughout the borehole depths.

The logs of the dynamic sampling boreholes, annotated with subsampling details and `N`

values are given in Appendix E.

5.4 Monitoring Installations

Standpipes comprising 50mm diameter HDPE plain and slotted welltube were installed in three of the boreholes. The standpipes were fitted with gas valve connections, and were protected by flush covers set in concrete. Standpipe details are included on the borehole logs in Appendix E.

The standpipes were periodically monitored for flow rate and composition of ground gas using a Geotechnical Instruments GA 2000 infra red analyser. The standpipes were also monitored for standing water levels with an electronic dipmeter.

The results of the gas and groundwater monitoring and calibration certificates for the equipment used are given in Appendix G.

5.6 CBR Determination by Dynamic Cone Penetrometer

Four CBR tests were performed using the dynamic cone penetrometer (DCP method) in the school playing fields. This method of determination involves the driving of a 1m steel rod carrying a hardened steel 60° cone at its base, into the ground with an 8kg trip hammer. The tests were performed at ten locations across the site. The results of the tests are presented in Appendix F.

5.7 Falling Head Permeability Tests

Falling head permeability tests were performed in boreholes WS3, WS6 and WS8, in accordance with the methodology given in BS5930: Section 4. The results are presented in Appendix H.

6.0 OBSERVED STRATIGRAPHY

The geology encountered during the fieldwork was generally consistent with the documented geology. The observed succession may be generalised as hereunder:

Table 7: Summary of Strata Encountered

DESCRIPTION	OBSERVATIONS / TYPICAL BASE DEPTH
Grassed Topsoil/Asphalt	0.30
Made Ground in some locations	0.55mbgl
Weathered Sandstone becoming fresher with depth	Base not proven.

7.0 LABORATORY TESTING

7.1 Soil Engineering Testing

Particle size analyses by wet sieving were carried out on selected samples in accordance with BS 1377: Part 2: 1990

The soil engineering test results are presented in Appendix J.

7.2 Chemical Laboratory Testing

A programme of chemical analyses was undertaken on samples recovered from the investigation. The programme comprised of the following:

- Five subsamples of soil were analysed to a broad range of contaminants
- Leachate samples were prepared from three soil samples and the elute analysed for a broad range of contaminants

The soil and leachate contamination test results are presented in Appendix K.

8.0 GENERIC QUANTITATIVE (TIER 2) HUMAN HEALTH RISK ASSESSMENT

8.1 Introduction

The assessment of the contamination data was carried out in accordance with the guidance presented in CLR11 and other current guidance and legislation (Appendix L).

Current methods of risk assessment of soil contamination data are based on comparisons with assessment criteria for various proposed land uses, although specific criteria for school sites is not available. To provide a conservative assessment, the Human Health Risk Assessment was carried out in accordance with the methodology for assessing soil samples based on a 'Residential without Plant Uptake' scenario. Since only five samples were analysed, statistical analyses of the data were considered inappropriate, and the results were individually assessed against the threshold criteria. A summary of the assessments of the contamination test data is presented in Appendix M, and discussed hereunder:

8.2 Assessment of Metal Data

None of five samples tested exhibited concentrations above the screening criteria

8.3 Assessment of Non-Metal Data

None of five samples tested exhibited concentrations above the screening criteria.

8.4 Assessment of Polycyclic Aromatic Hydrocarbon Data

None of five samples tested exhibited concentrations above the screening criteria

8.5 Assessment of Hydrocarbon Data

None of five samples tested exhibited concentrations above the screening criteria

8.6 Assessment of Asbestos Results

Asbestos was not detected in any of the five samples analysed.

8.7 Summary Human Health Assessment

Based on the foregoing assessment, no risk to human health will arise from exposure to the soils on this site. In terms of soil chemistry, the site soils are suitable for re-use in earthworks forming part of the development.

9.0 ASSESSMENT OF RISKS TO CONTROLLED WATERS

Risks to controlled waters (groundwater and surface water) were assessed by comparison of the results of soil leachate analyses with criteria for Drinking Water and Environmental Quality Standards. The determinants for which measurable concentrations were recorded are presented hereunder:

Table 9: Assessment of Soil Water Results

Contaminant	Highest level (µg)	Drinking Water Standard (µg)	Environmental Quality Standard
Arsenic	31	**10**	**50**
Lead	47	**25**	**20**
Copper	14	2,000	**5**
Zinc	29	N/A	300
Boron	47	1,000	1,000
Vanadium	6	N/A	20
Barium	78	1000	N/A
Sulphate	6,000	250,000	N/A
Nitrate	6,000	50,000	N/A

It can be seen that leachable Arsenic levels are above the Drinking Water Standard but not the Environmental Quality Standard. Leachable Lead and Copper levels in the made ground exceed the Environmental Quality Standards. Since the site lies over a minor aquifer, and it is not located in a Groundwater Protection Zone, these results are unlikely to indicate a risk

to the wider aquatic environment from this result. However, it is recommended that any soakaways constructed as part of the development use clean imported granular fill as the drainage media.

10.0 ASSESSMENT OF RISKS TO THE BUILT ENVIRONMENT

10.1 Water Supply Mains

Based on the criteria specified in Paper 9-04-03: Oct 2002 published by the Water Regulations Advisory Scheme for pipe materials selection, the soil analyses indicate that the soils are impacted by a range of contaminants at above the permitted threshold as shown in Appendix M.

In this circumstance, the guidance permits the adoption of normal alkathene mains laid in a remediated alignment comprising of clean granular fill extending to 1m + pipe diameter and to 300mm below pipe underside.

10.2 Buried Concrete

The risk of deterioration of buried concrete was assessed by comparison of soil data presented in Appendix M against the guidance given in BRE Special Digest 1: 2005, as summarised hereunder:

Table 10: Design Chemical Class Based on Soil and Soil Water Data

CONCRETE SPECIFICATION DATA SHEET		
Is the site brownfield or greenfield?		Brownfield
Is the water table static or mobile?		Static
Highest water soluble Sulphate result	154mg/l on soil:water extract	Design Sulphate Class of DS-1 and ACEC Class of AC-1s
Lowest pH result	7.3	
Intended Working Life	50 years	**Adopt Design Chemical Classification of DC-1**

On the basis of the foregoing assessments, concrete in the ground should be specified to conform to the compositional requirements of Design Chemical Class DC 1, as defined in BRE Special Digest 1: 2005.

10.0 FALLING HEAD PERMEABILITY TESTS

Three borehole permeability tests were performed in WS3, WS6 and WS8. The tests were carried out with the borehole casing inserted into the head of the sandstone bedrock, and hence the tests were assessments of the sandstone permeability. The tests gave permeability (k) values (m/s) of 1.05E-3, 3.88E-6 and 4.35E-5 respectively. It is

recommended that soakaways in the sandstone bedrock be designed on a Soil Infiltration Rate of 1.0E-6m.sec^{-1}.

11.0 ASSESSMENT OF RISK FROM GROUND GAS

A soil gas risk assessment was undertaken in accordance with current UK guidance set out in CIRIA C665 2007 "Assessing Risks Posed by Hazardous Gases to Buildings". The CIRIA risk assessment methodology uses typical maximum soil gas concentrations and worst case borehole flow rates to define a "Characteristic Situation" for the shallow gas regime.

The volumetric gas flow rate used by the risk assessment is termed "Gas Screening Value (GSV)" in the guidance, and is defined by:
GSV (litres/hr) = borehole flow rate (litres/hr) x gas concentration (v/v).

There are two stages to the assessment method proposed in CIRIA C665; compliance with a GSV Threshold Value and secondly, compliance with any additional factors such as maximum permissible gas concentration.

A summary of the gas monitoring data is presented hereunder (the full set of results are presented in Appendix H).

Table 11: Summary of Gas Monitoring Data

Position	BH3	BH5	BH7
No Monitoring Visits	3	3	3
CH_4 (%)	NIL	NIL	NIL
CO2 (%)	0.3-0.9	0.5-0.7	0.3-0.5
O2 (%)	20.2-20.5	19.8-20.3	20.0-20.5
H_2S (ppm)	NIL	NIL	NIL
CO (ppm)	NIL	NIL	NIL
Flow (l/hr)	<0.1	<0.1	<0.1
Water Levels (mbgl)	1.00 - DRY	1.70 - DRY	1.60 - DRY
Pressure Range (mbar)	1007 - 1012	1007 - 1012	1007 - 1012

It can be seen that the maximum CO_2 reading obtained to date was 0.9%. No positive results were obtained for CH_4. The maximum borehole flow rate was <0.1l/hr.

Based on these results, a Gas Screening Value of 0.0009/hr is calculated for CO_2.

Using this GSV, the risk to the proposed development was assessed in line with Situation A as defined in CIRIA C665, and it was determined that the site complies with Characteristic Situation 1, a classification for which protective measures are not required.

This conclusion is based on 3 visits. A further 3 visits over 10 weeks are required to confirm the preliminary conclusions above.

13.0 REFINED CONCEPTUAL MODEL & REMEDIAL RECOMMENDATIONS

Based on the findings of the investigation, a conceptual model was constructed illustrating proven pollution linkages and refining the pre investigation model, and conceptual remediation recommendations proposed against each proven linkage, as tabulated hereunder.

Table 9: Conceptual Model

Source	Pathway	Receptor	Remedial Options
		WRAS ASSESSMENT	
Arsenic and pH levels above permitted WRAS thresholds	Dermal contact Accidental ingestion	Installation and maintenance workers	Adopt normal alkathene water mains to be laid in a clean remediated alignment comprising granular fill placed to 1m width and to 300mm below pipe underside

12.0 PREVENTION OF RISKS TO HUMAN HEALTH DURING THE CONSTRUCTION PHASE

During the construction works dust releases may present a risk to health of site workers and workers and pupils within the school campus. Appropriate controls for mitigation of dust releases, and other risks, must be implemented. Risks can be controlled to within acceptable limits by:

- Control of dust generation (see below)
- Use of suitable Personal Protective Equipment (PPE)
- Provision of adequate hygiene facilities for workers
- Prohibition of smoking and eating on site

Control of fugitive dust will be a priority to reduce the risk to on site construction workers and to workers and patients in close proximity to the site. As a minimum, it is anticipated the works will be undertaken in accordance with BRE best practice guidance, and that the following measures will be introduced to assist with control of dust generation:

- Access road and stockpiles should be regularly damped down with water
- Vehicles entering and leaving site should pass through a wheel wash
- Vehicles used to transport materials and aggregates should be enclosed or covered by tarpaulin
- Equipment generating dust should be located to minimise potential impacts to receptors as far as is practicable
- Minimising drop heights of all loading and unloading activities that involve the transfer of soils and demolition materials

It is recommended that the appointed Contractor consults with the Local Authority Air Quality Officer to determine whether a programme of dust monitoring is required for the duration of the works.

13.0 FOUNDATIONS AND FLOOR SLABS

Spread foundations (pad or strip) may be adopted for new buildings on this area. Foundations must be founded on the weathered sandstone at around 1.2-1.5mbgl, and may be designed on a Presumed Bearing Value of 250kN/m^2.

Ground bearing slabs may be adopted subject to satisfactory preparation of the subgrade. Minimum preparation requirements for ground bearing slabs are considered to be:

- Removal of all organic topsoil
- Reduction of site levels to 500mm below ffl
- Thorough compaction at reduced level
- Placement and compaction of 1 x 200mm durable, well graded granular fill (DTp Type 1 or equivalent)
- Construction of 1200 gauge dpm, insulation and slab

14.0 PAVEMENT DESIGN

The design of pavements should be based on a Design CBR value of 10%.

15.0 SUMMARY CONCLUSIONS & RECOMMENDATIONS

The conclusions and recommendations hereunder are based on the salient sections of the report and should not be referred to in isolation of the relevant sections of the text. All recommendations are subject to Regulatory Authority review.

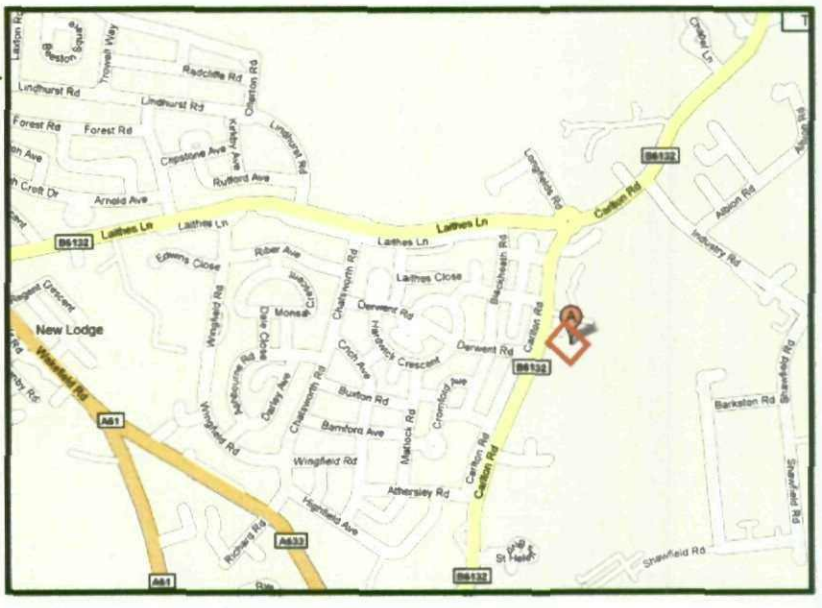
Table 10: Summary of Conclusions

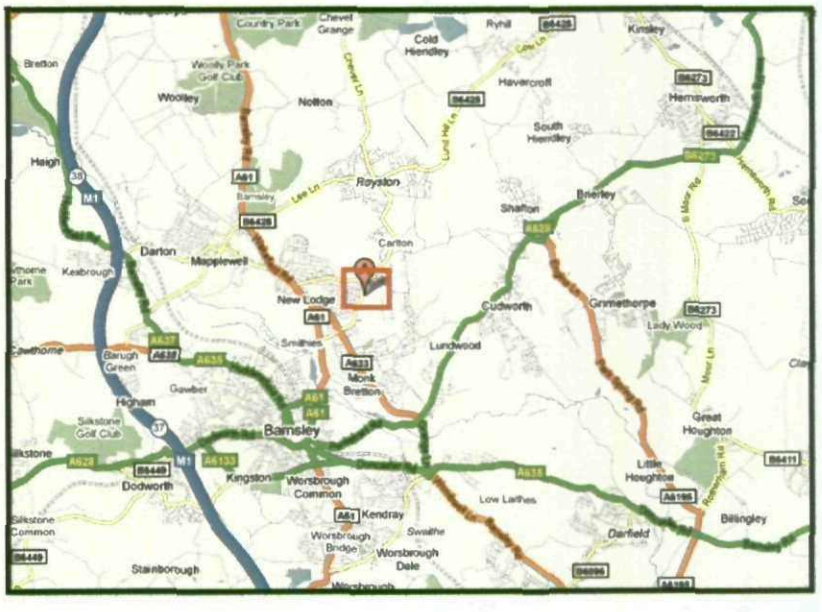
Foundations	Spread foundations (pad or strip) may be adopted for new buildings on this area. Foundations must be founded on the weathered sandstone at around 1.2-1.5mbgl, and may be designed on a Presumed Bearing Value of 250kN/m2.
Floor slabs	Ground bearing slabs may be adopted subject to satisfactory preparation of the subgrade. Minimum preparation requirements for ground bearing slabs are considered to be: • Removal of all organic topsoil • Reduction of site levels to 500mm below ffl • Thorough compaction at reduced level • Placement and compaction of 1 x 200mm durable, well graded granular fill (DTp Type 1 or equivalent) • Construction of 1200 gauge dpm, insulation and slab
Pavement Design	The design of pavements should be based on a Design CBR value of 10%.
Soakaway Drainage	It is recommended that soakaways be placed in sandstone bedrock designed on a Soil Infiltration Rate of 1.0E-6m.sec-1.
Contamination status of the soils	The site soils are not contaminated to a degree which would require remediation for the proposed end use.
Concrete specification	Concrete in the ground should be specified to conform to the compositional requirements of Design Chemical Class DC 1, as defined in BRE Special Digest 1: 2005.
Ground Gas Assessment	The risk to the proposed development has been assessed in line with Situation A as defined in CIRIA C665, and it can be seen that the site complies with Characteristic Situation 1. Therefore no protective measures are required. This is a preliminary assessment based on 3 visits a further three visits is required to confirm this assessment.
Environmental Risk	There is negligible risk to the wider aquatic environment from the soils on the site.
Further work	A further 3 visits over 10 weeks are required to confirm the preliminary conclusions of the gas risk assessment

DRAWINGS

CC Geotechnical

N

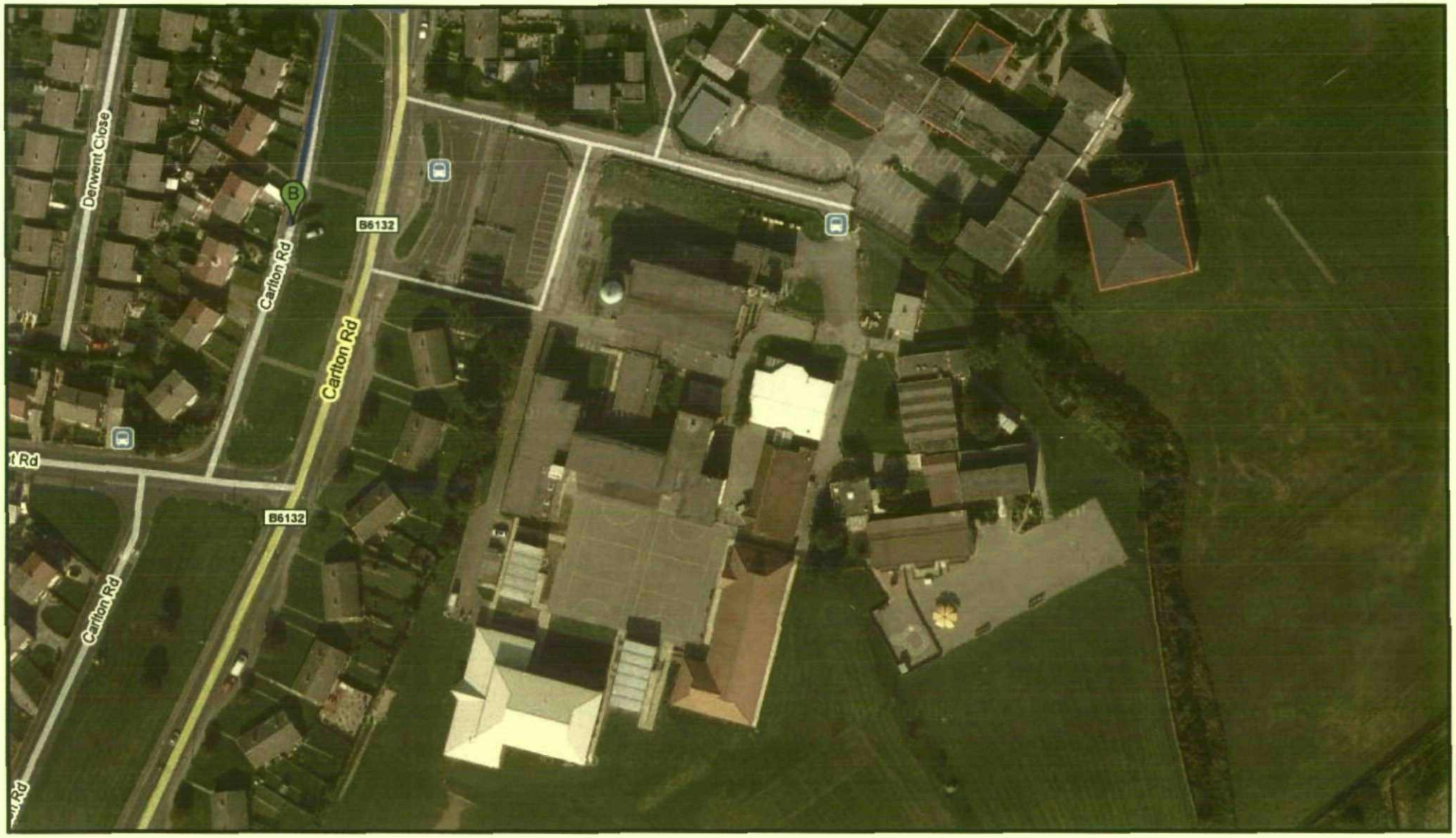




Drawing Number:	08/5514
Site Location:	St Michaels School Barnsley
Map Information:	Site Location

Reproduced with the permission of the Ordnance Survey Crown Copyright Licence No AL 52467A0001

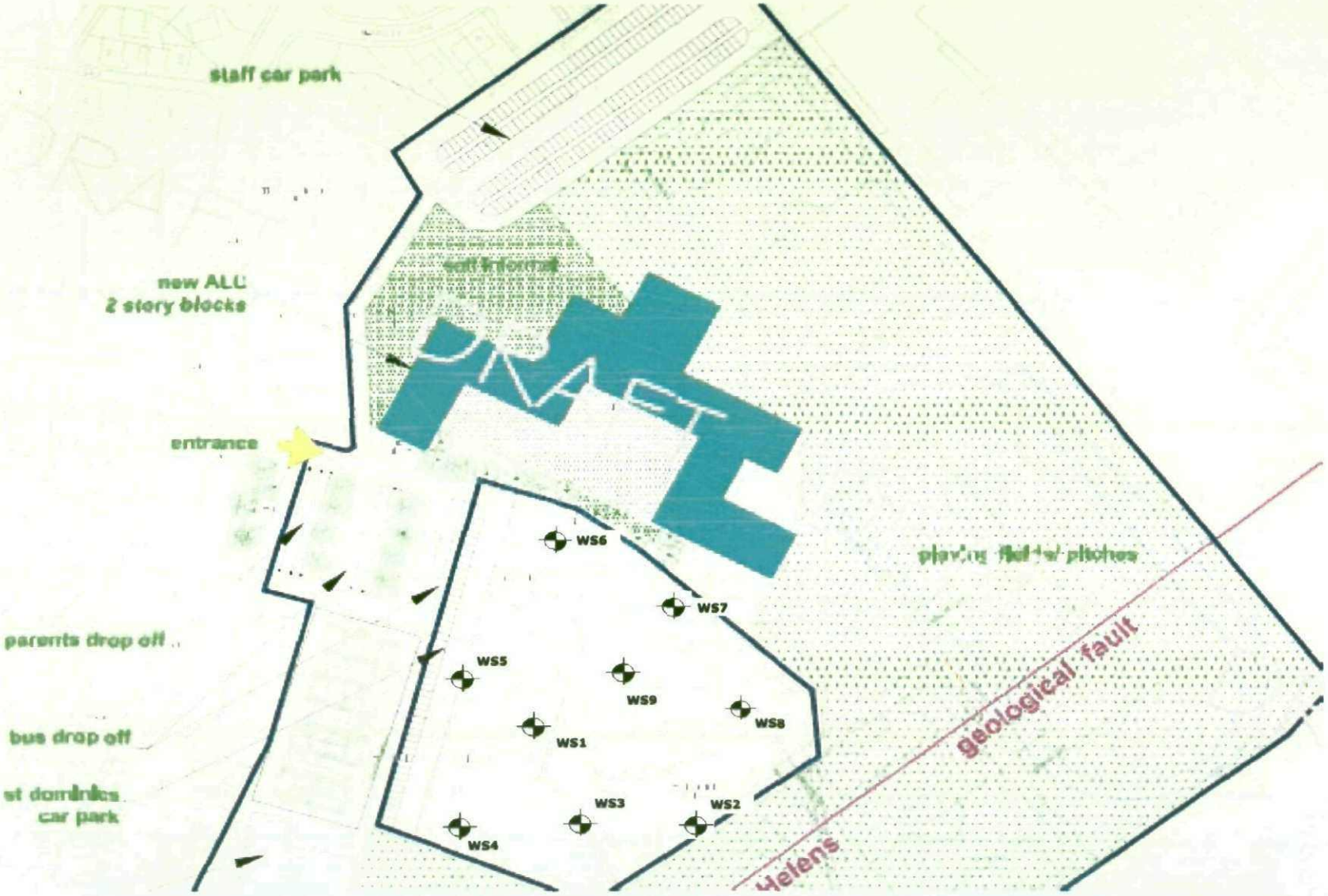
Essex House Bridle Road Bootle Merseyside L30 4UE
TEL: 0151 523 0202 FAX: 0151 523 0252



CC Geotechnical
Consulting Geotechnical and Geoenvironmental Engineers

Telephone: (0151) 523 0202
Fax: (0151) 523 0252
Email: enquiries@ccgeotechnical.co.uk
Website: www.ccgeotechnical.co.uk

Drawing Number:	**08/5514/2**
Site Location:	**St Michaels School barnsley**
Map Information:	**Aerial Photograph**



CC Geotechnical	**Project** ST MICHAELS HIGH SCHOOL
Consulting Geotechnical and Geoenvironmental Engineers	**Drawing** Proposed site investigation layout
Tel: (0151) 523 0202 Fax: (0151) 523 0252	**Scale** NTS
	Date May 2009 **Number** 5514/3

APPENDIX A:

NOTES ON LIMITATIONS

Standard Terms and Conditions of Engagement
Notes on Limitations
For
Geoenvironmental and Geotechnical Consultancy Services

General

CC GEOTECHNICAL LTD has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from CC GEOTECHNICAL LTD and a charge may be levied against such approval.

CC GEOTECHNICAL LTD accepts no responsibility or liability for:

1. the consequences of this document being used for any purpose or project other than for which it was commissioned

and/or

2. the consequences of use of this document by any party with whom an agreement has not been executed.

Phase I Environmental Audits / Desk Studies

The work undertaken to provide the basis of a Phase 1 Desk Study report comprises a study of available documented information from a variety of sources (including the client), together with (where appropriate) a walk over inspection of the site and meetings and discussions with relevant authorities and other interested parties. The opinions given in a Desk Study report have been dictated by finite data on which they are based and are relevant only to the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in the report, CC GEOTECHNICAL LTD reserves the right to review such information and to modify the opinions accordingly.

It should be noted that any risks identified in this report are perceived risks based on the information reviewed; actual risks can only be assessed following a physical investigation of the site.

Phase II Environmental Audits

The investigation of the site has been carried out with the intention of providing sufficient information concerning the type and degree of contamination, and ground and groundwater conditions to allow a reasonable risk assessment to be made. The objectives of the investigation have been limited to establishing the risks associated to potential human targets, building materials, the environment (including adjacent land), and surface and groundwater.

The amount of exploratory work and chemical testing undertaken may have been restricted by the timescale available, and the locations of the exploratory holes may have been restricted to areas unoccupied by the building(s) on the site, and further restricted by the existence of buried services. A more comprehensive investigation may be required if the site is to be redeveloped as, in addition to risk assessment, a number of important engineering and environmental issues may need to be resolved.

For those reasons, if costs have been included in relation to site remediation these must be considered as tentative only and must, in any event, be confirmed by a qualified quantity surveyor.

The exploratory holes undertaken, investigate only a small volume of the ground in relation to the size of the site, and can only provide a general indication of site conditions. The number of sampling points and the methods of sampling and testing do not preclude the existence of localised "hotspots" of contamination where concentrations may be significantly higher than those actually encountered.

Geoenvironmental Ground Investigations

The investigation of the site has been carried out to provide sufficient information within the agreed scope of the investigation, under the general headings of type and degree of contamination, geotechnical characteristics, and ground and groundwater conditions, to provide a reasonable assessment of the environmental risks together with engineering and development implications.

If costs have been included in relation to the site remediation, these must be confirmed by a qualified quantity surveyor.

The exploratory holes undertaken, investigate only a small volume of the ground in relation to the size of the site, and can only provide a general indication of the site conditions. The opinions provided and recommendations given in this report are based on the ground conditions apparent at the site of each of the exploratory holes. There may be ground conditions present on the site which have not been disclosed by this investigation, and which have therefore not been taken into account in this report.

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 groundwater levels will vary owing to seasonal, tidal, weather, or other effects.

The risk assessment and opinions provided, inter alia, take into consideration currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values.

APPENDIX B:

SITE WALKOVER PHOTOGRAPHS AND PHOTOGRAPH LOCATION PLAN



CC Geotechnical

Telephone: (0151) 523 0202
Fax: (0151) 523 0252
Email: enquiries@ccgeotechnical.co.uk
Website: www.ccgeotechnical.co.uk

Consulting Geotechnical and Geoenvironmental Engineers

Plate Number	09/5514/1
Site Location	St Michaels School Barnsley
Description	View of front of school



CC Geotechnical

Telephone: (0151) 523 0202
Fax: (0151) 523 0252
Email: enquiries@ccgeotechnical.co.uk
Website: www.ccgeotechnical.co.uk

Consulting Geotechnical and Geoenvironmental Engineers

Plate Number	09/5514/2
Site Location	St Michaels School Barnsley
Description	Looking west from the south eastern corner of the site



CC Geotechnical

Telephone: (0151) 523 0202
Fax: (0151) 523 0252
Email: enquiries@ccgeotechnical.co.uk
Website: www.ccgeotechnical.co.uk

Consulting Geotechnical and Geoenvironmental Engineers

Plate Number	09/5514/3
Site Location	St Michaels School Barnsley
Description	Looking south from the most eastern part of the site



CC Geotechnical
Consulting Geotechnical and Geoenvironmental Engineers

Telephone: (0151) 523 0202
Fax: (0151) 523 0252
Email: enquiries@ccgeotechnical.co.uk
Website: www.ccgeotechnical.co.uk

Plate Number	09/5514/4
Site Location	St Michaels School Barnsley
Description	Looking at the playground in to the south of the site



CC Geotechnical

Telephone: (0151) 523 0202
Fax: (0151) 523 0252
Email: enquiries@ccgeotechnical.co.uk
Website: www.ccgeotechnical.co.uk

Consulting Geotechnical and Geoenvironmental Engineers

Plate Number	09/5514/5
Site Location	St Michaels School Barnsley
Description	Looking at north west from the eastern corner of the site

APPENDIX C:

ENVIRONMENT AGENCY DATA MAPS

CC Geotechnical



Key:

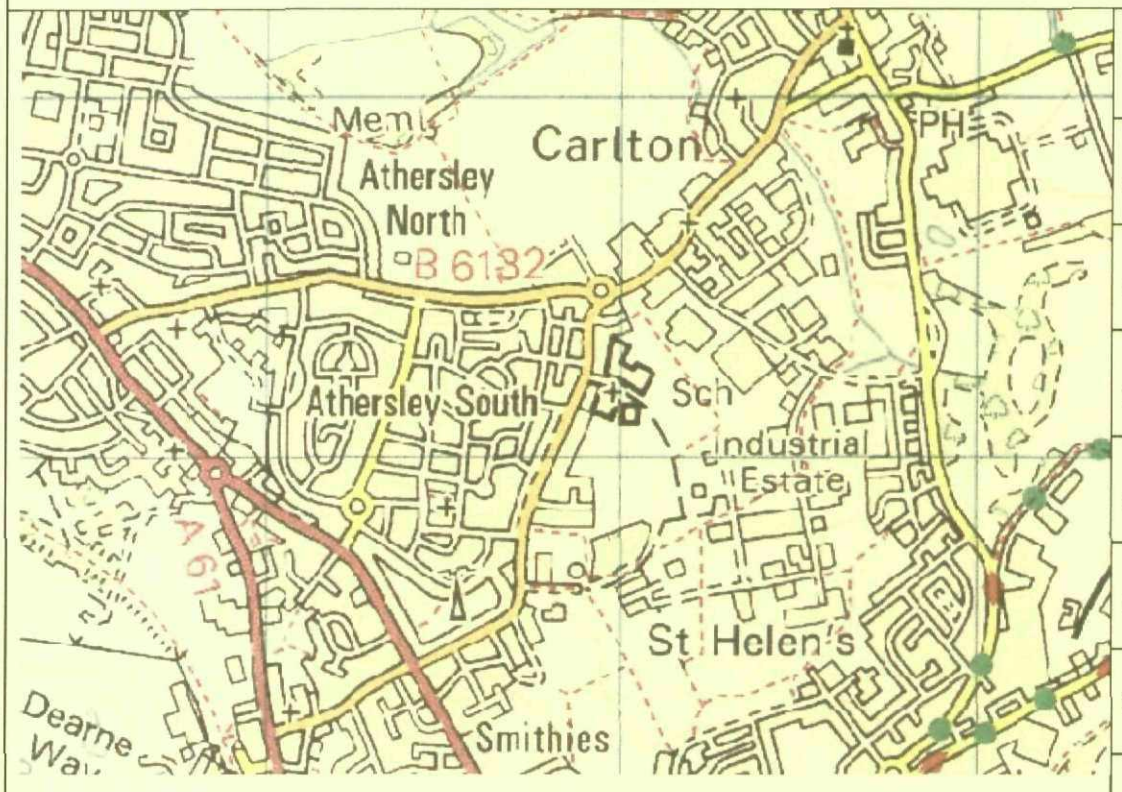
- Flooding from rivers or sea without defences
- Extent of extreme flood
- Flood defences
- Areas benefiting from flood defences

Job Number:	09/5514
Site Name:	St Michaels School Barnsley
Map information:	EA FLOOD MAP

Reproduced with the permission of the Ordnance Survey Crown Copyright
Licence No AL 52467A0001

CC Geotechnical Ltd Essex House Bridle Road Bootle Merseyside L30 4UE
TEL: 0151 523 0202 FAX: 0151 523 0252

CC Geotechnical



Key:

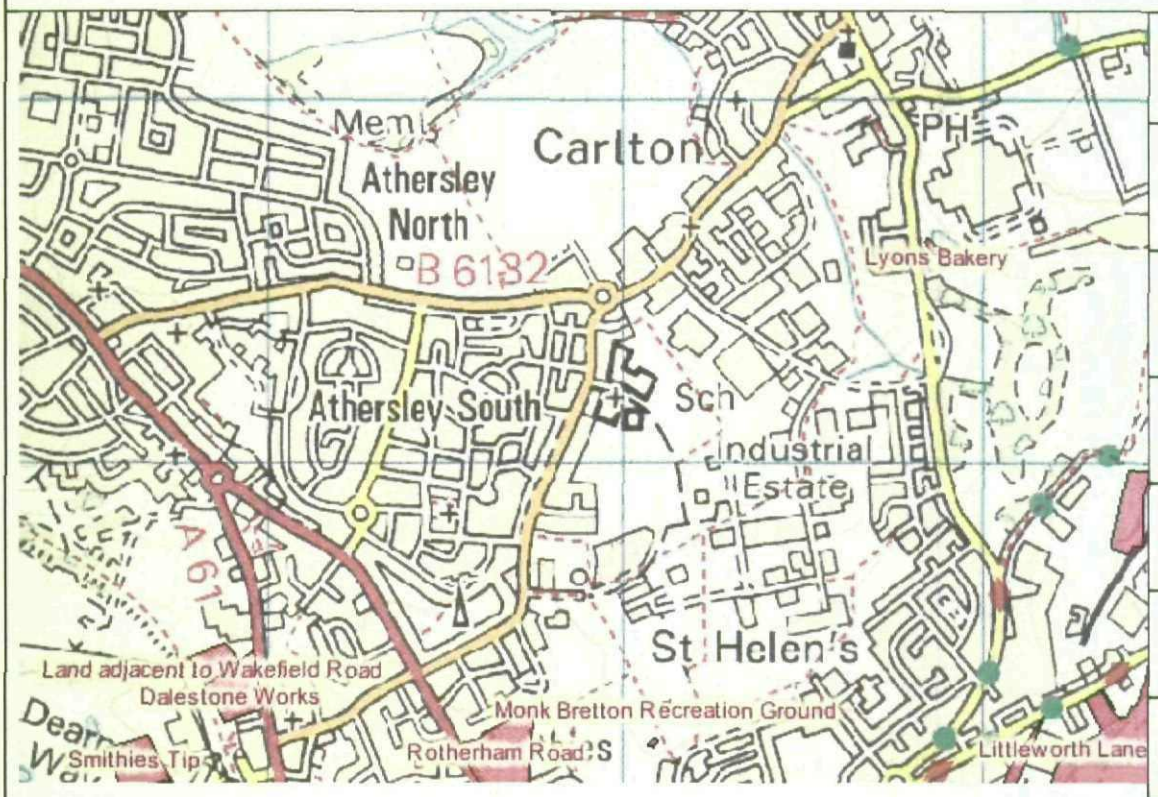
- River quality targets
- River quality (chemistry)
- River quality (nitrates)
- River quality (biology)
- River quality (phosphates)
- Hi-flows
- Sewage works
- Sensitive area

Job Number:	09/5514
Site Name:	St Michaels School Barnsley
Map information:	EA RIVER QUALITY MAP

Reproduced with the permission of the Ordnance Survey Crown Copyright
Licence No AL 52467A0001

CC Geotechnical Ltd Essex House Bridle Road Bootle Merseyside L30 4UE
TEL: 0151 523 0202 FAX: 0151 523 0252

CC Geotechnical



Key:

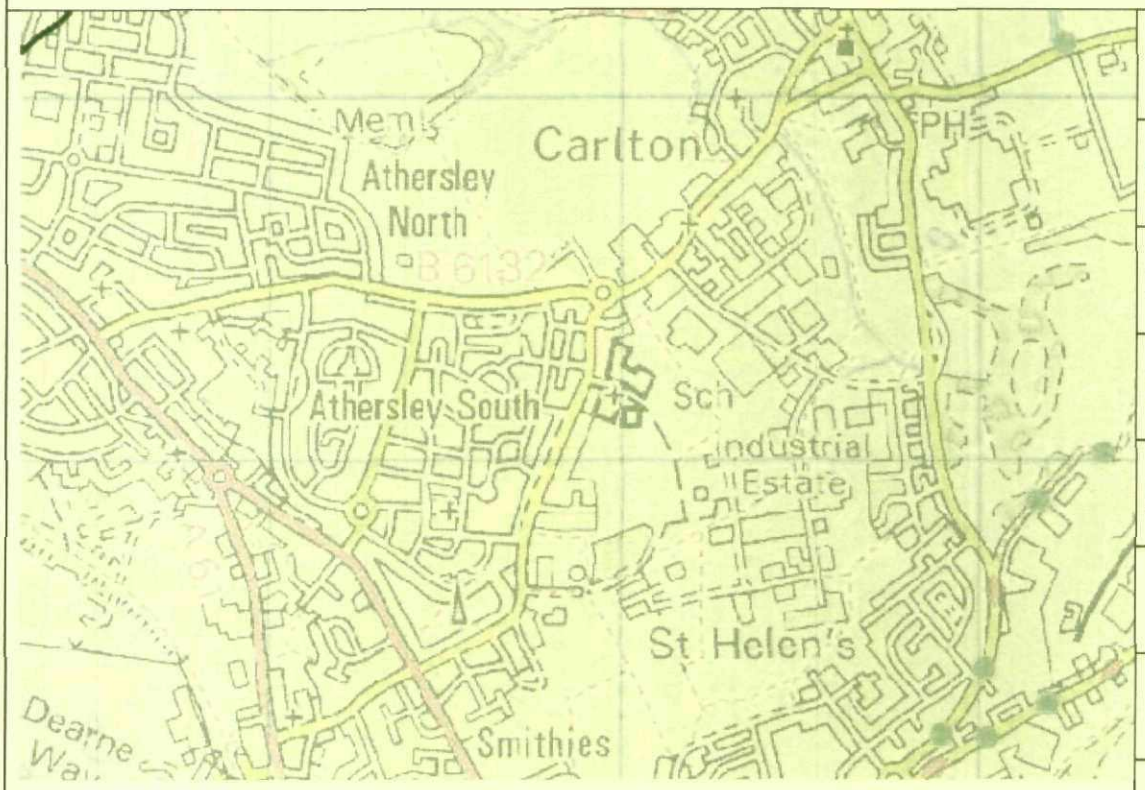
- Active Landfill site boundary
- Historical Landfill site boundary

Job Number:	09/5514
Site Name:	St Michaels School Barnsley
Map information:	EA WASTE MAP

Reproduced with the permission of the Ordnance Survey Crown Copyright
Licence No AL 52467A0001

CC Geotechnical Ltd Essex House Bridle Road Bootle Merseyside L30 4UE
TEL: 0151 523 0202 FAX: 0151 523 0252

CC Geotechnical



Key:

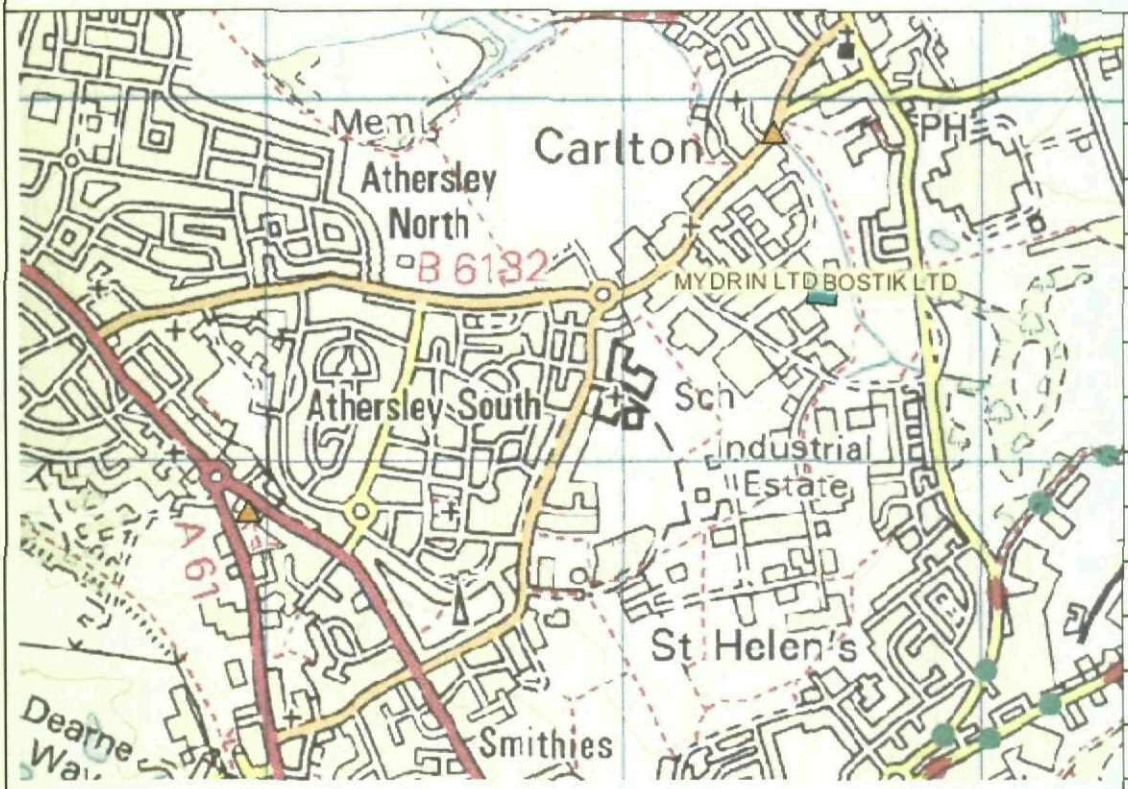
	Inner zone
	Outer zone
	Total catchment
	Special interest

Job Number:	09/5514
Site Name:	St Michaels School Barnsley
Map information:	EA GROUNDWATER MAP

Reproduced with the permission of the Ordnance Survey Crown Copyright
Licence No AL 52467A0001

CC Geotechnical Ltd Essex House Bridle Road Bootle Merseyside L30 4UE
TEL: 0151 523 0202 FAX: 0151 523 0252

CC Geotechnical



Key:

☆	Pollution hazards
	Fuel & Power
	Metal
	Mineral
	Chemical
	Waste
	Water
	Radioactive
	Associated
	Other
	Not Classified
▲	Major
▲	Significant

Job Number:	09/5514
Site Name:	St Michaels School Barnsley
Map information:	EA POLLUTION MAP

Reproduced with the permission of the Ordnance Survey Crown Copyright
Licence No AL 52467A0001

CC Geotechnical Ltd Essex House Bridle Road Bootle Merseyside L30 4UE
TEL: 0151 523 0202 FAX: 0151 523 0252

APPENDIX D:

SAMPLING AND MONITORING METHODOLOGIES

CC Geotechnical

SAMPLING, SAMPLE TRANSPORTATION, AND FIELD MONITORING PROTOCOLS

Soil / water / gas sampling and monitoring methodologies employed by ***CC GEOTECHNICAL LTD*** are presented hereunder.

SAMPLING OF SOIL FOR CONTAMINATION ASSESSMENTS

Soil samples are recovered in contamination site investigations by one or both of two sampling methodologies - dynamic sampling boreholes or trial pits.

Sampling equipment (steel casing tubes, spatulas etc) is cleaned using deionised water between sample positions to avoid cross contamination. Gloves are changed on completion of each sampling location)

Dynamic Sampling Boreholes

In this method of investigation samples are recovered in relatively undisturbed 1m long plastic tubes. Each tube is uniquely labelled with the Project Name / Project No / Borehole No / Depth increment / Date Sampled. The tubes are sealed by air tight caps fitted at each end, and are temporarily stored out of sunlight, awaiting transportation to the laboratory, where they are immediately split, scanned by PID, logged and subsampled.

Trial Pits

Samples are taken from the bucket of an excavator and placed in airtight containers. Each container is uniquely labelled with the Project No / Trial Pit No / Depth increment/ Date Sampled. The samples are then immediately placed in a cool box chilled by ice packs, and the boxes are sealed for transportation to the laboratory.

SAMPLING CONTAINERS

Subsamples from dynamic sampling boreholes or samples from trial pits comprise of a 1kg plastic tub and a 500g amber glass jar. Whilst in the laboratory awaiting courier collection, samples are stored in a refrigerator at 4^{o}C, when they are replaced in a cool box with ice packs.

CHAIN OF CUSTODY RECORDS

A Chain of Custody Record (CoC) is sent with the batch of samples. A copy of the CoC is also emailed to the laboratory prior to sample delivery. ***A copy of the CoC is included in the analyses certificates.***

HEADSPACE ANALYSES

Duplicate subsamples of ALL samples selected for laboratory analysis, are taken for headspace analyses, using a Photo Ionisation Detector (PID). In the test method, an amber glass jar is half filled with soil, and the lid is sealed with aluminium foil secured by an elastic band. The jar and contents are agitated for 30 seconds and left for a minimum of 30 minutes out of direct sunlight for the headspace to achieve equilibrium. The PID then pierces the seal and the maximum reading is recorded.

The prevailing weather conditions, and ambient temperature are also recorded.

The PID headspace results are recorded on the exploratory borehole or trial pit logs.

Laboratory VOC analyses will be obtained where the PID headspace data indicate a potential presence of volatiles.

SAMPLING OF WATER IN STANDPIPES

Water is sampled from standpipes installed during borehole drilling. On completion of the construction of the standpipe, the installation is developed by removing up to 4 x the internal volume of the installation. The volume of water removed is recorded. The standpipe is then left for a week for hydraulic equilibrium to be restored.

Prior to sampling the standpipe, the depth to the water table, and the depth to the base of the standpipe are monitored using an electronic dipmeter. In circumstances where free phase product is suspected to be present, then an 'Interface Meter' is used to determine the free phase film thickness.

A minimum of 3 x the standpipe volume is then removed. The pH of the water is then monitored and the sample is taken when the change in pH between any two consecutive standpipe extracts is less than 10%. The volume of water removed is recorded.

A sample comprises of a minimum of 3 litres. Two litres are taken in amber glass bottles, and one litre in a plastic bottle.

To avoid cross-contamination one bailer is used per position.

The samples are uniquely labelled with Project Name / Project No / Borehole No / Depth / Date Sampled. They are placed in a cool box chilled by ice packs, and the containers are sealed for transportation to the laboratory.

Once the samples are received in the ***CC GEOTECHNICAL LTD*** laboratory, the samples are stored in a refrigerator and returned to the cool boxes once collected.

Water taken from the installations are taken back to the ***CC GEOTECHNICAL LTD*** laboratory and disposed.

Other data recorded in the sampling comprises:

- Volume of water removed during development of well
- Volume of water removed during purging of the well
- Results of on-site pH analyses
- Sample appearance – colour, suspended solids

MONITORING OF GAS

Prior to embarking on a gas-monitoring round, all equipment is checked for functionality and the calibration status is confirmed.

At the commencement of the monitoring round, the prevailing weather conditions, air temperature, barometric pressure and direction of movement of barometric pressure are recorded.

The flow meter is first attached to the standpipe valve, and the flow rate is measured (peak and steady flow) for 1 minute. The results are recorded in $l.hr^{-1}$.The flow meter tube is protected from the effects of wind by aligning the exhaust downwind.

Following measurement of borehole flow rate, the installation is left for a minimum of 10 minutes for the headspace to restore equilibrium.

Once the gas in the installation has regained equilibrium, the gas analyser is connected and monitoring commences. The peak and steady state readings for CH_4, CO_2, CO, H_2S and CO are recorded. The steady state is monitored for a minimum of one minute, and possibly up to a maximum of 10 minutes where fluctuations continue.

When the monitoring is complete, the depth to the water table, and the depth to the base of the well are monitored using an electronic dipmeter. In circumstances where free phase product is suspected to be present, then an 'Interface Meter' is used to determine the free phase film thickness.

APPENDIX E:

DYNAMIC SAMPLING BOREHOLE SECTION SHEETS

CC Geotechnical
Tel: 0151-523-0202
Fax: 0151-523-0252

BOREHOLE LOG

HOLE NO. WS1
Sheet 1 of 1

CLIENT	SITE
Barnsley MBC	St Michaels School Barnsley

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
28/05/09	1:25	SEE LOCATION PLAN	SH	CSH	09/5514

SAMPLE RECORD DEPTH	TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	REDUCED LEVEL	LEGEND
0.00 - 1.00	U90			Ashphalt (0.10)			
					0.10		
				MADE GROUND comprising of grey/white silty snady gravel. Geravel is angular/subangular of limestone. (SUB-BASE) (0.30)			
					0.40		
				Brown/yellow silty clayey SAND with frequent sandstone gravels (0.50)			
					0.90		
1.00 - 2.00	U80			Weathered SANDSTONE recovered as yellow gravelly sand			
1.00 - 1.45	SPT	27					
1.90 - 2.35	SPT	50+		BOREHOLE TERMINATED	1.90		

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
NS					

BORING METHOD AND REMARKS

DANDO TERRIER RIG AND CREW

All dimensions are in metres unless otherwise stated

CC Geotechnical
Tel: 0151-523-0202
Fax: 0151-523-0252

BOREHOLE LOG

HOLE NO. WS2
Sheet 1 of 1

CLIENT	SITE
Barnsley MBC	St Michaels School Barnsley

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
28/05/09	1:25	SEE LOCATION PLAN	SH	CSH	09/5514

SAMPLE RECORD DEPTH	TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	REDUCED LEVEL	LEGEND
0.00 - 1.00	U90			Grassed TOPSOIL with frequent footlets and occasional gravels (0.60)			
				Brown silty clayey SAND with occasional sandstone gravel (0.30)	0.60		
1.00 - 2.00	U80			Weathered SANDSTONE recovered as yellow sandstone gravels	0.90		
1.00 - 1.45	SPT	54					
1.80 - 2.25	SPT	50+		BOREHOLE TERMINATED	1.80		

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
NS					

BORING METHOD AND REMARKS

DANDO TERRIER RIG AND CREW

All dimensions are in metres unless otherwise stated

CC Geotechnical	Tel: 0151-523-0202 Fax: 0151-523-0252	BOREHOLE LOG	HOLE NO. WS3 Sheet 1 of 1

CLIENT	SITE
Barnsley MBC	St Michaels School Barnsley

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
29/05/09	1:25	SEE LOCATION PLAN	SH	CSH	09/5514

SAMPLE RECORD DEPTH	TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	REDUCED LEVEL	LEGEND
0.00 - 1.00	U90			Grassed TOPSOIL with frequent rootlets and yellow sandstone gravels (0.35)			
				Weathered SANDSTONE recovered as yellow sandstone gravels in yellow sand	0.35		
1.00 - 2.00				BOREHOLE TERMINATED - BOREHOLE PERMEABILITY TEST PERFORMED	1.00		

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
NS					

BORING METHOD AND REMARKS

DANDO TERRIER RIG AND CREW

All dimensions are in metres unless otherwise stated

CC Geotechnical
Tel: 0151-523-0202
Fax: 0151-523-0252

BOREHOLE LOG

HOLE NO. WS4
Sheet 1 of 1

CLIENT	SITE
Barnsley MBC	St Michaels School Barnsley

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
28/05/09	1:25	SEE LOCATION PLAN	SH	CSH	09/5514

SAMPLE RECORD DEPTH	TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	REDUCED LEVEL	LEGEND
0.00 - 1.00	U90			Grassed TOPSOIL with occasional rootlets (0.20)			
				MADE GROUND comprising of gravelly brown sand. Gravel is angular/subangular of sandstone and brick (0.40)	0.20		
				Weathered SANDSTONE recovered as yellow gravelly sand. Gravel is angular/subangular of sandstone.	0.60		
1.00 - 2.00	U80						
1.00 - 1.45	SPT	38					
1.60 - 2.05	SPT	50+		BOREHOLE TERMINATED	1.60		

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
NS					

BORING METHOD AND REMARKS

DANDO TERRIER RIG AND CREW

All dimensions are in metres unless otherwise stated

CC Geotechnical	Tel: 0151-523-0202 Fax: 0151-523-0252	BOREHOLE LOG	HOLE NO. WS5 Sheet 1 of 1

CLIENT	SITE
Barnsley MBC	St Michaels School Barnsley

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
28/05/09	1:25	SEE LOCATION PLAN	SH	CSH	09/5514

SAMPLE RECORD DEPTH	TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	REDUCED LEVEL	LEGEND
0.00 - 1.00	U90			Grassed TOPSOIL with occasional rootlets and sandstone gravels (0.15)	0.15		
				MADE GROUND comprising of brown SAND (0.10)	0.25		
				MADE GROUND comprising of silty sandy gravels. Gravel is angular/subangular of limestone (SUB-BASE) (0.35)	0.60		
				Brown/yellow weathered SANDSTONE recovered as yellow gravels in brown/yellow sand			
1.00 - 2.00	U80						
1.00 - 1.45	SPT	62					
1.60 - 2.05	SPT	50+		BOREHOLE TERMINATED	1.60		

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
NS					

BORING METHOD AND REMARKS

DANDO TERRIER RIG AND CREW

All dimensions are in metres unless otherwise stated

CC Geotechnical
Tel: 0151-523-0202
Fax: 0151-523-0252

BOREHOLE LOG

HOLE NO. WS6
Sheet 1 of 1

CLIENT	SITE
Barnsley MBC	St Michaels School Barnsley

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
29/05/09	1:25	SEE LOCATION PLAN	SH	CSH	09/5514

SAMPLE RECORD DEPTH	TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	REDUCED LEVEL	LEGEND
0.00 - 1.00	U90			Grassed TOPSOIL with frequent rootlets and occasional sndstone gravels (0.30)			
				MADE GROUND comprising of dark brown gravelly sand with occasional pockets of light brown/yelow silty sand (0.40)	0.30		
				Weathered SANDSTONE recovered as yellow gravelly sand. Gravel is subangular of sandstone.	0.70		
1.00 - 2.00	U80						
1.00 - 1.45	SPT			BOREHOLE TERMINATED - PERMEABILITY TEST PERFORMED IN BOREHOLE	1.00		

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
NS					

BORING METHOD AND REMARKS

DANDO TERRIER RIG AND CREW

All dimensions are in metres unless otherwise stated

CC Geotechnical	Tel: 0151-523-0202 Fax: 0151-523-0252	BOREHOLE LOG	HOLE NO. WS7 Sheet 1 of 1

CLIENT	SITE
Barnsley MBC	St Michaels School Barnsley

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
28/05/09	1:25	SEE LOCATION PLAN	SH	CSH	09/5514

SAMPLE RECORD DEPTH	TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	REDUCED LEVEL	LEGEND
0.00 - 1.00	U90			Grassed TOPSOIL with frequent rootlets occasional sandstone gravels and rare coal fragments (0.60)			
				Brown SAND (0.10)	0.60		
				Weathered SANDSTONE recovered as yellow/brown gravelly sand	0.70		
1.00 - 2.00	U80						
1.00 - 1.45	SPT	48					
1.50 - 1.95	SPT	50+		BOREHOLE TERMINATED	1.50		

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
NS					

BORING METHOD AND REMARKS

DANDO TERRIER RIG AND CREW

All dimensions are in metres unless otherwise stated

CC Geotechnical
Tel: 0151-523-0202
Fax: 0151-523-0252

BOREHOLE LOG

HOLE NO. WS8
Sheet 1 of 1

CLIENT	SITE
Barnsley MBC	St Michaels School Barnsley

DATE OF FIELDWORK	SCALE	LEVEL/POSITION	OPERATOR	LOGGED BY	JOB NO.
29/05/09	1:25	SEE LOCATION PLAN	SH	CSH	09/5514

SAMPLE RECORD DEPTH	TYPE	SPT N (Cu-kN/m^2)	Standp/ Piezo	DESCRIPTION OF STRATUM (thickness)	DEPTH	REDUCED LEVEL	LEGEND
0.00 - 1.00	U90			Grassed TOPSOIL with frequent rootlets (0.10)	0.10		
				MADE GROUND comprising of yellow gravelly sand. Gravel is angular/subangular od sandstone and cinders (0.10)	0.20		
				MADE GROUND comprising of dark brown gravelly sand. Gravel is angular/subangular of sandstone and cinders (0.25)	0.45		
				Weathered SANDSTONE recovered as yellow gravelly sand. Gravel is subangular of sandstone			
				BOREHOLE TERMINATED - PERMEABILITY TEST CONDUCTED IN BOREHOLE	1.00		

GROUNDWATER AND CASING INFORMATION

DEPTH STRUCK	DEPTH CASED	ELAPSED TIME	WATER LEVEL	DEPTH SEALED	REMARKS ON GROUNDWATER AND CASING
NS					

BORING METHOD AND REMARKS

DANDO TERRIER RIG AND CREW

All dimensions are in metres unless otherwise stated

APPENDIX F:

CBR DETERMINATION BY DYNAMIC CONE PENETROMETER

CC Geotechnical

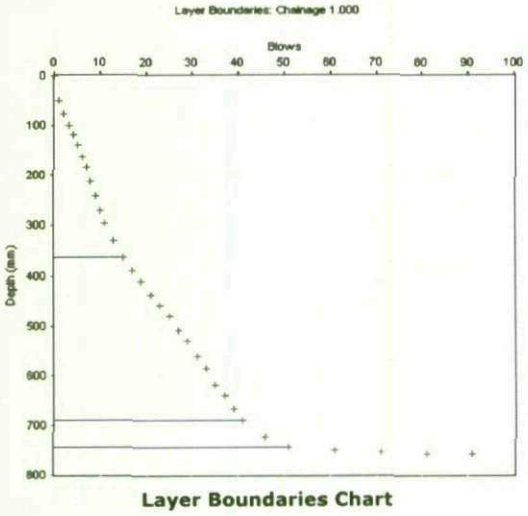
Dynamic Cone Penetrometer Strenth Analysis Report

Site: ST. MICHAELS SCHOOL
Location: CBR1
Cone Angle: 60 degrees
Zero Error: 33
Test Date: 29/05/2009

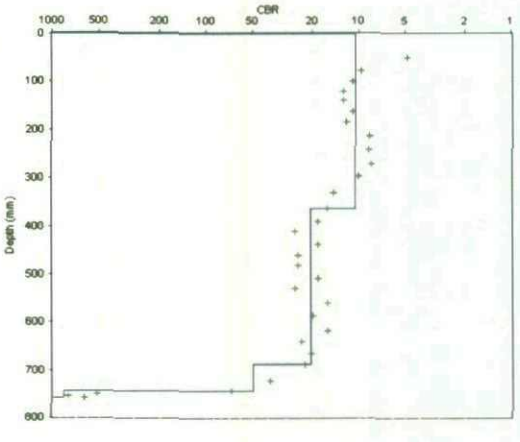
Job Number: 09/5514
Surface Type: -
Thickness (mm): -

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/b)
1	1	1	83	50.0
2	1	2	109	26.0
3	1	3	132	23.0
4	1	4	152	20.0
5	1	5	172	20.0
6	1	6	195	23.0
7	1	7	216	21.0
8	1	8	245	29.0
9	1	9	274	29.0
10	1	10	304	30.0
11	1	11	329	25.0
12	2	13	364	17.5
13	2	15	396	16.0
14	2	17	424	14.0
15	2	19	444	10.0
16	2	21	472	14.0
17	2	23	493	10.5
18	2	25	514	10.5
19	2	27	542	14.0
20	2	29	562	10.0

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/b)
21	2	31	594	16.0
22	2	33	620	13.0
23	2	35	652	16.0
24	2	37	674	11.0
25	2	39	699	12.5
26	2	41	722	11.5
27	5	46	757	7.0
28	5	51	777	4.0
29	10	61	783	0.6
30	10	71	787	0.4
31	10	81	792	0.5
32	10	91	792	0.0



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	CBR value	Thickness	Depth	Position	Strength Coefficient
1	10	363	363		
2	21	326	689		
3	50	55	744		
4	852	15	759		

CBR Derived by TDR equation $Log_{10}(CBR)=2.48-1.057 \times Log_{10}(penetration\ rate)$

Remarks Surface material description: Grassed TOPSOIL

CC Geotechnical

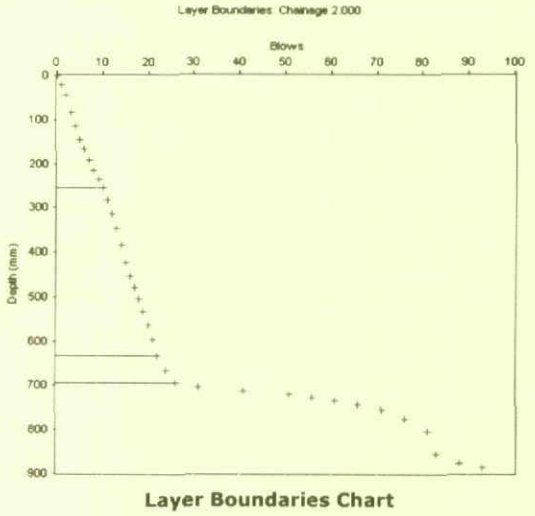
Dynamic Cone Penetrometer Strenth Analysis Report

Site: ST. MICHAELS SCHOOL
Location: CBR2
Cone Angle: 60 degrees
Zero Error: 30
Test Date: 29/05/2009

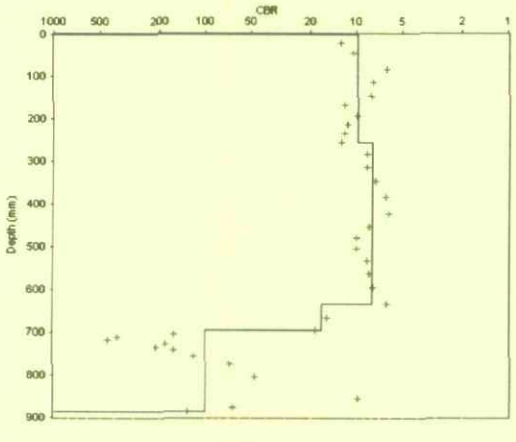
Job Number: 09/5514
Surface Type: -
Thickness (mm): -

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/b)
1	1	1	50	20.0
2	1	2	74	24.0
3	1	3	113	39.0
4	1	4	145	32.0
5	1	5	176	31.0
6	1	6	197	21.0
7	1	7	222	25.0
8	1	8	244	22.0
9	1	9	265	21.0
10	1	10	285	20.0
11	1	11	314	29.0
12	1	12	343	29.0
13	1	13	376	33.0
14	1	14	414	38.0
15	1	15	454	40.0
16	1	16	484	30.0
17	1	17	509	25.0
18	1	18	534	25.0
19	1	19	563	29.0
20	1	20	593	30.0

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/b)
21	1	21	625	32.0
22	1	22	664	39.0
23	2	24	697	16.5
24	2	26	725	14.0
25	5	31	734	1.8
26	10	41	742	0.8
27	10	51	749	0.7
28	5	56	757	1.6
29	5	61	764	1.4
30	5	66	773	1.8
31	5	71	785	2.4
32	5	76	805	4.0
33	5	81	834	5.8
34	2	83	885	25.5
35	5	88	906	4.2
36	5	93	917	2.2



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	CBR value	Thickness	Depth	Position	Strength Coefficient
1	10	255	255		
2	8	379	634		
3	17	61	695		
4	99	192	887		

CBR Derived by TDR equation $Log_{10}(CBR)=2.48-1.057 \times Log_{10}(penetration\ rate)$

Remarks Surface material description: Grassed TOPSOIL

CC Geotechnical

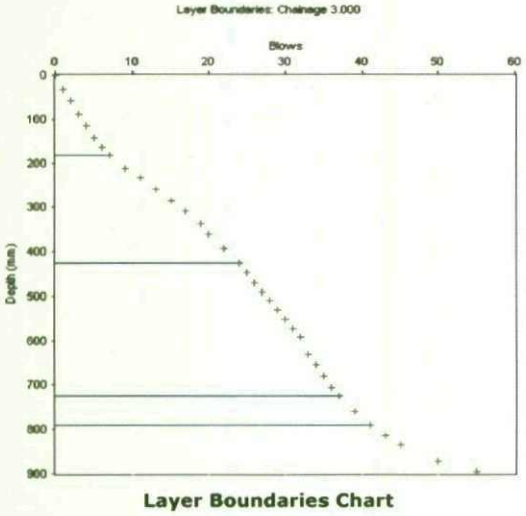
Dynamic Cone Penetrometer Strenth Analysis Report

Site: ST. MICHAELS SCHOOL
Location: CBR3
Cone Angle: 60 degrees
Zero Error: 41
Test Date: 29/05/2009

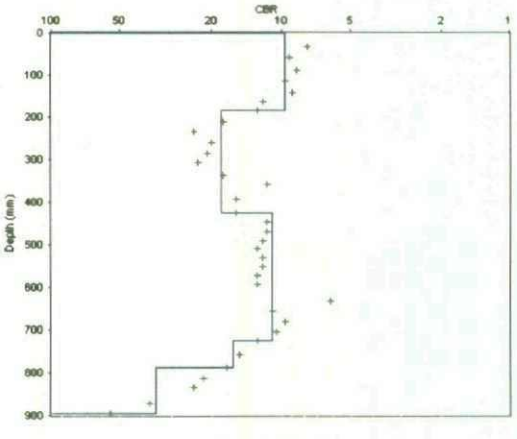
Job Number: 09/5514
Surface Type: -
Thickness (mm): -

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/b)
1	1	1	73	32.0
2	1	2	100	27.0
3	1	3	129	29.0
4	1	4	155	26.0
5	1	5	183	28.0
6	1	6	204	21.0
7	1	7	224	20.0
8	2	9	253	14.5
9	2	11	275	11.0
10	2	13	301	13.0
11	2	15	326	12.5
12	2	17	349	11.5
13	2	19	378	14.5
14	2	21	400	11.0
15	1	22	433	33.0
16	2	24	466	16.5
17	2	26	488	11.0
18	1	27	510	22.0
19	1	28	531	21.0
20	1	29	551	20.0

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/b)
21	1	30	572	32.0
22	1	31	593	21.0
23	1	32	613	20.0
24	1	33	633	20.0
25	1	34	673	40.0
26	1	35	696	23.0
27	1	36	722	26.0
28	1	37	746	24.0
29	1	38	766	20.0
30	2	40	800	17.0
31	2	42	830	15.0
32	2	44	854	12.0
33	2	46	876	11.0
34	5	51	912	7.2
35	5	56	937	5.0



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	CBR value	Thickness	Depth	Position	Strength Coefficient
1	10	183	183		
2	18	242	425		
3	11	300	725		
4	16	64	789		
5	35	107	896		

CBR Derived by TDR equation $Log_{10}(CBR)=2.48-1.057 \times Log_{10}(penetration\ rate)$

Remarks Surface material description: Grassed TOPSOIL

CC Geotechnical

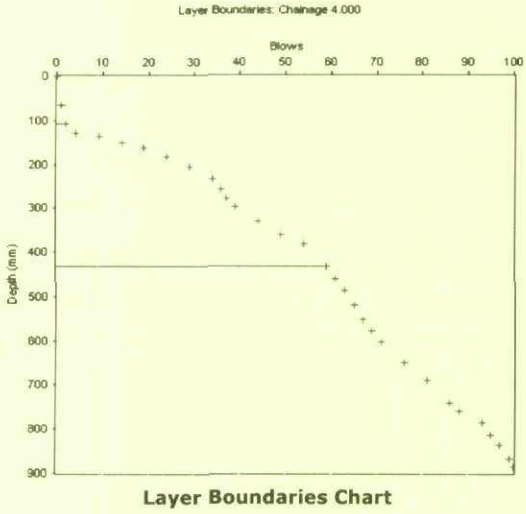
Dynamic Cone Penetrometer Strenth Analysis Report

Site: ST. MICHAELS SCHOOL
Location: CBR4
Cone Angle: 60 degrees
Zero Error: 51
Test Date: 29/05/2009

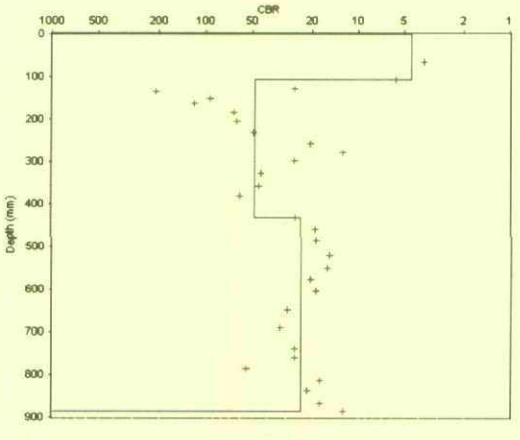
Job Number: 09/5514
Surface Type: -
Thickness (mm): -

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/b)
1	1	1	116	32.0
2	1	2	159	43.0
3	2	4	179	10.0
4	5	9	186	1.4
5	5	14	201	3.0
6	5	19	213	2.4
7	5	24	234	4.2
8	5	29	256	4.4
9	5	34	284	5.6
10	2	36	309	12.5
11	1	37	329	20.0
12	2	39	349	10.0
13	5	44	380	6.2
14	5	49	410	6.0
15	5	54	433	4.6
16	5	59	484	10.2
17	2	61	511	13.5
18	2	63	538	13.5
19	2	65	571	16.5
20	2	67	603	16.0

No.	Blows	Cumulative Blows	Penetration Depth (mm)	Penetration Rate (mm/b)
21	2	69	628	32.0
22	2	71	655	13.5
23	5	76	700	9.0
24	5	81	741	8.2
25	5	86	791	10.0
26	2	88	811	10.0
27	5	93	836	5.0
28	2	95	865	14.5
29	2	97	889	12.0
30	2	99	918	14.5
31	1	100	938	20.0



Layer Boundaries Chart



CBR Chart

Layer Properties

No.	CBR value	Thickness	Depth	Position	Strength Coefficient
1	4	108	108		
2	48	325	433		
3	24	454	887		

CBR Derived by TDR equation $Log_{10}(CBR)=2.48-1.057 \times Log_{10}(penetration\ rate)$

Remarks Surface material description: Grassed TOPSOIL

APPENDIX G:

GAS AND GROUNDWATER MONITORING RESULTS AND CALLIBRATION CERTIFICATES

GAS MONITORING RESULTS

Job Number:	09/5514		Site Name:	St Michaels School Barnsley

	VISIT NUMBER	1	2	3			
	DATE	5/06/09	16/06/09	28/06/09			
	ATMOSPHERIC PRESSURE (mB)	1007	1011	1012			
	PRESSURE TREND (FALLING / STEADY / RISING)	Steady	Steady	Steady			
BH	AIR TEMPERATURE (^{o}C)	11	14	19			
	CLOUD COVER	Light Cloud	Clear	Clear			
	WIND	Slight Breeze	Slight Breeze	Light breeze			
	PRECIPITATION	Dry	Dry	Dry			
	STATE OF GROUND	Dry Grass	Dry	Dry			
3	CH_4 (%) (max/steady)	NIL	NIL	NIL			
	CO_2 (%)(max/steady)	0.9	0.4	0.3			
	O_2 (%)	20.2	20.5	20.2			
	H_2S (p.p.m.) (max/steady)	NIL	NIL	NIL			
	CO (p.p.m.) (max/steady)	NIL	NIL	NIL			
	PID READING (ppm) (max/steady)	0.0	0.0	0.0			
	FLOW (l/hr) (max/steady)	<0.1	<0.1	<0.1			
	STANDING WATER LEVEL (m)	1.00	DRY	DRY			
5	CH_4 (%) (max/steady)	NIL	NIL	NIL			
	CO_2 (%)(max/steady)	0.5	0.7	0.7			
	O_2 (%)	20.3	19.8	19.9			
	H_2S (p.p.m.) (max/steady)	NIL	NIL	NIL			
	CO (p.p.m.) (max/steady)	NIL	NIL	NIL			
	PID READING (ppm) (max/steady)	0.0	0.0	0.0			
	FLOW (l/hr) (max/steady)	<0.1	<0.1	<0.1			
	STANDING WATER LEVEL (m)	1.70	DRY	DRY			
7	CH_4 (%) (max/steady)	NIL	NIL	NIL			
	CO_2 (%)(max/steady)	0.5	0.4	0.3			
	O_2 (%)	21.0	20.5	20.4			
	H_2S (p.p.m.) (max/steady)	NIL	NIL	NIL			
	CO (p.p.m.) (max/steady)	NIL	NIL	NIL			
	PID READING (ppm) (max/steady)	0.0	0.0	0.0			
	FLOW (l/hr) (max/steady)	<0.1	<0.1	<0.1			
	STANDING WATER LEVEL (m)	1.60	DRY	DRY			
	CH_4 (%) (max/steady)						
	CO_2 (%)(max/steady)						
	O_2 (%)						
	H_2S (p.p.m.) (max/steady)						
	CO (p.p.m.) (max/steady)						
	PID READING (ppm) (max/steady)						
	FLOW (l/hr) (max/steady)						
	STANDING WATER LEVEL (m)						
	CH_4 (%) (max/steady)						
	CO_2 (%)(max/steady)						
	O_2 (%)						
	H_2S (p.p.m.) (max/steady)						
	CO (p.p.m.) (max/steady)						
	PID READING (ppm) (max/steady)						
	FLOW (l/hr) (max/steady)						
	STANDING WATER LEVEL (m)						

INSTRUMENTS USED: GA2000 AND FLOW POD / MINIRAE 2000

Geotech

A subsidiary of LANDTEC

CERTIFICATE OF CALIBRATION

Certificate number: GA08842_1/3830
Date of check: 01 June 2009
Product: GA2000
Serial number: GA08842

Calibration checked at: 22.1°C to 32.1°C

Primary Gas Channels

Methane (CH4)		Carbon Dioxide (CO2)	
Certified Gas (%)	Reading (%)	Certified Gas (%)	Reading (%)
49.97	48.6	50.03	49.9
15.12	15.0	15.44	15.1
5.00	4.9	4.94	4.7

Oxygen (O2)	
Certified Gas (%)	Reading (%)
20.95	21.1

Additional Gas Cells		
Gas	Certified Gas (ppm)	Reading (ppm)
H2S	52.1	52.6
CO	506.0	508.2

Barometer	
Certified (mb)	Reading (mb)
1017	1018

Approved by: [redacted] **(Name)**

(Signature)

All gases are traceable to certified National Standards

As the Manufacturer, we recommend that this unit be Serviced in accordance with the date specified by the analyser. This is to be done ONLY by a Geotechnical Instruments (UK) Ltd approved Service Facility.

Registered in England and Wales 1898734
Geotechnical Instruments (UK) Ltd
Sovereign House, Queensway, Leamington Spa, Warwickshire, CV31 3JR, England.
Tel: +44 (0)1926 338111 Fax: +44 (0)1926 338110 www.geotech.co.uk

Geotech

A subsidiary of LANDTEC

FLOW POD CALIBRATION CERTIFICATE

Certificate number: **00853090521**
Date of Calibration: **21/05/2009**
Product: **GA5.3 - Flow Pod for Gas Analyser**
Serial number: **853**

Flow range (units)	Flow reference ID no	Ambient temperature (°c)
0-12l/hr	345	22.7

Actual Flow		Displayed Flow Reading		Permissible error
0.0	l/hr	00.0	l/hr	± 0.3
3.0	l/hr	03.0	l/hr	± 0.3
6.0	l/hr	06.0	l/hr	± 0.3
9.0	l/hr	08.9	l/hr	± 0.3
12.0	l/hr	11.8	l/hr	± 0.3

EEPROM Information

Byte address	00	01	02	03	04	05	06	07	08	09	10	11
Byte data	071	009	180	010	072	005	180	010	072	005	009	009

Calibrated by: **M. Moloney** (Name)

[redacted] (Signature)

All equipment used to obtain these results are traceable to international standards.

Test Date and Conditions	
Date	15/06/09.
Atmospheric Pressure	1005 mbar
Ambient Temp	27.9°C

GAS DATA LTD
Pegasus House
Seven Stars Estate
Wheler Rd.
Coventry
CV3 4LB
Tel: 024 76 303311 Fax: 024 76 307711

GF60 FINAL INSPECTION & CALIBRATION CERTIFICATE

INSTRUMENT DETAILS			
Serial No	3305	CUSTOMER	[redacted]
S/W Version	[redacted]		

INSTRUMENT CHECKS			
Keyboard	✓	Clock Set / Running	✓
Backlight	✓		
Display Contrast	✓	Labels Fitted	✓

ABSOLUTE PRESSURE	
Atmos accept current +/-1	1004
Atmos + 50 mbar accept current +48-+52	1055
Atmos - 50 mbar accept current -48--52	954

Flow Tests					
Target Flow	-4 l/h	0 l/h	5 l/h	20 l/h	30 l/h
Applied Flow	-4	0	5	20	30
Flow Reading	-3.9 accept applied +/- 0.2	0 accept applied +/- 0.0	5.0 accept applied +/- 0.5	20.0 accept applied +/- 0.7	30.1 accept applied +/- 3
dp Applied (Pa)	-11.1	0	14.5	75.9	135.6
dp Reading (Pa)	-12 accept applied +/- 5	0 accept applied +/- 0.0	14 accept applied +/- 5	76 accept applied +/- 10	135 accept applied +/- 20

OPTIONS	
Data Logging	
Leather carry case	

PACKING			
Euro Charger		Sample Pipe	✓
US Charger			
UK Charger		Software & Cable	
Manual		Cal Certificate	✓

Tested by [redacted] .....

Approved .....

CERTIFICATE OF CALIBRATION
MiniRAE 2000

CALIBRATION CERTIFICATE NO: 35414

ISSUED BY: SHAWCITY LIMITED
DATE: 21.04.09

APPROVED SIGNATORY: [redacted]

NAME: Peter Gunter

CUSTOMER: CC Geotechnical
INSTRUMENT: MiniRAE 2000
SERIAL NUMBER: 110-009958

CALIBRATION METHOD: CM03
AMBIENT CONDITIONS: 20°C ± 2°C and 50% (± 20%) RH

Prior to calibration the instrument was allowed to stabilise in the laboratory for at least 30 minutes.
The instrument was calibrated by exposing the sensor to known values of gas concentrations.
All gases were sampled through the complete probe and in line filter, where applicable.
The reference value is that generated by the certified source and the indicated value is that measured by the instrument.

CALIBRATION RESULTS

GAS	LOT No	REF. VALUE	INDICATED VALUE
Isobutylene	592696	100 ppm	100 ppm

COMMENTS:
The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor of $k=2$.
This provides a level of confidence of uncertainty of approximately 95%.
The uncertainty of measurement is ±2 ppm.
The results indicate that the instrument conforms to the applicable parts of the published specification.

Tel: 01367 241675 Fax: 01367 242491
www.shawcity.co.uk 13 Pioneer Road, FARINGDON, Oxon., SN7 7BU service@shawcity.co.uk

APPENDIX D:

SOAKAWAY RESULTS

CC Geotechnical

PERMEABILITY CALCULATIONS FOR IN SITU VARIABLE HEAD TEST

JOB NUMBER:	09/5514
SITE NAME:	St Micheals School Barnsley
CLIENT:	Barnsley MBC
DATE:	29/05/09

BOREHOLE NUMBER:	WS3
DEPTH OF TEST (m):	1.00
TYPE OF TEST (FALLING OR RISING HEAD TEST):	FALLING HEAD TEST
SOIL/ROCK TYPE IN TEST SECTION:	SANDSTONE BEDROCK

OUTSIDE DIAMETER OF CASING (m):	1.000
DIAMETER OF CASING (m):	0.087
CROSS-SECTIONAL AREA OF BOREHOLE CASING (m), A:	0.006
LENGTH OF HOLE EXTENDED IN GROUND (m):	1.00
LENGTH OF CASING EXTENDED IN GROUND (m):	1.00
WITH REFERENCE TO FIGURE 6, SECTION 4, BS5930:1999, WHICH SCENARIO WAS USED (A,B,C,D,E OR F):	A
INTAKE FACTOR, F:	0.17

TIME (seconds)	HEAD (m)
0	1.00
30	80.00
60	30.00
120	10.00
150	0.01

PERMEABILITY, k (m/s):	**0.00105**

REMARKS

PERMEABILITY CALCULATED USING THE GENERAL APPROACH GIVEN IN BS5930:SECTION 4

CC Geotechnical

PERMEABILITY CALCULATIONS FOR IN SITU VARIABLE HEAD TEST

JOB NUMBER:	09/5514
SITE NAME:	St Micheals School Barnsley
CLIENT:	Barnsley MBC
DATE:	29/05/09

BOREHOLE NUMBER:	WS6
DEPTH OF TEST (m):	1.00
TYPE OF TEST (FALLING OR RISING HEAD TEST):	FALLING HEAD TEST
SOIL/ROCK TYPE IN TEST SECTION:	SANDSTONE BEDROCK

OUTSIDE DIAMETER OF CASING (m):	0.120
DIAMETER OF CASING (m):	0.100
CROSS-SECTIONAL AREA OF BOREHOLE CASING (m), A:	0.008
LENGTH OF HOLE EXTENDED IN GROUND (m):	1.00
LENGTH OF CASING EXTENDED IN GROUND (m):	1.00
WITH REFERENCE TO FIGURE 6, SECTION 4, BS5930:1999, WHICH SCENARIO WAS USED (A,B,C,D,E OR F):	A
INTAKE FACTOR, F:	0.20

TIME (seconds)	HEAD (m)
0	1.00
5	1.00
10	0.99
20	0.98
30	0.98
60	0.98
120	0.97
300	0.96
600	0.93
900	0.91
1200	0.89
1500	0.87
1800	0.85
3600	0.74
5400	0.62
7200	0.49

PERMEABILITY, k (m/s):	**3.88526E-06**

REMARKS

PERMEABILITY CALCULATED USING THE GENERAL APPROACH GIVEN IN BS5930:SECTION 4

CC Geotechnical

PERMEABILITY CALCULATIONS FOR IN SITU VARIABLE HEAD TEST

JOB NUMBER:	09/5514
SITE NAME:	St Micheals School Barnsley
CLIENT:	Barnsley MBC
DATE:	29/05/09

BOREHOLE NUMBER:	WS8
DEPTH OF TEST (m):	1.00
TYPE OF TEST (FALLING OR RISING HEAD TEST):	FALLING HEAD TEST
SOIL/ROCK TYPE IN TEST SECTION:	SANDSTONE BEDROCK

OUTSIDE DIAMETER OF CASING (m):	1.000
DIAMETER OF CASING (m):	0.087
CROSS-SECTIONAL AREA OF BOREHOLE CASING (m), A:	0.006
LENGTH OF HOLE EXTENDED IN GROUND (m):	1.00
LENGTH OF CASING EXTENDED IN GROUND (m):	1.00
WITH REFERENCE TO FIGURE 6, SECTION 4, BS5930:1999, WHICH SCENARIO WAS USED (A,B,C,D,E OR F):	A
INTAKE FACTOR, F:	0.17

TIME (seconds)	HEAD (m)
0	1.00
30	0.95
60	0.90
90	0.86
240	0.82
300	0.77
600	0.58
900	0.52
1200	0.42
1500	0.22
1800	0.16
2100	0.13
2400	0.08
3060	0.02

PERMEABILITY, k (m/s):	**4.35317E-05**

REMARKS

PERMEABILITY CALCULATED USING THE GENERAL APPROACH GIVEN IN BS5930:SECTION 4

APPENDIX J:

SOIL ENGINEERING TEST RESULTS

T5

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with BS1377 Part 2:1990 & B.R.E. IP 4/93 (soil suction values)

BH / TP / WS Number	Type	Depth From (m)	Depth To (m)	Moisture Content (%)	Bulk Density (Mg/m^3)	Dry Density (Mg/m^3)	Shear Strength (kN/m^2)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 425micron (%)	Soil Classification	Description / Remarks Samples described in accordance with BS 5930:1999 Clause 6
WS1	WS	0.90	0.90	-	-	-	-	-	-	-	-	-	Yellow slightly clayey silty SAND and GRAVEL. Gravel is subangular sandstone. (see PSD result sheet)
WS2	WS	1.00	1.00	-	-	-	-	-	-	-	-	-	Yellow clayey silty cobbly very gravelly SAND. Gravel is subangular sandstone. (see PSD result sheet)
WS3	WS	0.90	0.90	-	-	-	-	-	-	-	-	-	Yellow slightly clayey silty cobbly very sandy GRAVEL. Gravel is subangular sandstone. (see PSD result sheet)
WS5	WS	0.90	0.90	-	-	-	-	-	-	-	-	-	Yellow clayey silty very gravelly SAND. Gravel is subangular sandstone. *(see PSD result sheet)*
WS6	WS	0.80	0.80	-	-	-	-	-	-	-	-	-	Yellow slightly clayey silty cobbly very gravelly SAND. Gravel is subangular sandstone. (see PSD result sheet)
WS8	WS	0.90	0.90	-	-	-	-	-	-	-	-	-	Yellow slightly clayey silty very cobbly very gravelly SAND. Gravel is subangular sandstone. (see PSD result sheet)

SITE: ST. MICHAELS SCHOOL, BARNSLEY (09/5514)

CLIENT: BARNSLEY MBC

DATE: Jun-09

SHEET: 1 of 1

CC Geotechnical

Telephone: (0151) 523 0202

Key - BD = Bulk Disturbed; SD = Small Disturbed; U100 = Undisturbed 100mm

CL = Low Plasticity; CI = Intermediate; CH = High; CV = Very high; CE = Extremely high; NP = Non-plastic

(* Denotes Hand Shear Vane test result)

CC Geotechnical

PARTICLE SIZE DISTRIBUTION
SEDIMENTATION BY HYDROMETER METHOD

B.S. 1377 (1990) : Part 2 : Clause 9.5

HYDROMETER No.:- 963135

CYLINDER REFERENCE:- 14

INITIAL MASS OF DRY SOIL = 40.00 g

MENISCUS CORRECTION (C_m) = 0.5

PARTICLE DENSITY (G_s) = 2.60 Mg/m^3

WATER VISCOSITY ( ) = 1.137

HYDROMETER READING IN SOLUTION (R_o') = 1.0005

JOB No.:- 09/5514

SITE:- ST. MICHAELS SCHOOL, BARNSLEY

CLIENT:- BARNSLEY MBC

SAMPLE REF.:- WS1

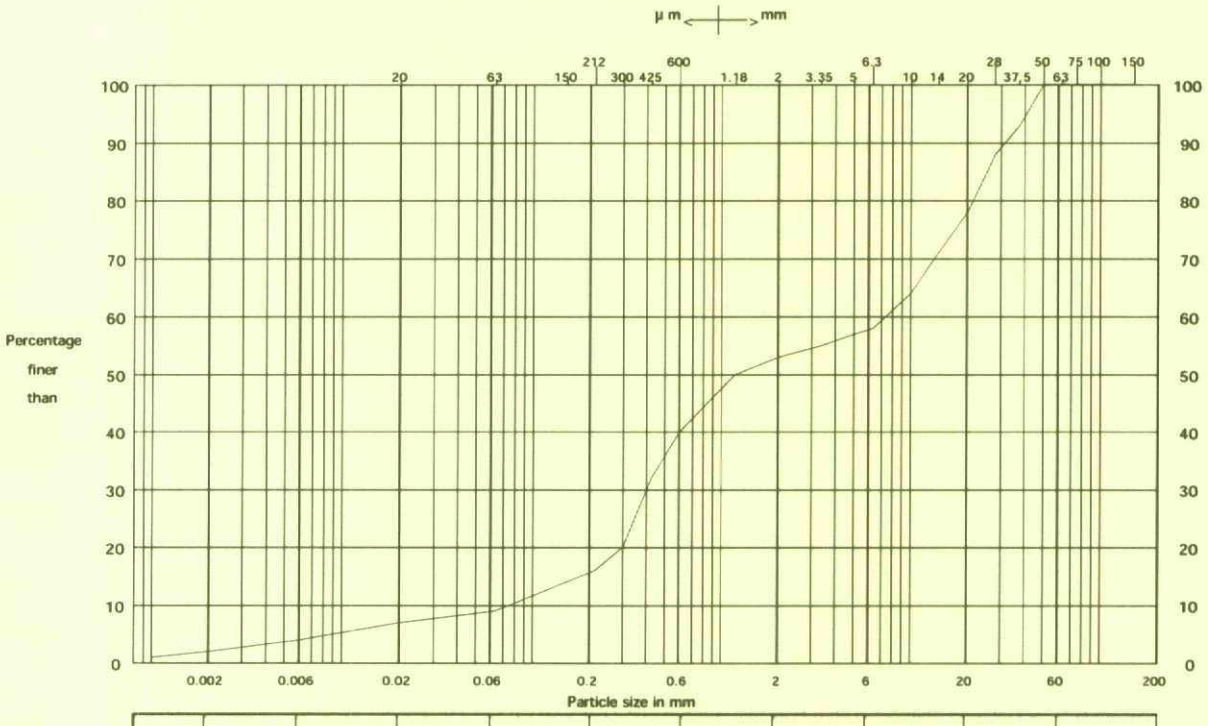
SAMPLE DEPTH:- 0.90 m

DATE SAMPLED:-

DATE	TIME			ELAPSED TIME	TEMP.	READING	CORRECTED READING $Rh' + C_m$	EFFECTIVE DEPTH	PARTICLE DIAMETER	$R_h' - R_o'$	PERCENTAGE FINER THAN D
	Hrs	Mins	Secs	(min)	(°C)	(R_h')	(R_h)	(H_r mm)	(D_{mm})	(R_d)	(K%)
	9	12	0	0	15						
	9	12	30	0.5	15	24.6	25.1	106.9	**0.0682**	24.7	**100.3**
	9	13	0	1.0	15	24.0	24.5	109.3	**0.0487**	24.1	**97.9**
	9	14	0	2.0	15	22.7	23.2	114.5	**0.0353**	22.8	**92.6**
	9	16	0	4.0	15	20.5	21.0	123.4	**0.0259**	20.6	**83.7**
	9	20	0	8.0	15	17.8	18.3	134.3	**0.0191**	17.9	**72.7**
	9	42	0	30.0	15	13.2	13.7	152.9	**0.0105**	13.3	**54.0**
	10	12	0	60.0	15	11.1	11.6	161.3	**0.0076**	11.2	**45.5**
	11	12	0	120.0	15	9.4	9.9	168.2	**0.0055**	9.5	**38.6**
	16	12	0	420.0	15	6.6	7.1	179.5	**0.0030**	6.7	**27.2**
	9	12	0	1440.0	15	5.3	5.8	184.7	**0.0017**	5.4	**21.9**

CC Geotechnical	Tel: 0151-523-0202 Fax: 0151-523-0252	DETERMINATION OF PARTICLE SIZE DISTRIBUTION	HOLE NO. WS1
CLIENT	BARNSLEY MBC	SITE	ST. MICHAELS SCHOOL, BARNSLEY
SAMPLE DEPTH	0.90 - 0.90	SAMPLE REF	1
JOB NO.	09/5514		
METHOD OF PRETREATMENT		METHOD OF TEST	Wet Sieve + Hydrometer

	Size (microns)											Size (mm)													
Sieve Size	1	2	6	20	63	75	150	212	300	425	600	1.18	2	3.35	5	6.3	10	14	20	28	37.5	50	63	75	100	150
% by Mass passing Sieve			7	9	10	14	16	20	32	40	50	53	55	57	58	64	71	78	88	93	100	100	100	100	100	



	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
		SILT			SAND			GRAVEL			
%	2	7			44			47			0

SAMPLE DESCRIPTION

Yellow slightly clayey silty SAND and GRAVEL. Gravel is subangular sandstone

REMARKS

CC Geotechnical

PARTICLE SIZE DISTRIBUTION
SEDIMENTATION BY HYDROMETER METHOD

B.S. 1377 (1990) : Part 2 : Clause 9.5

HYDROMETER No.:- 88933

CYLINDER REFERENCE:- 13

INITIAL MASS OF DRY SOIL = 40.00 g

MENISCUS CORRECTION (C_m) = 0.5

PARTICLE DENSITY (G_s) = 2.60 Mg/m^3

WATER VISCOSITY ( ) = 1.137

HYDROMETER READING IN SOLUTION (R_o') = 1.0005

JOB No.:- 09/5514

SITE:- ST. MICHAELS SCHOOL, BARNSLEY

CLIENT:- BARNSLEY MBC

SAMPLE REF.:- WS2

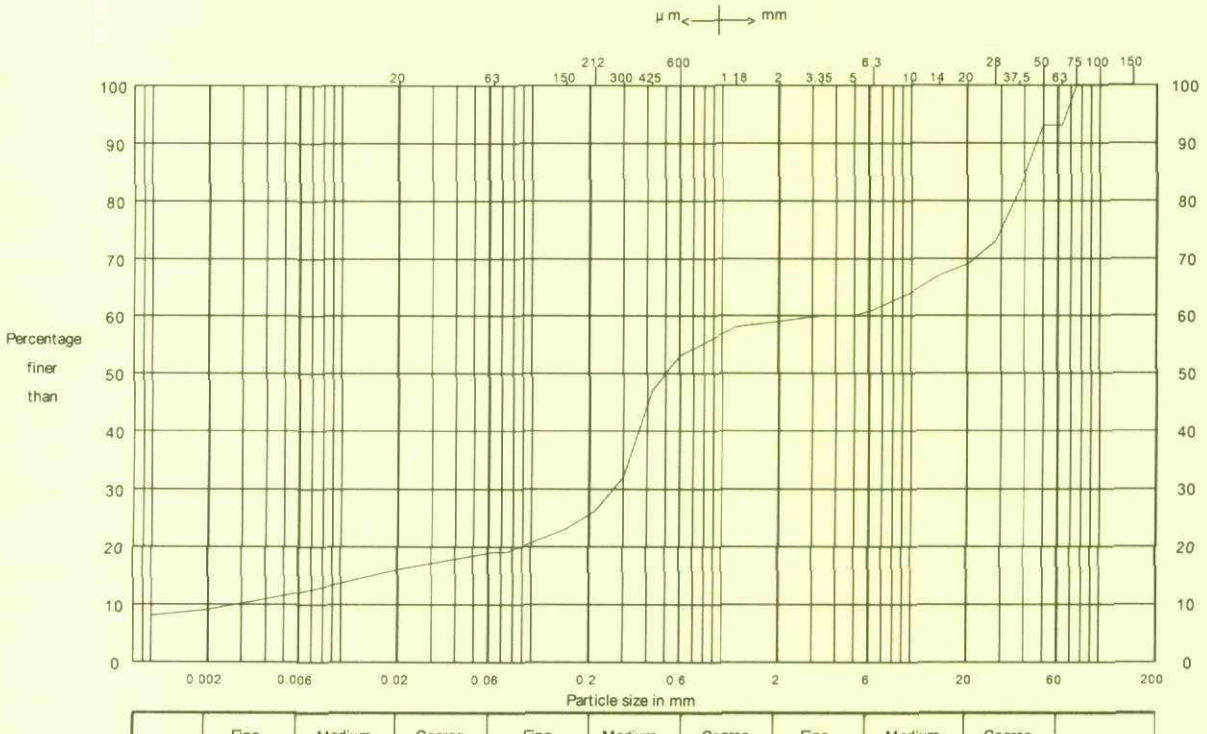
SAMPLE DEPTH:- 1.00 m

DATE SAMPLED:-

DATE	TIME			ELAPSED TIME	TEMP.	READING	CORRECTED READING $Rh' + C_m$	EFFECTIVE DEPTH	PARTICLE DIAMETER	$R_h' - R_o'$	PERCENTAGE FINER *THAN D*
	Hrs	Mins	Secs	(min)	(^oC)	(R_h')	(R_h)	(H_r mm)	(D_{mm})	(R_d)	(K%)
	8	59	0	0	15						
	8	59	30	0.5	15	26.2	26.7	100.4	**0.0661**	26.3	**106.8**
	9	0	0	1.0	15	25.9	26.4	101.6	**0.0470**	26.0	**105.6**
	9	1	0	2.0	15	24.5	25.0	107.3	**0.0341**	24.6	**99.9**
	9	3	0	4.0	15	22.9	23.4	113.7	**0.0249**	23.0	**93.4**
	9	7	0	8.0	15	21.0	21.5	121.4	**0.0182**	21.1	**85.7**
	9	29	0	30.0	15	17.9	18.4	133.9	**0.0099**	18.0	**73.1**
	10	59	0	120.0	15	16.2	16.7	140.8	**0.0050**	16.3	**66.2**
	11	59	0	180.0	15	14.8	15.3	146.4	**0.0042**	14.9	**60.5**
	16	59	0	480.0	15	12.7	13.2	154.9	**0.0026**	12.8	**52.0**
	9	59	0	1440.0	15	11.2	11.7	160.9	**0.0016**	11.3	**45.9**

CC Geotechnical	Tel: 0151-523-0202 Fax: 0151-523-0252	DETERMINATION OF PARTICLE SIZE DISTRIBUTION	HOLE NO. WS2
CLIENT	BARNSLEY MBC	SITE	ST. MICHAELS SCHOOL, BARNSLEY
SAMPLE DEPTH	1.00 - 1.00	SAMPLE REF	1
			JOB NO. 09/5514
METHOD OF PRETREATMENT		METHOD OF TEST	Wet Sieve + Hydrometer

	Size (microns)											Size (mm)													
Sieve Size	1	2	6	20	63	75	150	212	300	425	600	1.18	2	3.35	5	6.3	10	14	20	28	37.5	50	63	75	100	150
% by Mass passing Sieve	16	19	19	23	26	32	47	53	58	59	60	60	61	64	67	69	73	82	93	93	100	100	100			



	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
		SILT			SAND			GRAVEL			
%	9	10			40			34			7

SAMPLE DESCRIPTION	REMARKS
Yellow clayey silty cobbly very gravelly SAND. Gravel is subangular sandstone	

CC Geotechnical

PARTICLE SIZE DISTRIBUTION
SEDIMENTATION BY HYDROMETER METHOD

B.S. 1377 (1990) : Part 2 : Clause 9.5

HYDROMETER No.:- 963135

CYLINDER REFERENCE:- 12

INITIAL MASS OF DRY SOIL = 40.00 g

MENISCUS CORRECTION (C_m) = 0.5

PARTICLE DENSITY (G_s) = 2.60 Mg/m^3

WATER VISCOSITY ( ) = 1.137

HYDROMETER READING IN SOLUTION (R_o') = 1.0005

JOB No.:- 09/5514

SITE:- ST. MICHAELS SCHOOL, BARNSLEY

CLIENT:- BARNSLEY MBC

SAMPLE REF.:- WS3

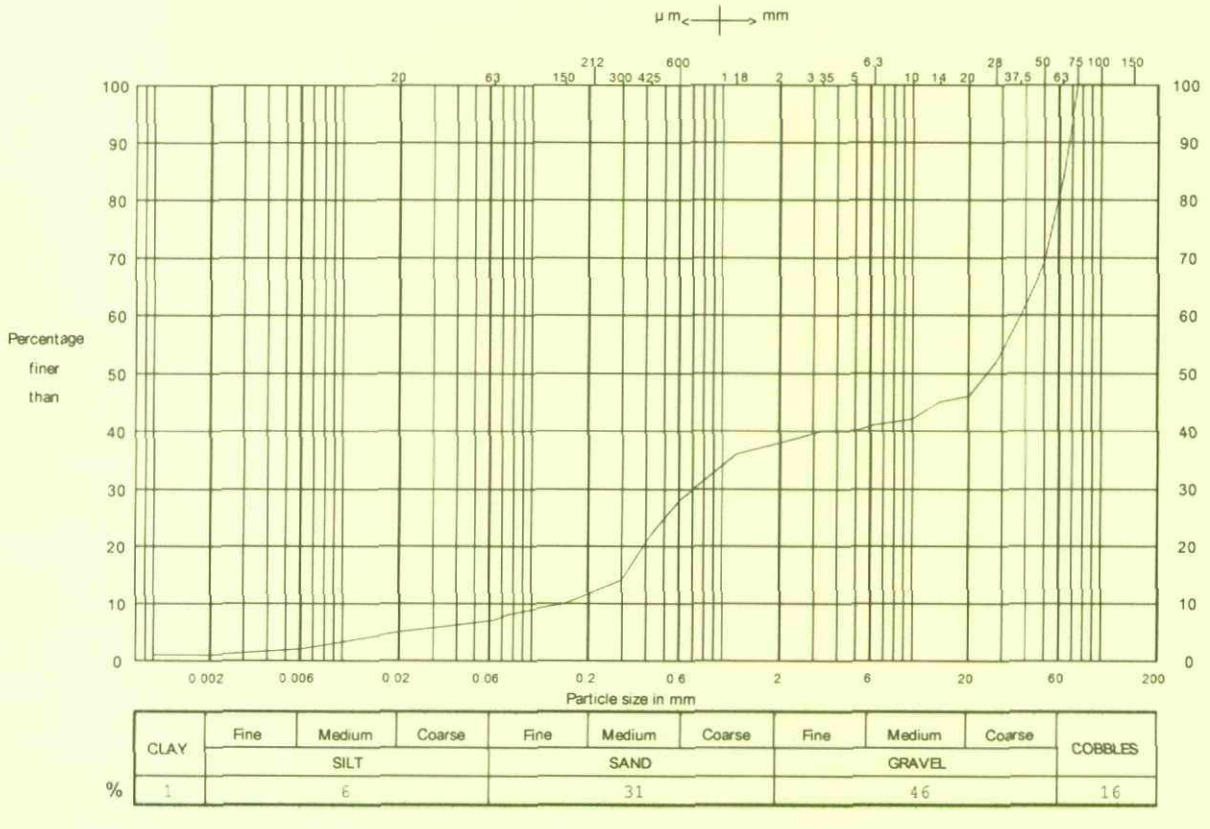
SAMPLE DEPTH:- 0.90 m

DATE SAMPLED:-

DATE	TIME			ELAPSED TIME	TEMP.	READING	CORRECTED READING $Rh' + C_m$	EFFECTIVE DEPTH	PARTICLE DIAMETER	$R_h' - R_o'$	PERCENTAGE FINER THAN D
	Hrs	Mins	Secs	(min)	(^oC)	(R_h')	(R_h)	(H_r mm)	(D_{mm})	(R_d)	(K%)
	9	9	0	0	15						
	9	9	30	0.5	15	24.7	25.2	106.5	**0.0680**	24.8	**100.8**
	9	10	0	1.0	15	24.0	24.5	109.3	**0.0487**	24.1	**97.9**
	9	11	0	2.0	15	22.1	22.6	117.0	**0.0357**	22.2	**90.2**
	9	13	0	4.0	15	19.6	20.1	127.0	**0.0263**	19.7	**80.0**
	9	17	0	8.0	15	16.7	17.2	138.7	**0.0194**	16.8	**68.3**
	9	39	0	30.0	15	11.9	12.4	158.1	**0.0107**	12.0	**48.8**
	10	9	0	60.0	15	9.7	10.2	167.0	**0.0078**	9.8	**39.8**
	11	9	0	120.0	15	7.7	8.2	175.0	**0.0056**	7.8	**31.7**
	16	9	0	420.0	15	5.4	5.9	184.3	**0.0031**	5.5	**22.3**
	9	9	0	1440.0	15	3.5	4.0	192.0	**0.0017**	3.6	**14.6**

CC Geotechnical	Tel: 0151-523-0202 Fax: 0151-523-0252	DETERMINATION OF PARTICLE SIZE DISTRIBUTION	HOLE NO. WS3
CLIENT BARNSLEY MBC		SITE ST. MICHAELS SCHOOL, BARNSLEY	
SAMPLE DEPTH 0.90 - 0.90		SAMPLE REF 1	JOB NO. 09/5514
METHOD OF PRETREATMENT		METHOD OF TEST Wet Sieve + Hydrometer	

	Size (microns)											Size (mm)														
Sieve Size	1	2	6	20	63	75	150	212	300	425	600	1.18	2	3.35	5	6.3	10	14	20	28	37.5	50	63	75	100	150
% by Mass passing Sieve			5	7	8	10	12	14	22	28	36	38	40	40	41	42	45	46	52	60	69	84	100	100	100	



	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
		SILT			SAND			GRAVEL			
%	1	6			31			46			16

SAMPLE DESCRIPTION

Yellow slightly clayey silty cobbly very sandy GRAVEL. Gravel is subangular sandstone

REMARKS

CC Geotechnical

PARTICLE SIZE DISTRIBUTION
SEDIMENTATION BY HYDROMETER METHOD

B.S. 1377 (1990) : Part 2 : Clause 9.5

HYDROMETER No.:- 426076

CYLINDER REFERENCE:- 11

INITIAL MASS OF DRY SOIL = 40.00 g

MENISCUS CORRECTION (C_m) = 0.5

PARTICLE DENSITY (G_s) = 2.60 Mg/m^3

WATER VISCOSITY ( ) = 1.137

HYDROMETER READING IN SOLUTION (R_o') = 1.0005

JOB No.:- 09/5514

SITE:- ST. MICHAELS SCHOOL, BARNSLEY

CLIENT:- BARNSLEY MBC

SAMPLE REF.:- WS5

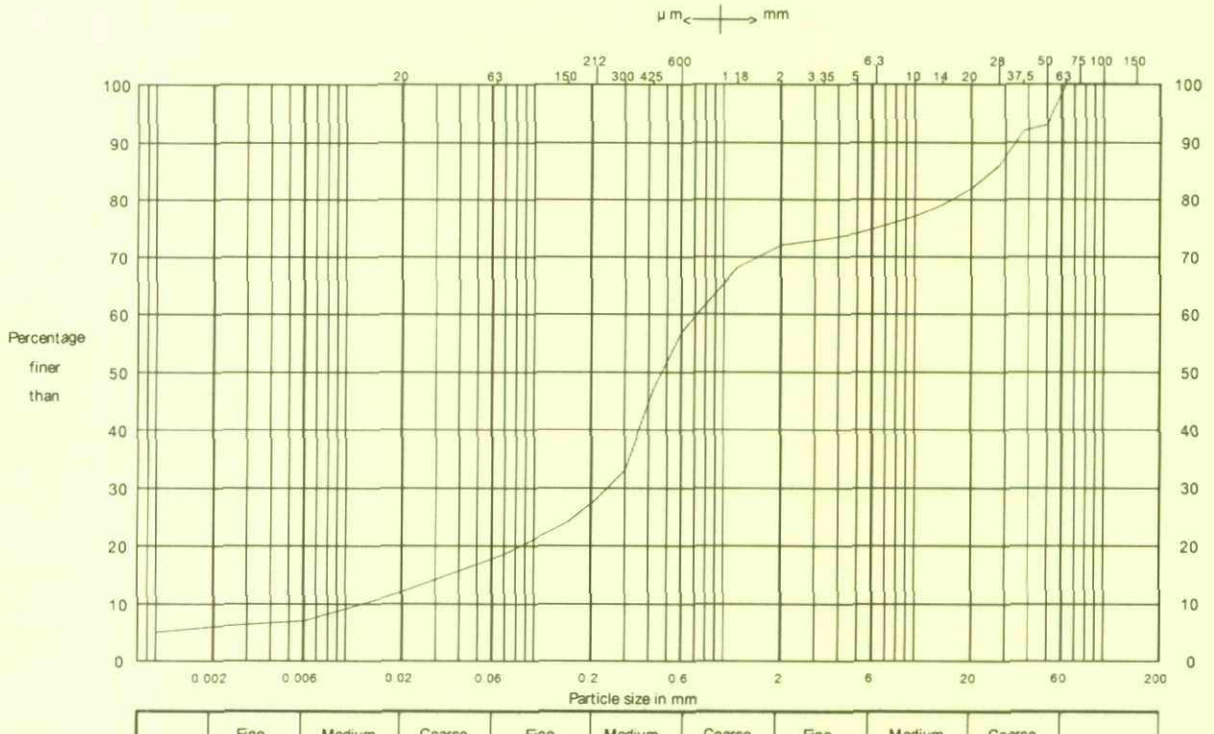
SAMPLE DEPTH:- 0.90 m

DATE SAMPLED:-

DATE	TIME			ELAPSED TIME	TEMP.	READING	CORRECTED READING $Rh' + C_m$	EFFECTIVE DEPTH	PARTICLE DIAMETER	$R_h' - R_o'$	PERCENTAGE FINER THAN D
	Hrs	Mins	Secs	(min)	(^oC)	(R_h')	(R_h)	(H_r mm)	(D_{mm})	(R_d)	(K%)
	9	46	0	0	15						
	9	46	30	0.5	15	24.1	24.6	108.9	**0.0688**	24.2	**98.3**
	9	47	0	1.0	15	23.2	23.7	112.5	**0.0495**	23.3	**94.7**
	9	48	0	2.0	15	21.7	22.2	118.6	**0.0359**	21.8	**88.6**
	9	50	0	4.0	15	18.0	18.5	133.5	**0.0269**	18.1	**73.6**
	9	54	0	8.0	15	15.2	15.7	144.8	**0.0198**	15.3	**62.2**
	10	16	0	30.0	15	12.0	12.5	157.7	**0.0107**	12.1	**49.2**
	10	46	0	60.0	15	10.5	11.0	163.7	**0.0077**	10.6	**43.1**
	11	46	0	120.0	15	9.6	10.1	167.4	**0.0055**	9.7	**39.4**
	16	46	0	420.0	15	8.0	8.5	173.8	**0.0030**	8.1	**32.9**
	9	46	0	1440.0	15	6.2	6.7	181.1	**0.0017**	6.3	**25.6**

CC Geotechnical	Tel: 0151-523-0202 Fax: 0151-523-0252	DETERMINATION OF PARTICLE SIZE DISTRIBUTION	HOLE NO. WS5
CLIENT BARNSLEY MBC		SITE ST. MICHAELS SCHOOL, BARNSLEY	
SAMPLE DEPTH 0.90 - 0.90		SAMPLE REF 1	JOB NO. 09/5514
METHOD OF PRETREATMENT		METHOD OF TEST Wet Sieve + Hydrometer	

	Size (microns)											Size (mm)														
Sieve Size	1	2	6	20	63	75	150	212	300	425	600	1.18	2	3.35	5	6.3	10	14	20	28	37.5	50	63	75	100	150
% by Mass passing Sieve			12	18	19	24	28	33	47	57	68	72	73	74	75	77	79	82	86	92	93	100	100	100	100	



	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
		SILT			SAND			GRAVEL			
%	6	12			54			28			0

SAMPLE DESCRIPTION	REMARKS
Yellow clayey silty very gravelly SAND. Gravel is subangular sandstone	

CC Geotechnical

PARTICLE SIZE DISTRIBUTION
SEDIMENTATION BY HYDROMETER METHOD

B.S. 1377 (1990) : Part 2 : Clause 9.5

HYDROMETER No.:- 88941

CYLINDER REFERENCE:- 12

INITIAL MASS OF DRY SOIL = 40.00 g

MENISCUS CORRECTION (C_m) = 0.5

PARTICLE DENSITY (G_s) = 2.60 Mg/m^3

WATER VISCOSITY ( ) = 1.137

HYDROMETER READING IN SOLUTION (R_o') = 1.0005

JOB No.:- 09/5514

SITE:- ST. MICHAELS SCHOOL, BARNSLEY

CLIENT:- BARNSLEY MBC

SAMPLE REF.:- WS6

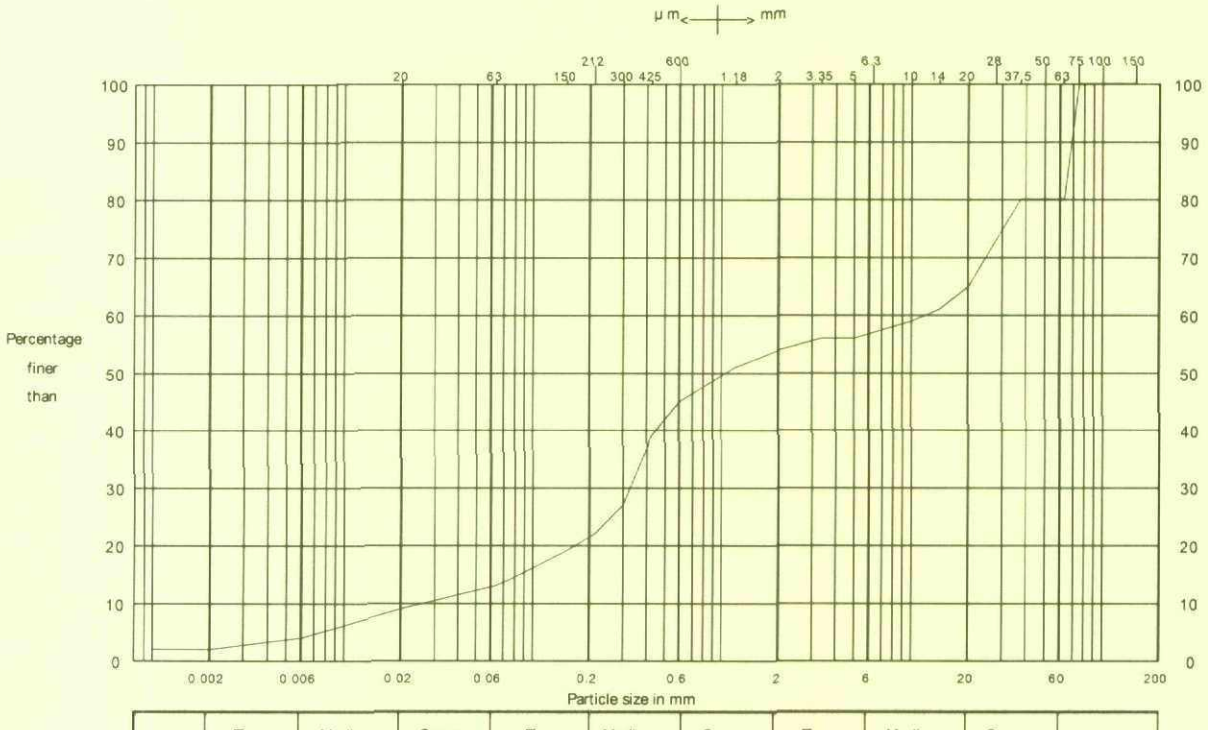
SAMPLE DEPTH:- 0.80 m

DATE SAMPLED:-

DATE	TIME			ELAPSED TIME	TEMP.	READING	CORRECTED READING $Rh' + C_m$	EFFECTIVE DEPTH	PARTICLE DIAMETER	$R_h' - R_o'$	PERCENTAGE FINER THAN D
	Hrs	Mins	Secs	(min)	(°C)	(R_h')	(R_h)	(H_r mm)	(D_{mm})	(R_d)	(K%)
	9	26	0	0	15						
	9	26	30	0.5	15	26.1	26.6	100.8	**0.0662**	26.2	**106.4**
	9	27	0	1.0	15	25.2	25.7	104.5	**0.0477**	25.3	**102.8**
	9	28	0	2.0	15	23.3	23.8	112.1	**0.0349**	23.4	**95.1**
	9	30	0	4.0	15	20.4	20.9	123.8	**0.0259**	20.5	**83.3**
	9	34	0	8.0	15	16.7	17.2	138.7	**0.0194**	16.8	**68.3**
	9	56	0	30.0	15	11.2	11.7	160.9	**0.0108**	11.3	**45.9**
	10	26	0	60.0	15	9.3	9.8	168.6	**0.0078**	9.4	**38.2**
	11	26	0	120.0	15	8.0	8.5	173.8	**0.0056**	8.1	**32.9**
	16	26	0	420.0	15	5.8	6.3	182.7	**0.0031**	5.9	**24.0**
	9	26	0	1440.0	15	4.8	5.3	186.7	**0.0017**	4.9	**19.9**

CC Geotechnical	Tel: 0151-523-0202 Fax: 0151-523-0252	DETERMINATION OF PARTICLE SIZE DISTRIBUTION	HOLE NO. WS6
CLIENT BARNSLEY MBC		SITE ST. MICHAELS SCHOOL, BARNSLEY	
SAMPLE DEPTH 0.80 - 0.80		SAMPLE REF 1	JOB NO. 09/5514
METHOD OF PRETREATMENT		METHOD OF TEST Wet Sieve + Hydrometer	

	Size (microns)											Size (mm)													
Sieve Size	1	2	6	20	63	75	150	212	300	425	600	1.18	2	3.35	5	6.3	10	14	20	28	37.5	50	63	75	100	150
% by Mass passing Sieve			9	13	14	19	22	27	39	45	51	54	56	56	57	59	61	65	73	80	80	80	100	100	100	



	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
		SILT			SAND			GRAVEL			
%	2	11			41			26			20

SAMPLE DESCRIPTION

Yellow slightly clayey silty cobbly very gravelly SAND. Gravel is subangular sandstone

REMARKS

CC Geotechnical

PARTICLE SIZE DISTRIBUTION
SEDIMENTATION BY HYDROMETER METHOD

B.S. 1377 (1990) : Part 2 : Clause 9.5

HYDROMETER No.:- 88933

CYLINDER REFERENCE:- 14

INITIAL MASS OF DRY SOIL = 40.00 g

MENISCUS CORRECTION (C_m) = 0.5

PARTICLE DENSITY (G_s) = 2.60 Mg/m^3

WATER VISCOSITY ( ) = 1.137

HYDROMETER READING IN SOLUTION (R_o') = 1.0005

JOB No.:- 09/5514

SITE:- ST. MICHAELS SCHOOL, BARNSLEY

CLIENT:- BARNSLEY MBC

SAMPLE REF.:- WS8

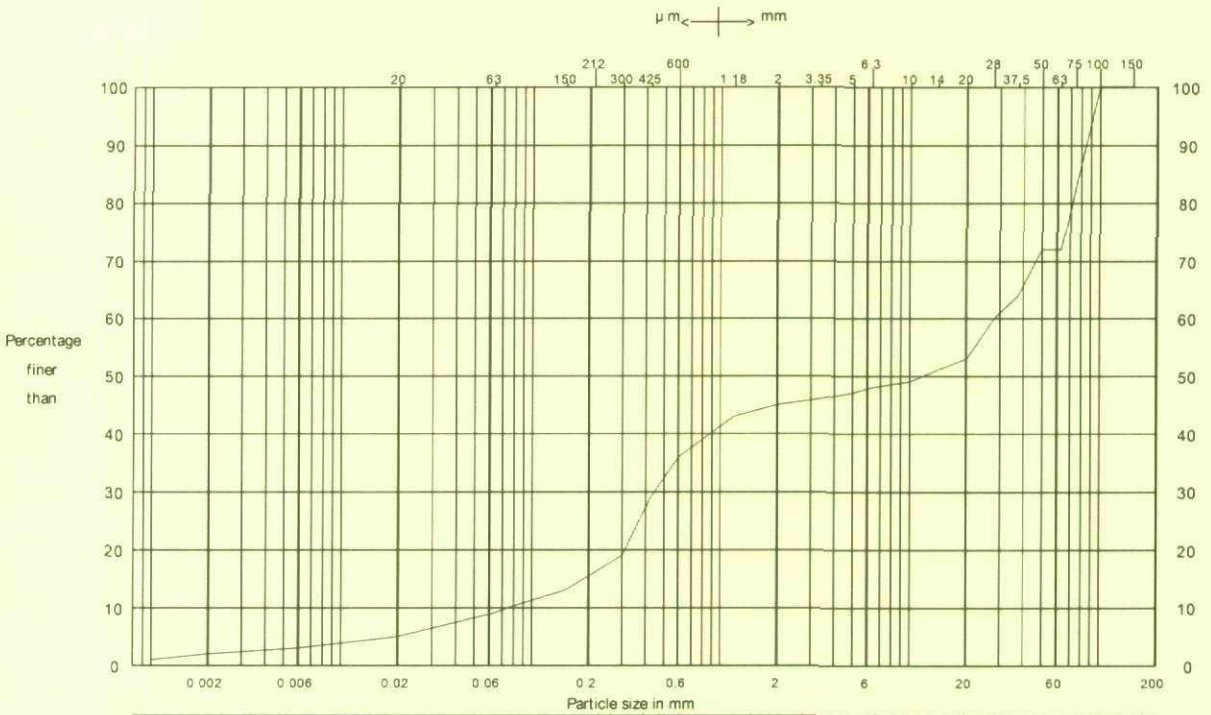
SAMPLE DEPTH:- 0.90 m

DATE SAMPLED:-

DATE	TIME			ELAPSED TIME	TEMP.	READING	CORRECTED READING $Rh' + C_m$	EFFECTIVE DEPTH	PARTICLE DIAMETER	$R_h' - R_o'$	PERCENTAGE FINER THAN D
	Hrs	Mins	Secs	(min)	(°C)	(R_h')	(R_h)	(H_r mm)	(D_{mm})	(R_d)	(K%)
	9	19	0	0	15						
	9	19	30	0.5	15	24.9	25.4	105.7	**0.0678**	25.0	**101.6**
	9	20	0	1.0	15	24.0	24.5	109.3	**0.0487**	24.1	**97.9**
	9	21	0	2.0	15	21.7	22.2	118.6	**0.0359**	21.8	**88.6**
	9	23	0	4.0	15	17.3	17.8	136.3	**0.0272**	17.4	**70.7**
	9	27	0	8.0	15	14.0	14.5	149.6	**0.0202**	14.1	**57.3**
	9	49	0	30.0	15	9.8	10.3	166.6	**0.0110**	9.9	**40.2**
	10	19	0	60.0	15	8.5	9.0	171.8	**0.0079**	8.6	**34.9**
	11	19	0	120.0	15	7.3	7.8	176.7	**0.0057**	7.4	**30.1**
	16	19	0	420.0	15	5.6	6.1	183.5	**0.0031**	5.7	**23.2**
	9	19	0	1440.0	15	4.2	4.7	189.2	**0.0017**	4.3	**17.5**

CC Geotechnical	Tel: 0151-523-0202 Fax: 0151-523-0252	DETERMINATION OF PARTICLE SIZE DISTRIBUTION	HOLE NO. WS8
CLIENT	BARNSLEY MBC	SITE	ST. MICHAELS SCHOOL, BARNSLEY
SAMPLE DEPTH	0.90 - 0.90	SAMPLE REF	1
JOB NO.	09/5514		
METHOD OF PRETREATMENT		METHOD OF TEST	Wet Sieve

	Size (microns)											Size (mm)													
Sieve Size	1	2	6	20	63	75	150	212	300	425	600	1.18	2	3.35	5	6.3	10	14	20	28	37.5	50	63	75	100	150
% by Mass passing Sieve			5	9	10	13	16	19	29	36	43	45	46	47	48	49	51	53	60	64	72	72	83	100	100	



	CLAY	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	COBBLES
		SILT			SAND			GRAVEL			
%	2	7			36			27			28

SAMPLE DESCRIPTION

Yellow slightly clayey silty very cobbly very gravelly SAND. Gravel is subangular sandstone

REMARKS

APPENDIX K:

SOIL AND SOIL WATER CONTAMINATION ANALYSES CERTIFICATES

The Harley Reed Building
Unit C, Drury Lane
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BA
Telephone (01424) 718618
Facsimile (01424) 729911

2683 2683

THE ENVIRONMENTAL LABORATORY LTD

F.A.O. Paul Hadjikyriacou
CC Geotechnical Limited
Essex House, Bridle Road
Bootle, Liverpool
Merseyside, L30 4UE

Reporting Date: 11/06/2009

ANALYTICAL REPORT No. AR21081

Samples Received By:-	Courier
Samples Received:-	03/06/09
Your Project No:	09/5514
Site Location:	St Michaels School, Barnsley
No Samples Received:-	5
Date of Sampling	28/05 - 29/05/09

Report Checked By:-

Steve Knight
Director

Authorised By:-

Cliff P.V. Knight BSc, EurChem, CChem FRSC
Managing Director

Any comments, opinions, or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)
The Environmental Laboratory Ltd. Reg. No.3882193.

THE ENVIRONMENTAL LABORATORY LTD

The Harley Reed Building, Unit C, Drury Lane, Ponswood Industrial Estate, St Leonard's on Sea, East Sussex, TN38 9BA
Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR21081

Location: St Michaels School, Barnsley

ELAB

Your Project No: 09/5514

Reporting Date: 11/06/09

2683 2683

F.A.O. Paul Hadjikyriacou
CC Geotechnical Limited
Essex House, Bridle Road
Bootle, Liverpool
Merseyside, L30 4UE

Soils

Characteristic	Date Sampled	TP/BH	Depth (m)	Our ref	Arsenic** (mg/kg)	Barium* (mg/kg)	Beryllium* (mg/kg)	Cadmium** (mg/kg)	Chromium** (mg/kg)	Lead** (mg/kg)	Mercury** (mg/kg)	Nickel** (mg/kg)	Copper** (mg/kg)	Zinc** (mg/kg)	Selenium (mg/kg)	Vanadium** (mg/kg)	Water Soluble Boron (mg/kg)
Sandy silt loam	28/05/09	WS2	0.40	22448	14.8	61	<1	0.5	16	53	<0.5	13	23	63	1.3	24	<0.5
Loamy sand	28/05/09	WS4	0.40	22449	6.2	42	<1	<0.5	10	16	<0.5	14	10	45	1.0	13	<0.5
Sandy silt loam	29/05/09	WS6	0.40	22450	16.4	136	<1	<0.5	14	59	<0.5	14	26	82	1.1	24	0.7
Sandy silt loam	28/05/09	WS8	0.40	22451	8.7	42	<1	<0.5	11	29	<0.5	8	13	39	0.7	17	0.9
Sandy silt loam	28/05/09	WS9	0.50	22452	5.9	43	<1	<0.5	7	16	<0.5	8	9	26	0.7	11	<0.5

All results expressed on dry weight basis
** - MCERTS accredited test
* = UKAS accredited test

THE ENVIRONMENTAL LABORATORY LTD

The Harley Reed Building, Unit C, Drury Lane, Ponswood Industrial Estate, St Leonard's on Sea, East Sussex, TN38 9BA
Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR21081

Location: St Michaels School, Barnsley

ELAB

Your Project No: 09/5514

Reporting Date: 11/06/09

2683 2683

F.A.O. Paul Hadjikyriacou
CC Geotechnical Limited
Essex House, Bridle Road
Bootle, Liverpool
Merseyside, L30 4UE

Soils

Characteristic	Date Sampled	TP/BH	Depth (m)	Our ref	pH Value** (Units)	Total Sulphate (mg/kg)	Water Soluble Sulphate** (mg/l as SO4)	Total Cyanide** (mg/kg)	Free Cyanide (mg/kg)	Complex Cyanide (mg/kg)	Sulphide (mg/kg)	Elemental Sulphur** (mg/kg)	Water Soluble Nitrate (mg/kg)	Soil Organic Matter* (%)
Sandy silt loam	28/05/09	WS2	0.40	22448	7.3	540	30	<1	<1	<1	<2	<10	6	0.8
Loamy sand	28/05/09	WS4	0.40	22449	7.5	<100	23	<1	<1	<1	<2	<10	<5	0.3
Sandy silt loam	29/05/09	WS6	0.40	22450	6.5	260	36	<1	<1	<1	<2	<10	<5	0.9
Sandy silt loam	28/05/09	WS8	0.40	22451	8.6	<100	154	<1	<1	<1	<2	<10	7	0.5
Sandy silt loam	28/05/09	WS9	0.50	22452	7.6	<100	25	<1	<1	<1	<2	<10	<5	0.6

All results expressed on dry weight basis
** - MCERTS accredited test
* = UKAS accredited test

THE ENVIRONMENTAL LABORATORY LTD

The Harley Reed Building, Unit C, Drury Lane, Ponswood Industrial Estate, St Leonard's on Sea, East Sussex, TN38 9BA
Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR21081

Location: St Michaels School, Barnsley

2683 2683

Your Project No: 09/5514

Reporting Date: 11/06/09

F.A.O. Paul Hadjikyriacou
CC Geotechnical Limited
Essex House, Bridle Road
Bootle, Liverpool
Merseyside, L30 4UE

Soils

Characteristic	Date Sampled	TP/BH	Depth (m)	Our ref	Naphthalene** (mg/kg)	Acenaphthylene** (mg/kg)	Acenaphthene** (mg/kg)	Fluorene** (mg/kg)	Phenanthrene** (mg/kg)	Anthracene** (mg/kg)	Fluoranthene** (mg/kg)	Pyrene** (mg/kg)	Benz(a)anthracene** (mg/kg)	Chrysene** (mg/kg)	Benzo(b)fluoranthene** (mg/kg)	Benzo(k)fluoranthene** (mg/kg)	Benzo(a)pyrene** (mg/kg)	Indeno(123-cd)pyrene** (mg/kg)	Dibenz(ah)anthracene** (mg/kg)	Benzo(ghi)perylene** (mg/kg)	Total PAH** (mg/kg)
Sandy silt loam	28/05/09	WS2	0.40	22448	<0.1	<0.1	<0.1	0.1	0.1	<0.1	0.3	0.2	0.2	0.2	0.4	0.3	0.2	0.3	0.1	0.2	2.9
Loamy sand	28/05/09	WS4	0.40	22449	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	0.1
Sandy silt loam	29/05/09	WS6	0.40	22450	<0.1	<0.1	0.2	0.1	1.0	0.5	2.0	1.5	0.9	1.0	0.8	0.8	0.6	0.7	<0.1	0.6	10.7
Sandy silt loam	28/05/09	WS8	0.40	22451	<0.1	<0.1	<0.1	0.1	0.2	<0.1	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.2	<0.1	0.1	2.1
Sandy silt loam	28/05/09	WS9	0.50	22452	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1	0.1	0.5

All results expressed on dry weight basis

** - MCERTS accredited test

THE ENVIRONMENTAL LABORATORY LTD

The Harley Reed Building, Unit C, Drury Lane, Ponswood Industrial Estate, St Leonard's on Sea, East Sussex, TN38 9BA
Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR21081

Location: St Michaels School, Barnsley

Your Project No: 09/5514

Reporting Date: 11/06/09

F.A.O. Paul Hadjikyriacou
CC Geotechnical Limited
Essex House, Bridle Road
Bootle, Liverpool
Merseyside, L30 4UE

TPH CWG - Soil

Characteristic	Date Sampled	TP/BH	Depth (m)	Our ref	Aromatic							Aliphatic						TPH (C_6 - C_{40})
					>EC_5-EC_7 (mg/kg)	>EC_7-EC_8 (mg/kg)	>EC_8-EC_{10} (mg/kg)	>EC_{10}-EC_{12} (mg/kg)	>EC_{12}-EC_{16} (mg/kg)	>EC_{16}-EC_{21} (mg/kg)	>EC_{21}-EC_{35} (mg/kg)	>EC_5-EC_6 (mg/kg)	>EC_6-EC_8 (mg/kg)	>EC_8-EC_{10} (mg/kg)	>EC_{10}-EC_{12} (mg/kg)	>EC_{12}-EC_{16} (mg/kg)	>EC_{16}-EC_{35} (mg/kg)	(mg/kg)
Sandy silt loam	28/05/09	WS2	0.40	22448	<0.01	<0.01	<0.1	<1	<1	<1	12	<0.01	<0.01	<0.1	<1	<1	2	14
Loamy sand	28/05/09	WS4	0.40	22449	<0.01	<0.01	<0.1	<1	<1	<1	6	<0.01	<0.01	<0.1	<1	<1	1	8
Sandy silt loam	29/05/09	WS6	0.40	22450	<0.01	<0.01	<0.1	<1	<1	1	14	<0.01	<0.01	<0.1	<1	<1	4	20
Sandy silt loam	28/05/09	WS8	0.40	22451	<0.01	<0.01	<0.1	<1	<1	<1	5	<0.01	<0.01	<0.1	<1	<1	3	8
Sandy silt loam	28/05/09	WS9	0.50	22452	<0.01	<0.01	<0.1	<1	<1	<1	1	<0.01	<0.01	<0.1	<1	<1	<1	1

All results expressed on dry weight basis

SP

THE ENVIRONMENTAL LABORATORY LTD

The Harley Reed Building, Unit C, Drury Lane, Ponswood Industrial Estate, St Leonard's on Sea, East Sussex, TN38 9BA

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR21081

Location: St Michaels School, Barnsley

F.A.O. Paul Hadjikyriacou
CC Geotechnical Limited
Essex House, Bridle Road
Bootle, Liverpool
Merseyside, L30 4UE

Your Project No: 09/5514

Reporting Date: 11/06/09

Asbestos Identification

Sample ref:	WS2
Depth (m)	0.40
Our ref:	22448
#Description of Sample Matrix:	Sandy silt loam
Result	No asbestos identified

Sample ref:	WS4
Depth (m)	0.40
Our ref:	22449
#Description of Sample Matrix:	Loamy sand
Result	No asbestos identified

Sample ref:	WS6
Depth (m)	0.40
Our ref:	22450
#Description of Sample Matrix:	Sandy silt loam
Result	No asbestos identified

Sample ref:	WS8
Depth (m)	0.40
Our ref:	22451
#Description of Sample Matrix:	Sandy silt loam
Result	No asbestos identified

Sample ref:	WS9
Depth (m)	0.50
Our ref:	22452
#Description of Sample Matrix:	Sandy silt loam
Result	No asbestos identified

* = UKAS accredited

THE ENVIRONMENTAL LABORATORY LTD

The Harley Road Building, Unit C, Drury Lane, Ponswood Industrial Estate, St Leonard's on Sea, East Sussex, TN38 9BA

Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR21081

Location: St Michaels School, Barnsley

F.A.O. Paul Hadjikyriacou
CC Geotechnical Limited
Essex House, Bridle Road
Bootle, Liverpool
Merseyside, L30 4UE

Your Project No: 09/5514

Reporting Date: 11/06/09

Analytical result only applies to the sample as submitted by the client.

Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

ELAB

UKAS TESTING 2683

mCERTS 2683

The Harley Reed Building
Unit C, Drury Lane
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BA
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

SAMPLE RECEIPT AND TEST DATES

Our Analytical Report Number	AR21081
Your Project No:	09/5514
Sample Receipt Date:	03/06/09
Reporting Date:	11/06/09
Registered:	03/06/09
Prepared:	04/06/09
Analysis complete:	11/06/09

TEST METHOD SUMMARY

PARAMETER	Analysis Undertaken on	Date Tested	Method Number	Technique
Chromium**	Air dried sample	08/06/09	118	ICPMS
Nickel**	Air dried sample	08/06/09	118	ICPMS
Copper**	Air dried sample	08/06/09	118	ICPMS
Zinc**	Air dried sample	08/06/09	118	ICPMS
Arsenic**	Air dried sample	08/06/09	118	ICPMS
Selenium	Air dried sample	08/06/09	118	ICPMS
Cadmium**	Air dried sample	08/06/09	118	ICPMS
Mercury**	Air dried sample	08/06/09	118	ICPMS
Lead**	Air dried sample	08/06/09	118	ICPMS
Water Soluble Boron	Air dried sample	08/06/09	202	Colorimetry
Barium*	Air dried sample	08/06/09	118	ICPMS
Beryllium*	Air dried sample	08/06/09	118	ICPMS
Vanadium	Air dried sample	08/06/09	118	ICPMS
pH Value**	Air dried sample	05/06/09	113	Probe
Total Sulphate	Air dried sample	08/06/09	208	Colorimetry
Total Cyanide**	As submitted sample	09/06/09	204	Automated Flow Digital Colorimetry
Free Cyanide	As submitted sample	09/06/09	106	Colorimetry
Complex Cyanide	As submitted sample	09/06/09	145	Calculation
Sulphide	As submitted sample	04/06/09	109	Colorimetry
Elemental Sulpur**	Air dried sample	09/06/09	122	HPLC
Water Soluble Sulphate**	Air dried sample	10/06/09	172	Ion Chromatography
Water Soluble Nitrate	Air dried sample	10/06/09	172	Ion Chromatography
Soil Organic Matter*	Air dried sample	08/06/09	111	Titration
Asbestos*	As submitted sample	09/06/09	179	see note
Speciated PAH**	As submitted sample	08/06/09	133	Gas Chromatography
TPH CWG	As submitted sample	05/06/09	117	Gas Chromatography

Note:- Documented In-house procedure based on HSG 248 2005 Asbestos analysis qualitative only

Accredited for TPH only, not banding

** - MCERTS Accredited test * = UKAS Accredited test

Determinands not marked with * or ** are non accredited

MCERTS accreditation covers samples which are predominantly sand, clay, loam or combinations of these three soil types

Any comments, opinions, or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

The Harley Reed Building
Unit C, Drury Lane
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BA
Telephone (01424) 718618
Facsimile (01424) 729911

2683

THE ENVIRONMENTAL LABORATORY LTD

F.A.O. Carl Highton
CC Geotechnical Ltd
Essex House, Bridle Road
Bootle, Liverpool
Merseyside. L30 4UE

Reporting Date: 09/07/09

ANALYTICAL REPORT No. AR21536

Samples Received By:-	Courier
Samples Received:-	01/07/09
Your Project No:	09/5514
Site Location:-	St Michaels School, Barnsley
No Samples Received:-	3
Date of Sampling	28/05 - 29/05/09

Report Checked By:-

Steve Knight
Laboratory Manager

Authorised By:-

Cliff P.V. Knight BSc, EurChem, CChem FRSC
Managing Director

Any comments, opinions, or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

THE ENVIRONMENTAL LABORATORY LTD

The Harley Read Building, Unit C, Drury Lane, Ponswood Industrial Estate, St Leonard's on Sea, East Sussex, TN38 9BA
Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR21536

Location: St Michaels School, Barnsley

2683

Your Project No: 09/5514

Reporting Date: 09/07/09

F.A.O. Carl Highton
CC Geotechnical Ltd
Essex House, Bridle Road
Bootle, Liverpool
Merseyside. L30 4UE

Leachates

Date Sampled	TP/BH	Depth (m)	Our ref	Total Hardness (mg $CaCO_3$/l)	Arsenic* (µg/l)	Cadmium* (µg/l)	Chromium* (µg/l)	Lead* (µg/l)	Nickel* (µg/l)	Copper* (µg/l)	Zinc* (µg/l)	Mercury* (µg/l)	Selenium* (µg/l)	Boron (µg/l)	Vanadium (µg/l)	Barium* (µg/l)
28/05/09	WS2	0.40	22448	32	31	<1	<5	19	<5	12	29	<0.1	<5	34	<5	50
28/05/09	WS4	0.40	22449	53	<5	<1	<5	6	<5	6	17	<0.1	<5	47	<5	49
29/05/09	WS6	0.40	22450	34	<5	<1	<5	47	<5	14	29	<0.1	<5	47	6	78

* = UKAS accredited test

THE ENVIRONMENTAL LABORATORY LTD

The Harley Reed Building, Unit C, Drury Lane, Ponswood Industrial Estate, St Leonard's on Sea, East Sussex, TN38 9BA
Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR21536

Location: St Michaels School, Barnsley

2683

Your Project No: 09/5514

Reporting Date: 09/07/09

F.A.O. Carl Highton
CC Geotechnical Ltd
Essex House, Bridle Road
Bootle, Liverpool
Merseyside. L30 4UE

Leachates

Date Sampled	TP/BH	Depth (m)	Our ref	pH Value* (Units)	Sulphate* (mg/l)	Total Cyanide* (µg/l)	Free Cyanide (µg/l)	Complex Cyanide (µg/l)	Elemental Sulphur (mg/l)	Total PAH (SUM DW4#) (µg/l)	TPH (C6-C40)* (µg/l)	Nitrate* (mg/l)
28/05/09	WS2	0.40	22448	7.0	6	<5	<5	<5	<0.1	<0.01	<10	6.0
28/05/09	WS4	0.40	22449	7.0	<5	<5	<5	<5	<0.1	<0.01	<10	0.8
29/05/09	WS6	0.40	22450	7.0	5	<5	<5	<5	<0.1	<0.01	<10	3.0

- Sum of benzo(b)flouranthene, benzo(k)flouranthene, benzo(ghi)perylene & indeno (1.2.3-cd) pyrene

* = UKAS accredited test

THE ENVIRONMENTAL LABORATORY LTD

The Harley Reed Building, Unit C, Drury Lane, Ponswood Industrial Estate, St Leonard's on Sea, East Sussex, TN38 9BA
Tel: 01424 718618 Fax: 01424 729911

ANALYTICAL REPORT No. AR21536

Location: St Michaels School, Barnsley

Your Project No: 09/5514

Reporting Date: 09/07/09

F.A.O. Carl Highton
CC Geotechnical Ltd
Essex House, Bridle Road
Bootle, Liverpool
Merseyside. L30 4UE

Leachates

Date Sampled	TP/BH	Depth (m)	Our ref	Naphthalene (µg/l)	Acenaphthylene (µg/l)	Acenaphthene (µg/l)	Fluorene (µg/l)	Phenanthrene (µg/l)	Anthracene (µg/l)	Fluoranthene (µg/l)	Pyrene (µg/l)	Benz(a)anthracene (µg/l)	Chrysene (µg/l)	Benzo(b)fluoranthene (µg/l)	Benzo(k)fluoranthene (µg/l)	Benzo(a)pyrene (µg/l)	Indeno(123-cd)pyrene (µg/l)	Dibenz(ah)anthracene (µg/l)	Benzo(ghi)perylene (µg/l)	Total PAH (µg/l)
28/05/09	WS2	0.40	22448	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
28/05/09	WS4	0.40	22449	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
29/05/09	WS6	0.40	22450	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

ELAB

UKAS TESTING
2683

The Harley Reed Building
Unit C, Drury Lane
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BA
Telephone (01424) 718618
Facsimile (01424) 729911

THE ENVIRONMENTAL LABORATORY LTD

LEACHATE SAMPLE RECEIPT AND TEST DATES

Our Analytical Report Number	AR21536
Your Ref No:	09/5514
Sample Receipt Date:	01/07/09
Reporting Date:	09/07/09
Registered:	01/07/09
Prepared:	02/07/09
Analysis complete:	09/07/09

LEACHATE TEST METHOD SUMMARY

PARAMETER	Method Number	Technique
Total Hardness	101	ICPMS
Chromium*	101	ICPMS
Nickel*	101	ICPMS
Copper*	101	ICPMS
Zinc*	101	ICPMS
Arsenic*	101	ICPMS
Selenium*	101	ICPMS
Cadmium*	101	ICPMS
Mercury*	101	ICPMS
Lead*	101	ICPMS
Boron	101	ICPMS
Vanadium	101	ICPMS
Barium*	101	ICPMS
pH Value*	113	Electrometric
Sulphate*	131	Ion Chromatography
Total Cyanide*	130	Colorimetry
Free Cyanide	132	Colorimetry
Complex Cyanide	143	Calculation
Elemental Sulphur	122	HPLC
Total PAH (SUM DW4#)	135	GCMS
TPH (C6-C40)*	117	Gas chromatography
Nitrate*	131	Ion Chromatography
Speciated PAH	135	GCMS

* = UKAS Accredited test

Any *comments*, opinions, or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683)

APPENDIX L:

RISK ASSESSMENT METHODOLOGY

CURRENT CONTAMINATED LAND LEGISLATION / GUIDANCE & ENVIRONMENTAL RISK ASSESSMENT METHODLOGY

LEGISLATION OVERVIEW

This report includes hazard identification and risk assessment in line with the risk-based methods referred to in relevant UK legislation and guidance. Government environmental policy is based upon a "suitable for use approach". When considering the current use of land, Part IIA of the Environment Protection Act 1990 (EPA 1990) provides the regulatory regime, which was introduced by Section 57 of the Environment Act 1995, which came into force in England on 1 April 2000. The main objective of introducing the Part IIA regime is to provide an improved system for the identification and remediation of land where contamination is causing unacceptable risks to human health or the wider environment given the current use and circumstances of the land.

Part IIA provides a statutory definition of contaminated land under Section 78A(2) 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, 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."

Part IIA provides a statutory definition of the pollution of controlled waters under Section 78A(9) as:

*"the entry into controlled waters of **any** poisonous, noxious or polluting matter or **any** solid waste matter".*

In order to assist in establishing if there is a "significant possibility of significant harm" there must be a "significant pollutant linkage" for potential harm to exist. That means there must be a source(s) of contamination, sensitive receptors present and a connection or pathway between the two. This combination of source-pathway-receptor is termed a "pollutant linkage or SPR linkage."

Part IIA of The Environmental Protection Act 1990 is supported by a substantial quantity of guidance and other Regulations, especially *DEFRA Circular 01/2006 Contaminated Land (this replaces DETR Circular 02/2000). Part IIA defines the duties of* Local Authorities in dealing with it. With the exception of situations of very high pollution risk, Part IIA places contaminated land responsibility on thee planning and redevelopment process. In situations where there is very high pollution risk direct action from the Local Authority is usually necessary. Planning Policy Statement 23 (PPS23) provides guidance on the planning process and requires that sites which have been developed shall not be capable of being determined "contaminated land" under Part IIA.

The criteria for assessing levels of pollutants and hence determining whether a site represents a hazard are based on a range of techniques, models and guidance. Within this context it is relevant to note that Government objectives are:

(a) to identify and remove unacceptable risks to human health and the environment;
(b) to seek to bring damaged land back into beneficial use;
(c) to seek to ensure that the cost burdens faced by individuals, companies and society as a whole are proportionate, manageable and economically sustainable.

These three objectives underlie the "suitable for use" approach to remediation of contaminated land. The "suitable for use" approach focuses on the risks caused by land contamination. The approach recognises that the risks presented by any given level of contamination will vary greatly according to the use of the land and a wide range of other factors, such as the underlying geology of the site. Risks therefore should be assessed on a site-by-site basis.

The "suitable for use" approach then consists of three elements:

(a) *ensuring that land is suitable for its current use - in other words, identifying any land where contamination is causing* unacceptable risks to human health and the environment, assessed on the basis of the current use and circumstances of the land, and returning such land to a condition where such risks no longer arise; the contaminated land regime provides the regulatory mechanisms to achieve this;

(b) ensuring that land is made suitable for any new use, as planning permission is given for that new use - in other words, assessing the potential risks from contamination, on the basis of the proposed future use and circumstances, before official permission is given for the development and, where necessary to avoid unacceptable risks to human health and the environment, remediating the land before the new use commences; this is the role of the town and country planning and building control regimes; and

(c) limiting requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to the current use or future use of the land for which planning permission is being sought - in other words, recognising that the risks from contaminated land can be satisfactory assessed only in the context of specific uses of the land (whether current or proposed), and that any attempt to guess what might be needed at some time in the future for other uses is likely to result either in premature work (thereby running the risk of distorting social, economic and environmental priorities) or in unnecessary work (thereby wasting resources).

The mere presence of pollutants does not therefore necessarily warrant action, and consideration must be given to the scale of risk involved for the current and proposed end use of the site.

RISK ASSESSMENT METHODOLOGY

Current practice recommends that the determination of potential liabilities that could arise from land contamination be carried **out using the process of risk assessment, whereby "risk" is defined as:**

"(a) The probability, or frequency, or occurrence of a defined hazard; and
(b) The magnitude (including the seriousness) of the consequences."

The UK's approach to the assessment of environmental risk is set out in by the Department of the Environment (2000) publication "A Guide to Risk Assessment and Risk Management for Environmental Protection." This established an iterative, systematic staged process which comprises:

(a) Hazard identification
(b) Hazard assessment
(c) Risk estimation
(d) Risk evaluation
(e) Risk Assessment

At each stage during the investigation process the above steps are repeated as more detailed information becomes available for the site.

CLR11- 'Model Procedures for the Management of Land Contamination', a document published by the Department for Environment, Food and Rural Affairs (DEFRA) and the Environment Agency (EA) outlines a tiered approach to the assessment of risks posed by contaminated land, as summarised hereunder:

Tier 1: Preliminary Risk Assessment

A Preliminary Risk Assessment is usually undertaken as part of a desk study, outlines potential risks posed by potential contamination to all receptors by **defining plausible "pollution linkages" and de**veloping a preliminary conceptual model (PCM). The purpose of this model is to define all possible complete **pollution linkages, where the requisite source – pathway – target** elements are present, and these elements being defined as:

- **a contaminant (source) is a** *hazardous substance or agent,* present at levels that have the potential to cause harm or damage a receptor
- **a pathway is the means by or through which a contaminant comes into contact with, or otherwise affects, the** receptor
- **a receptor (target) is an entity (human being, aquatic environment, flora and** fauna etc) that is vulnerable to the adverse effects of the contaminant

This relationship is termed a "pollution linkage". It should be recognised that for a health or environmental risk to exist, all *three elements of the relationship* or linkage must be present, i.e.

- **if there is no contaminant, or contaminant present at levels below those considered to be harmful or damaging to a** receptor, then there can be no adverse effect on a receptor
- **if there is no receptor present that can be adversely** affected by a contaminant, no harm or damage can arise
- **even where both a contaminant and a receptor are present,** no harm or damage will occur if there is no pathway by or through which a linkage between the two can be established

The absence of one or more of each component (source, pathway, receptor) would prevent a pollutant linkage being established and there would be no significant environmental risk.

The PCM is subject to continual refinement as additional data becomes available. As part of a Phase I Investigation (Desk Study and site walk over) a PCM is formed. Based on the PCM, potential pollutant linkages can be assessed. If the PCM and hazard assessment indicate that a pollution linkage is not of significance then no further assessment or action is required due to this linkage. For each significant and possible linkage a risk assessment is carried out. The linkages which potentially pose significant risks may require a variety of responses ranging from immediate remedial action or risk management or, more commonly, further investigation and risk assessment. This next stage is usually termed a Phase II Main Site Investigation and should provide additional data to allow refinement of the PCM and assess the level of risk from each pollutant linkage. Risk assessment will usually include Tier 2 Generic Quantitative Risk Assessment and / or, if necessary, a Tier 3 Detailed Quantitative Risk Assessment.

Tier 2: Generic Quantitative Risk Assessment (GQRA)

GQRA requires an intrusive investigation in order to characterise the site assisting in the re-assessment of the source-pathway receptor linkage. The conceptual model should be refined accordingly.

Upon completion of an intrusive investigation a it must be decided whether Generic Assessment Criteria (GAC) are suitable for assessing the risk posed by potential contaminantion at the site. If GAC are deemed unacceptable for risk assessment purposes or cannot be developed a Tier 3 Detailed Quantitative Risk Assessment (DQRA) is required.

If GQRA reveals that unnacceptable risks are not present then no further action is required. If GQRA identifies a possibility of risk, a decision must be made whether further work is required or necessary for the purposes of risk assessment. If further risk assessment is is deemed not suitable not required an Options Appraisal should be undertaken. If further risk assessment is required, the scope nature of further risk **assessment must be decided – it is possib**le that a Tier 3 DQRA will be undertaken *in this scenario.*

Tier 3: Detailed Quantitative Risk Assessment (DQRA)
DQRA is used when pollutant linkages require further assessment. DQRA is often undertaken for pollutant linkages where GAC are unavailable or inappropriate for or more conservative than the actual circumstances of the site. Site specific data is used to create Site Specific Assessment Criteria (SSAC) and enable a more accurate assessment of the risks. Further investigation may or may not be required to formulate SSAC depending on the site specific conditions and information alrerady obtained.

If DQRA reveals that unnacceptable risks are not present then no further action is required. If DQRA identifies a possibility of risk, a decision must be made whether further work is required or necessary for the purposes of risk assessment. If further risk assessment is is deemed not suitable not required an Options Appraisal should be undertaken. If further risk assessment is required, the scope and nature of further risk assessment must be decided at this point.

NOTE: A Tier 1 Preliminary Risk Assessment is undertaken as part of a Desk Study Report and a Preliminary Conceptual Model is devloped for all pollutant linkages. However, the methodologies for assessing the risks to human health, risks to controlled waters and risk posed by ground gas using quantative techniques vary considerably, therefore GQRA and DQRA for human health, controlled waters and ground gas must be undertaken seperately. The risk assessment methodologies where quantative assessment is used for risks to human health, risks to controlled waters and risks posed by ground gas, if relevant, are described hereunder.

BACKGROUND INFROMATION, CURRENT GUIDANCE AND RISK ASSESSMENT METHODOLOGY FOR RISKS POSED TO HUMAN HEALTH

Background

In March 2002, the Department for Environment, Food and Rural Affairs (DEFRA) and the EA published the Contaminated Land Exposure Assessment (CLEA) Model and a series of related reports. These were designed to provide a scientifically based framework for the assessment of chronic risks to human health from contaminated land. These reports (CLR7-10) **together with associated "SGV" documents have since been** withdrawn (August 2008) and the following documents have been published as revised guidance to the CLEA assessment:

- Environment Agency : 2008: Updated Technical Background to the CLEA model Science Report SC050021/SR3
- *Environment Agency : 2008: Human Health Toxicological Assessment of Contaminants in Soil SC050021/SR2*

Additional guidance on statistical assessment replacing CLR 7 is provided in:

- CL:AIRE :2008 Guidance on Comparing Data With a Critical Concentration

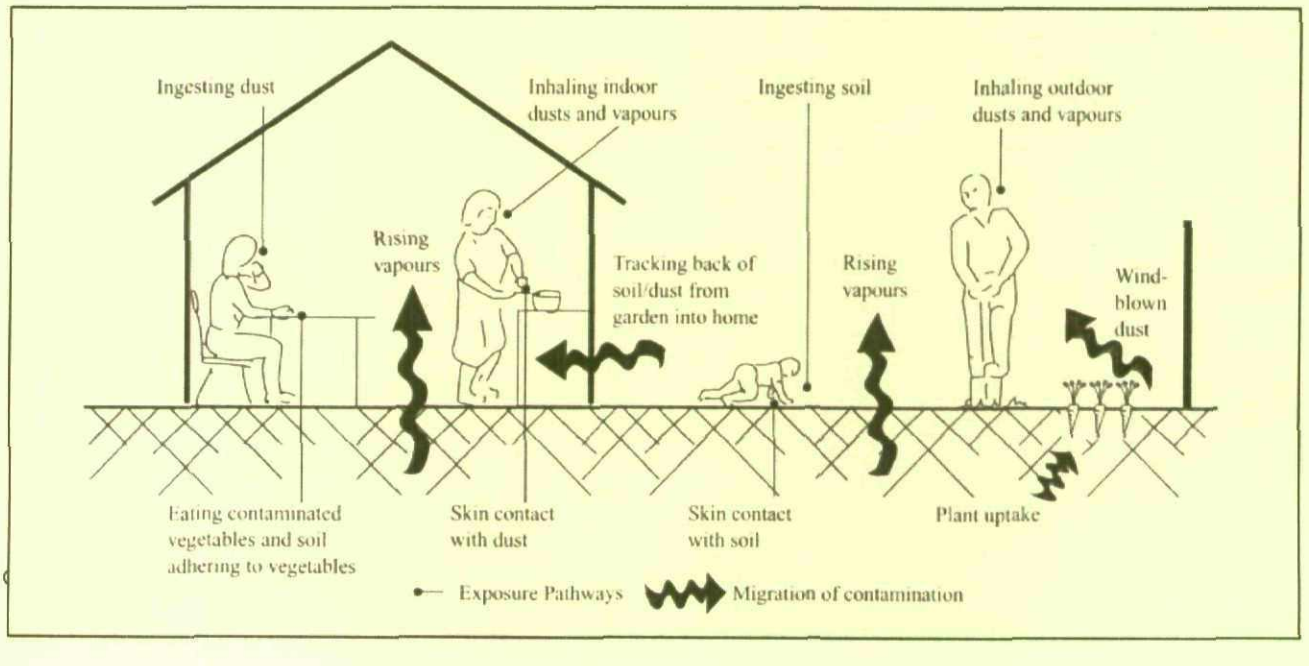
Other guidance/software used in spatial / statistical assessment is provided in:

- USEPA 2006: Data Quality Assessment: Statistical Methods for Practitioners
- **Spatial Analysis and Decision Assistance (SADA) – The University of Tennessee**

A different approach to the statistical appraisal of data is required depending on whether the assessment of risk is to assess whether land is Contaminated Land in accordance with regulations, or whether the assessment is to determine whether the site is suitable for new development in according with Planning guidance. This is discussed further in CL:AIRE :2008 **"Guidance on Comparing Data** With a Critical **Concentration".**

A program for the derivation of GAC`s based on the above guidance is provided by the Environment Agency and is entitled **"CLEA Software Version 1.04".**

The CLEA model has been developed to calculate an estimated tolerable daily soil intake (TDSI) for site users given a set **'default' exposure pathways. Ten human exposure pathways** are covered in the CLEA model as presented below:



Ingestion
- ingestion of outdoor soil
- ingestion of indoor dust
- ingestion of home grown produce
- ingestion of soil attached to home grown produce

Dermal Contact
- dermal contact with outdoor soil
- *dermal contact with indoor dust*

Inhalation
- inhalation of outdoor dust
- inhalation of indoor dust
- inhalation of outdoor soil vapour
- inhalation of indoor soil vapour

It should be noted that there are other potential exposure pathways on some sites not included in the CLEA model e.g. certain organic compounds can pass through plastic water pipes into drinking water supply.

Where contaminated water is present at a depth less than 2.00mbgl and there is a potential risk of inhalation of vapours (only when volatile compounds are present) the risk from inhalation of vapours from soil water will be assessed using a UK *compliant version of BP Risc v4.02.*

The presence and/or significance of each of the above exposure pathways are dependent on the type of land use being considered and the nature of the contaminant under scrutiny. **Accordingly, the CLEA model considers for principle 'default' land use types and makes a series of 'default' assumptions with** regard to human exposure frequency, duration and critical human target groups for each land use considered:

- residential
- allotments
- commercial / industrial land use

The above land use categories defined in the CLEA are detailed below:

Residential: This generic scenario assumes a typical residential property consisting of a two-storey house built on a ground-bearing slab with a private garden consisting of lawn, flowerbeds, and a small fruit and vegetable patch. The occupants are assumed to be parents with young children, who make regular use of the garden area.

Allotments: This generic scenario assumes a plot of open space (about 250 m2), commonly made available by the local authority to tenants to grow fruit and vegetables for their own consumption. There are usually several plots to a site and the overall site area may cover more than a hectare. The tenants are assumed to be parents or grandparents and that young children make occasional accompanied visits to the plot.

Commercial/Industrial: There are many different kinds of workplace and work-related activities. This generic scenario assumes a typical commercial or light industrial property consisting of a threestorey building at which employees spend most time indoors and are involved in officebased or relatively light physical work.

Human Health Risk Assessment Methodolgy
Assessment of risk for the protection of human health is undertaken using the methodology as outlined previously, and summarised hereunder:

- Tier 1 Preliminary Risk Assessmnent
- Tier 2 Generic Quantitative Risk Assessment
- Tier 3 Detailed Quantitative Risk Assessment

The Tier 1 Preliminary Risk Assessment is undertaken as part of the desk study report and includes the development of a Preliminary Conceptuel Model. Tier 2 and Tier 3 Quantitative Risk Assessments are undertaken in order to develop and refine the Preliminary Conceptual Model aiding a more detailed assessment of the risk posed by contaminants revelaed by site investigation and soil / soil water chemical analyses.

The methods used by ***CC GEOTECHNICAL LTD*** to derive assessment criteria, to statistically analyse chemical data and to compare chemical data to the derived assessment criteria are discussed herunder.

Derivation of Generic Assessment Criteria (GAC) and Site Specific Assessment Criteria (SSAC)
GAC`s are derived on the basis of the proposed land use and the associated applicable exposure pathways. It should be noted that there are difficulties in establishing soil concentrations of contaminants beyond which risks from exposure to these **contaminants would be 'unacceptable' and the GAC value does not necessarily equate to the level for "significant possibility of *significant harm" as defined in Part* IIA of** The Environmental Protection Act (1990) to determine whether land is **"contaminated." This ultimately requires detailed 'toxicological' information of the** health effects of individual contaminants and also a scientific judgement **on what constitutes an 'unacceptable' risk. The primary purpose of the CLEA derived GAC's are as 'minimal risk thresholds' for** the assessment of human health risks in relation to land use.

Minimal risk thresholds calculated using generic input parameters for each of the above land uses are termed Generic Assessment Criteria (GAC) and are used for Generic Quanatative Risk Assessment (GQRA). However, further assessment may be required taking into consideration site specific factors such as the way the land is used, the soil type, the building

characteristics and the exact nature of the receptor, to determine whether there is a significant possibility of risk to human health to site users. Such an assessment is known as a Detailed Quantitative Risk Assessment (DQRA) and the resultant threshold concentrations are known as Site Specific Assessment Criteria (SSAC). Such assessments should be conducted with the agreement of the local authority (or the Environment Agency) since it is the authority that determines whether land is Contaminated Land or whether Planning Permission for a new development may be granted.

For the purposes of this report, assessment criteria have been derived in accordance with current guidance based on the conceptual model for the proposed land use using the CLEA v1.04 software. These criteria are not intended to indicate whether the site may be contaminated land nor do they replace any published soil guideline values. However, the values are intended to provide guidance for the local authority on whether the site may be considered uncontaminated. If, based on the **site's proposed future use, the site would be considered by** the local authority to be uncontaminated and therefore, on the basis of soil concentrations, fit for purpose, then no further risk assessment based on soil concentrations and the risk to human health would be necessary. However, should these criteria be exceeded or the conceptual site model vary from the model used in the risk assessment to derive these values then the risk assessment should be updated accordingly.

For contamiants routinely analysed where inhalation is a significant pathway (naphthalene, phenanthrene, Aromatic EC5-EC7, Aromatic EC7-EC8, Aromatic EC8-EC10, Aromatci EC10-EC12, Aromatic EC12-EC16, Aliphatic EC5-EC6, Aliphatic EC8_EC10, Aliphatic EC10-EC12, Aliphatic EC12-EC16), plots of the GAC as a function of Soil Organic Matter (SOM) are used to determine if they pose a potential risk to human health, which are presented hereunder. Where there is an exceedance further assessment may be undertaken.

Statistical Assessment of Soil Contamination Data & Comparison of Contamination Data to Threshold Values
In any site investigation only a small fraction of the soil on the site is analysed. Therefore the mean derived from the contamination data for a contaminant may not be the same as the true mean for the contaminant distribution on the site. To improve the reliability of any assessment a statistical analyses **is undertaken in line with the CL:AIRE document "Guidance on** Comparing Soil Contamination Data **with a Critical Concentration".**

Statistical assessment of soil data is undertaken using programs based on the guidance in the CL:AIRE document or the USEPA software ProUCL v4.0.

Where the number of results in a dataset is less than four, a statistical assessment is not undertaken, and the assessment is performed by comparison of the maximum value(s) with a Health Criteria Value (HCV), such as Generic Assessement Criteria value(s).

For the Planning situation, the regulator needs to check whether the concentration of contaminants is low compared to the HCV. This decision is based on whether there is at least a 95% confidence level that the true mean of the dataset is lower than the HCV.

For the Part IIA scenario the regulator needs to determine whether the concentration of contaminants is greater than the HCV. This decision is based on whether there is at least a 95% confidence level that the true mean of the dataset is higher than the HCV. However, the regulator may proceed with determination **if there is just a 51% probability, "on the balance of probabilities".**

The Outlier Test used in the statistical assessment may not be able identify separate populations if numerous populations are present. Inorder to ensure that this is not the case a spatial assessment of the data will be undertaken using SADA.

If the screening levels are exceeded then more sophisticated quantitative risk assessment or remedial action may be undertaken. The benefits of undertaking a quantitative risk assessment must be weighed against the likelihood that it will bring about cost savings in the proposed remediation.

BACKGROUND INFORMATION, CURRENT GUIDANCE AND RISK ASSESSMENT METHODOLOGY FOR RISKS POSED TO CONTROLLED WATER

Definition of Controlled Waters
The term 'controlled waters' is defined in Section 104 of the Water Resources Act 1991 as:

"Territorial Waters...which extend seawards for three miles..., coastal waters..., inland freshwaters, waters in any relevant lake or pond or of so much of any relevant river or watercourse as is above the freshwater limit, and ground waters, that is to say, any waters contained in underground strata."

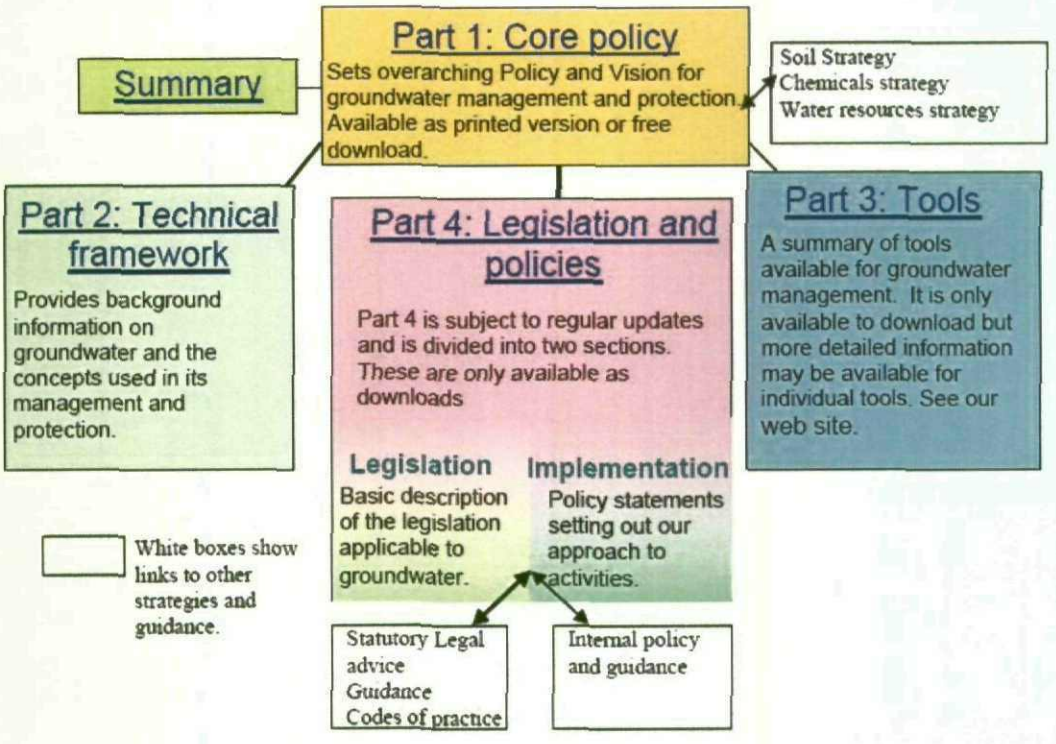
Note that the definition of groundwater under the Water Resources Act 1991 includes all water within underground strata (including soil / pore water in the unsaturated zone). The definition of groundwater under the Groundwater Directive however is limited to water in the saturated zone. For the purposes of Part IIA of the Environmental Protection Act 1990, the Environment Agency recommends that the groundwater within the saturated zone only is considered as the receptor (rather than soil / pore water).

Environment Agency Guidance
Legislation and guidance surrounding the protection of controlled waters in the UK is abundant and can be complex. The **Environment Agency's overall** position on groundwater is *"To protect and manage groundwater resources for present and future generation in ways that are appropriate for the risks that we identify"* (Groundwater Protection : Policy and Practice GP3, 2006). In brief, the core objectives of the existing legislation serve to enforce this position.

In 1992, the National Rivers Authority published their Policy and Practice for the Protection of Groundwater (PPPG), this document was influential as it provided a focus for key developments such as Source Protection Zones (SPZs) and

Groundwater Vulnerability Maps. The Policy was then revised in 1998, since which there have been substantial changes in legislation, driven by Europe. Key European Directives relating to groundwater include the Groundwater Directive (80/68/EEC) and the Water Framework Directive (2000/60/EC). Aspects of these directives are controlled by primary UK legislation such as the Water Resources Act 1991. Further to legislative changes, gaps identified in the 1998 PPPG required addressing. These changes are reflected in the forthcoming Environment Agency Policy document entitled *Groundwater Protection : Policy and Practice (GP3)*, a draft version of which was available for public consultation (Parts 1 to 3) ending July 2006 with Part 4 issued in March 2008. Part 4 includes a section on key groundwater legislation and the Environment **Agency's interpretation of it.**

The following gives a breakdown of the structure of the document (taken from the Environment Agency GP3 draft consultation document, 2006)



Controlled Water Risk Assessment Methodology
The risk posed to controlled water is assessed by ***CC GEOTECHNICAL*** in accordance with current guidance as outlined hereunder.

In order for a developer of a potentially contaminated site to fulfil their obligations under the legislation, a site assessment would be required to be undertaken in order to identify any potential risks to controlled waters and to derive suitable clean-up criteria if necessary to ensure the protection of controlled waters. The general approach for Groundwater Protection is detailed further in Part 3 of GP3.

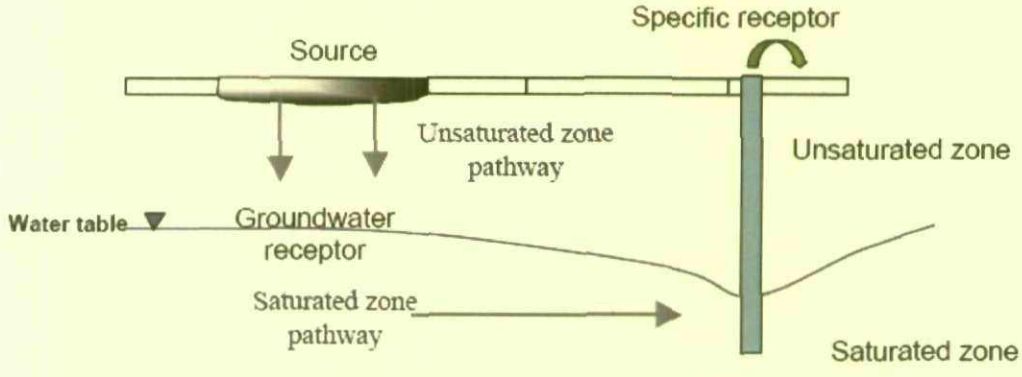
When assessing groundwater impact the Environment Agency advocate the application of their framework methodology **"Remedial Targets Methodology – Hydrogeological Risk Assessment for Land Contamination" Environment Agency (2006).** The methodology has four levels of assessment as described below:

- **Level 1** considers whether contaminant concentrations in "pore water" in contaminated soil are sufficient to impact on the receptor, ignoring dilution, dispersion and attenuation along the pathway. The "pore water" concentration is determined from:
  - i) measured "pore water" concentrations or perched water quality
  - ii) soil leaching tests
  - iii) theoretical calculations based on soil/water partitioning equations
- **Level 2** considers dilution by the receiving groundwater or surface water body and whether this is sufficient to reduce contaminant concentrations to acceptable levels. The remedial target is defined as the target concentration multiplied by a dilution factor (DF).
- **Levels 3 and 4** consider whether natural attenuation (including dispersion, retardation and degradation) of the contaminant as it moves through the unsaturated and saturated zones to the receptor are sufficient to reduce contaminant concentrations to acceptable levels. The remedial target is defined as target concentration multiplied by a dilution factor (DF) and attenuation factor (AF). In **Level 3** simple analytical models are used to calculate the significance **of attenuation. The Environment Agency has released a "Remedial targets worksheet v3.1" to carry out basic calculations** using a conservative approach up to **Level 3** using basic principles assuming a simple migration of contaminants from the

source zone into the aquifer receptor. **Level 4** assessment uses more sophisticated numerical models, and allows for the introduction of additional geological horizons and is used mainly to determine whether soil contaminants will reach their target within a specified timeframe. Use of such software should only be used once agreement has been obtained from the Environment Agency.

Three main stages apply to any risk assessment of controlled waters, these are:

1. **Risk Screening (Tier 1 Preliminary Risk Assessment):** The understanding of the Conceptual Site Model (CSM) is the key to assessing any site. Using a robust CSM, potential pathways or receptors may be screened out from any further assessment at an early stage. For example if the pathway through the unsaturated zone is blocked by the presence of a significant thickness of low permeability clay. A greater understanding of the CSM is achieved with each tier of risk assessment. An example of a basic CSM is given below (taken from the Environment Agency GP3 draft consultation document, 2006):



2. **Generic Hydrogeological Risk Assessment (EA Remedial Targets Methodology Level 1):** When undertaking the Generic Hydrogeological Risk Assessment (EA Remedial Targets Methodology Tier 1), comparison of chemical analytical results is made with screening criteria. Published values of screening criteria with which chemical test results can be compared are published in the following guidance:

   - Water Supply (Water Quality) Regulations 2000
   - The Private Water Supplies Regulations 1991
   - Environmental Quality Standards for surface waters based on The EC Dangerous Substnaces Directive (76/464/EEC and Daughter Directives)
   - The Surface Waters(Abstraction for Drinking Water Classification) Reguslations 1996
   - World Health Organisation Drinking Water Standards 2004

   Should the Level 1 assessment indicate threshold levels to be exceeded, then there are three alternative ways in which to proceed:

   - To devise suitable remedial solutions
   - To carry out more investigation, sampling and analysis
   - To conduct a site specific Detailed Quantitative Risk Assessment (DQRA) to determine determine if the materials are suitable for thair proposed use, or devise site specific clean-up level

3. **Detailed Quantitative Risk Assessment (EA Remedial Targets Methodology Levels 2 to 4):** The decision to carry out a DQRA will be dependant on the extent and implications of the initial qualitative and generic assessment. The scope of any such assessment will be accurately defined by the outcomes of the previous levels of assessment. The conceptual model will be sufficiently refined by this stage that only certain contaminants of concern, certain pathways and certain receptors will require further assessment, the remainder having been screened out.

   Additional site specific data is normally required for this stage of assessment, as explained above, more processes that are capable of affecting contaminant concentrations are considered (such as dilution and attenuation).

   Remediation criteria, if derived, will therefore be specific to each site and will be based on a detailed assessment of the potential impact at the identified receptor or *compliance point*. A greater level of confidence can be placed on the predicted impact on the compliance point following a DQRA.

BACKGROUND INFORMATION, CURRENT GUIDANCE AND RISK ASSESSMENT METHODOLOGY FOR RISKS POSED BY GROUND GAS

Background

Origin of Ground and Landfill Gases

When carrying out a ground gas risk assessment, the origin or source of the gases is important as potential risks will vary depending on the source. This Appendix relates to the risk of the two main ground gases of concern; methane and carbon dioxide, and does not apply to other ground gases (e.g. radon or vapours from hydrocarbon spills). Methane and carbon dioxide are major constituents of landfill gas but can also occur from a variety of anthropogenic and natural sources, as summarised in Table 5 below:

Gas	Source	Comments
Landfill Gas	Anaerobic decomposition of degradable waste within landfill sites. Typically 60% methane and 40% carbon dioxide during methanogenic phase.	Composition varies over time, particularly in early stages. Contains a range of minor constituents (particularly carbon monoxide and hydrogen sulphide).
Landfill Associated Gases	- Anaerobic degradation of leachate external to the site; - Degassing of dissolved gases in groundwater; - Evolution of gases following interaction between leachate and groundwater	Can result in secondary (external) production of methane or carbon dioxide.
Made Ground	Anaerobic degradation of organic components	Very variable depending on source
Sewer Gas, Cess Pits	Anaerobic degradation of organic components of sewage producing methane and carbon dioxide.	Often characterised by hydrogen sulphide odour.
Mains Gas	Leakage from underground pipework or storage tanks. Mainly methane but often contains higher alkanes.	An odouriser is added to permit detection of leaks. Typically 90% CH_4, but 1 to 27% C_2-C_4 alkanes, May also contain other trace gases e.g. CO, helium and CO_2 (from degradation of CH_4 in the ground).
Other Anthropogenic Sources	- Degradation of leaked or spilled hydrocarbons or other industrial chemicals; - Anaerobic degradation of organic contaminants in groundwaters (e.g. silage liquor); - Reactions between monitoring well construction components and environment; - Burial grounds/cemeteries.	**Hydrocarbon spillages often have an 'oily' odour. Fuel spillages common – Petrol or Diesel and can contain a wide range of VOC's. *Can degrade to produce methane*** / carbon dioxide.
Alluvium / Marsh / Peat Gas	Anaerobic microbial degradation of organic material (usually waterlogged vegetation / peat). Often associated with the presence of alluvial deposits or dredgings.	
Geogenic Gas	Natural seepages of carbon dioxide and hydrocarbon gases derived from geologic sources such as coal seams and deep oil / gas source formations. Can be present in solution in groundwaters.	Methane most common but can contain carbon dioxide and higher alkanes.
Mine Gases	**Various types. Most common is "fire damp" with high methane, produced by the desorption of gas trapped in coal. "Black damp" (Stythe gas) with high carbon dioxide and denser than air. "White damp" is high in carbon** monoxide.	Methane most common. Can contain higher alkanes, carbon dioxide and carbon monoxide. Often low in oxygen.
Natural *Shallow* Ground Gas	Various types - *high carbon dioxide formed* by subsurface aerobic activity leading to depleted oxygen and elevated carbon dioxide; - chemical degradation of rocks (e.g. carbonates) producing carbon dioxide; - carbon dioxide production in root zone of soils by plants.	Gases can be emitted from ground under falling barometric pressure conditions.

Table 5. Potential Sources of Ground Gases

This Appendix does not provide guidance for the assessment of risk when other gases **are present due to 'Other Sources' from** *the above table* (particularly organic compounds such as BTEX and **VOC's or for the risk from radon or hydrogen sulphide).**

To determine the origin of the gas a range of factors must be considered together, including;

1. Proximity of likely sources
2. Ground conditions (geology, hydrogeology, anthropogenic pathways etc)
3. Properties of gases present including:
   - Chemical composition
   - *Physical properties*
   - Ratios of components e.g. methane : carbon dioxide
4. Timeframe of activities such as infilling periods, capping works, installation of gas control systems etc

Identification of the originating source may be problematic given that there may be more than one source present and trace gas analysis may be required. Identification of the sources of the gases encountered during monitoring is usually carried out through a process of eliminating the most unlikely potential sources (given the site setting) and selecting those which are most likely.

Hazards Associated with Presence of Methane

Methane gas is combustible and potentially explosive. When the concentration of methane in air is between the limits of 5.0%v/v and 15.0%v/v an explosive mixture is formed. The Lower Explosive Limit (LEL) of methane is 5.0%v/v, which is equivalent to 100% LEL. The 15.0%v/v limit is known as the Upper Explosive Limit (UEL), but concentrations above this level cannot be assumed to represent safe concentrations. Further, the LEL and UEL will vary (up and down) depending upon the proportion of other gases (including oxygen). However, the fact that methane is a colourless, odourless gas means that there

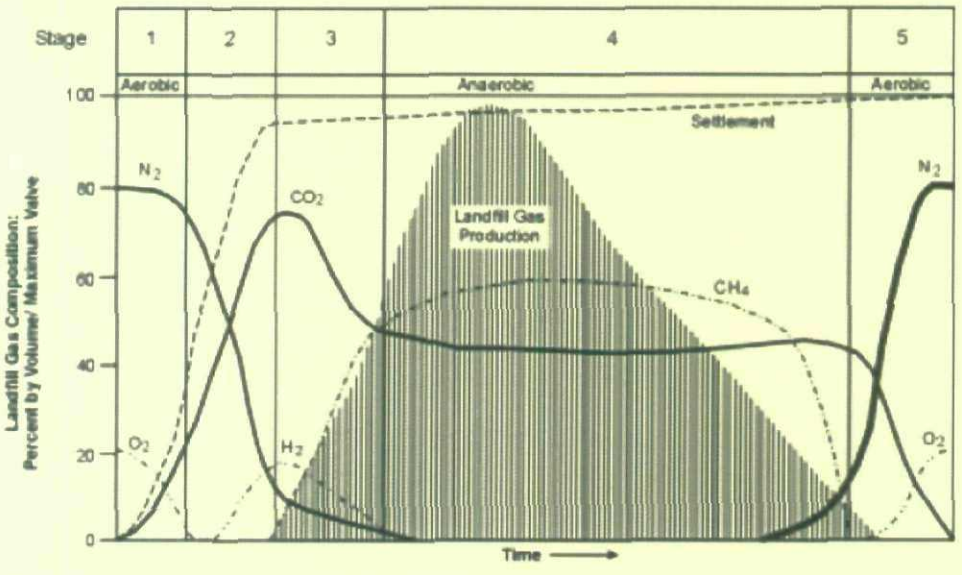
is no simple indicator of the presence of the gas until such a time as explosive limits are reached and an incident occurs. Methane is lighter than air and has a low toxicity. However, at high concentrations it can result in asphyxiation due to oxygen displacement.

Hazards Associated with Presence of Carbon Dioxide

Carbon dioxide is a colourless, odourless gas, which, although non-flammable, is both toxic and an asphyxiant. As carbon dioxide is denser than air, it will collect in low points and depressions. The UK Health & Safety Executive (HSE) has published information relating to concentrations of carbon dioxide that humans may be exposed to, which uses concentrations contained in the Control of Substances Hazardous to Health Regulations 2002 (as amended). These are the Long Term Occupational Exposure Limit (LTOEL, 8 hour period) and the Short Term Occupational Exposure Limit (STOEL, 15 minute period), which are 0.5% and 1.5% carbon dioxide, respectively.

Parameters Influencing the Rate of Ground Gas Production

The figure below is taken from EA guidance document LFTGN 03 illustrates typical ground gas generation curves from biodegradable materials:



The production of methane and carbon dioxide at a landfill site may be expected to be considerable and ongoing. Concentrations of methane will eventually decrease, followed by concentrations of carbon dioxide, but the duration and rate of gas production can vary markedly between sites. Five distinct phases of gas production occur during the process which are, in order of event as marked above, as follows:

1. An aerobic phase involving oxygen depletion and temperature increase through aerobic respiration;
2. The establishment of anaerobic conditions and the evolution of carbon dioxide and hydrogen through acidogenic activity;
3. Commencement of methanogenic activity; the establishment of populations of methanogenic bacteria;
4. A phase of stable methanogenic activity, which may go on for many tens of years;
5. A phase of decreasing methanogenic activity, representing depletion of the organic material and a return to aerobic conditions.

The time scale for the return to the normal ground gas concentrations will be highly variable, depending upon the types and quantities of materials present. In addition, the optimum parameters influencing the rate of decomposition and ground gas production within the ground at a site are as follows:

- High water content with adequate rainfall and water infiltration to provide moisture content between approximately 20 to 26%;
- Conditions that either are or are very close to anaerobic;
- High proportion of biodegradable materials;
- A pH between 6.5 and 8.5, ideally verging slightly on the acidic between pH 6 to 7;
- Temperature between 25°C and 55°C;
- The ratio of the biochemical and chemical oxygen demands (BOD:COD);
- High permeability;
- Small particle size, as finer subsurface materials possess a greater surface area to provide a growing 'face' for the micro-organisms but high fines levels reduces permeability and reduces decomposition rate.

For this reason, it is vital that sources of methane and carbon dioxide are identified prior to the commencement of any work on a construction site, and that the ground gas regime is characterised at the worst temporal conditions a site may experience. From this, a risk assessment is carried out to identify the risk at the site from ground gases so that suitable protection measures can be designed and incorporated into a development to prevent a dangerous build-up of gas occurring.

Factors Influencing the Migration and Behaviour of Ground Gases

CD37a

There are many factors that influence the migration of ground gases which can effect the risk from a gassing source:

- **driving force - pressure differential along a pa**thway, diffusion and dissolved in solution;
- **meteorological conditions - short term and seasonal conditi**ons including atmospheric pressure changes (e.g. rapidly falling pressure causes gas to expand increasing emission rates), rainfall, frozen ground and thawing, temperature;
- **geological and groundwater conditions - these can have the ov**er riding influence on the direction/pathways and quantity of migrating gas;
- **anthropogenic influences - man-made pathways include mine** shafts, service runs/drains, foundation piles, underground voids/pits/basements, foundation/building design/construction

Current Guidance
Previous versions of Building Regulations Approved Document C provided statutory guidance stating that consideration should be given to appropriate action and / or specific solutions in situations where methane concentration exceeded 1%v/v or carbon dioxide concentrations exceeded 5%v/v. The latest Building Regulations Approved Document C (DoE 2004) no longer endorses this approach and recommends the use of a risk based approach to interpreting a gas monitoring survey. This is in line with current EA guidance for landfill gas (LFTGN 03, 2004) which recommends the use of a structured risk based approach similar to that outlined in CLR 11. On this basis, recent guidance has been produced in 2006 and 2007 with the aim of providing up to date advice in relation to residential and commercial development. The guidance does not address issues associated with gas derived from landfills, for this refer to *"Guidance on the Management of Landfill Gas"* (Environment Agency 2004) for an overview.

Recent guidance relevant to gas assessments for residential and commercial development includes;

- **Wilson *et al.* (CIRIA C665, December 2007) *"Assessing Risks Posed by Hazardous Ground Gases for Buildings."***
  This document provides up to date advice on all aspects of ground gas risk assessment such as investigation, monitoring programmes, data collection and interpretation. The guidance presents separate methodologies for the characterisation of:
  - All development types except low rise housing with gardens (Situation A)
  - Low rise housing with gardens (Situation B)

- **Boyle and Witherington (NHBC / RSK Group, Report 10627-R01(04) January 2007) *"Guidance on the Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present."***
  This document presents the "Traffic Lights System" detailed below and is relevant only for low rise properties (e.g. bungalows and town houses) that have a ventilated sub-floor void (i.e. Situation B as described in CIRIA C665).

- **British Standard (BS 8485, December 2007) *"Code of Practice for the Characterization and Remediation from Ground Gas in Affected Developments"***
  This document provides an overview of gas characterisation and assessment. The Standard is intended to be used by designers of gas protection measures and regulators involved in the assessment of design solutions.

Further guidance, **Wilson and Card (CIEH) *"Ground Gas Handbook for Designers and Regulators"*** providing practical guidance on ground gas assesments and the design and evaluation of protection measures, is expected to be published in March 2009.

Each of these documents continues to highlight the importance of, and give further guidance towards, carrying out a tiered risk-based decision-making process in accord with government policy on dealing with contamination from historic or natural sources and highlight the importance of the Conceptual Model in site characterisation.

Ground Gas Risk Assessment Methodology
Assessment of risk posed by ground gas is undertaken using the methodology as outlined previously, and summarised hereunder:

- Tier 1 Preliminary Risk Assessmnent
- Tier 2 Generic Quantitative Risk Assessment
- Tier 3 Detailed Quantitative Risk Assessment

The methodology used in each of the above assessments with concern to ground gas is discussed hereunder.

Tier 1 Preliminary Risk Assessment
All potential sources of methane and carbon dioxide are identified in the Preliminary Conceptual Model and the generation potential determined. The background information discussed earlier is referred to in order to determine the potential for a source to generate ground gas.

CIRIA C665 provides idealised monitoring frequency / period dependant upon generation potential of gas source and sensitivity of the proposed land use as below:

Idealised Frequency and Period of Monitoring (after Table 5.5a and 5.5b, CIRIA C665)

		Generation Potential of Source				
		Very Low	**Low**	**Moderate**	**High**	**Very High**
Sensitivity of Development	**Low** (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with Gardens)	6/3	9/6	12/6	24/12	24/24

Notes
1. First number is the number of readings and the second is the minimum period in months (e.g. 6/2 – six sets of readings over two months).
2. At least two sets of readings must be at low (preferably under 1,000 mb) and falling pressure.

The monitoring programme is decided using the above table prior to the intrusive site investigation. However, if the intrusive investigation reveals that a the potential source is better or worse than anticipated the monitoring programme should be modified accordingly. For example, if the made ground contains no evidence of organic material and comprises entirely granular brick fill, the potential for that made ground to generate ground gas is reduced considerably.

Tier 2 Generic Quantitative Risk Assessment
Generic Quantitiative Risk Assessment is undertaken upon completion of the required gas monitoring period.

All three current guidance documents propose that both ground gas concentrations and flow rates are used to calculate the limiting gas well gas volume flow rates for methane and carbon dioxide, based on the ground gas conditions monitored for during the worse-case temporal conditions. This limiting gas well volume flow rate is termed the Gas Screening Value (GSV, note that this was termed borehole gas volume flow), and is calculated as follows:

$$\textbf{GSV}\ (\text{l/hr}) = \frac{[\text{gas well gas concentration (\%v/v)}] \times [\text{gas well flow rate (l/hr)}]}{100}$$

GSV's are compared to typical max concentrations and limiting gas screening values derived for either Situation A - All development except low rise housing with gardens, or Situation B low rise housing with gardens (NHBC Traffic Light System). Table 8.5 from CIRIA C665 is used for comparison of gas screening values for "Situation A Developments" and is presented hereunder:

Characteristic Situation (CIRIA R149)	Comparable Partners in Technology gas Regime (see Box 8.2)	Risk Classification	Gas Screening Value (CH_4 or CO_2) (l/hr)[1]	Additional Factors	Typical Source of Generation
1	A	Very low risk	<0.07	Typically methane ≤ 1% and/or carbon dioxide ≤ 5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" made ground
2	B	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to characteristic Situation 3	Natural soil, high peat/organic content. "Typical" made ground
3	C	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	D	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mineworking susceptible to flooding, completed landfill (WMP 26B criteria)
5	E	High risk	<70		Mineworking unflooded inactive with shallow workings near surface
6	F	Very high risk	>70		Recent landfill site

Table 8.5 from CIRIA C665 Modified Wilson and Card Classification

Table 8.7 is used for comparison of gas screening values for "Situation B Developments" and is presented herunder:

Traffic Light	Methane[1]		Carbon Dioxide[2]	
	Typical max concentration[3] (% by volume)	Gas screening value[2,4] (litres/hour)	Typical max concentration[3] (% by volume)	Gas screening value[2,4] (litres/hour)
Green	1	0.13	5	0.78
Amber 1	5	0.63	10	1.60
Amber 2	20	1.60	30	3.10
Red				

Notes:
1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decoder as to what Traffic Light is allocated;
2. Borehole Gas Volume Flow Rate, in litres per hour as defined in Wilson and Card (1999), is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;
3. The Typical Maximum Concentration can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;
4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

Table 8.7 from CIRIA C665 - NHBC Traffic light system for 150 mm void

Dependant on the outcome of the assessment of risk posed by ground gas it is determined whether gas protection measures are required for the proposed development, and or whether a detailed quantitative risk assessment is required for the site.

Selection & Design of Protective Measures
Table 8.6 and Box 8.4 of CIRIA C665 contain information on the detailed design of protection measures and were initially intended for the purposes of determining then level of protection measures a development requires. These tables and related text include some useful information on the design of gas protection measures, however BS84845:2007, which supersedes the guidance included within CIRIA C665, is used for selection of gas protection measures.

BS8485: 2007 uses a scoring system dependant on the Characteristic Situation / NHBC Traffic Light and proposed end use of the site. The scoring system is summarised in BS8485:2007 Table 2 as presented hereunder:

Characteristic gas situation, CS	NHBC traffic light	Required gas protection			
		Non-managed property e.g. private housing	Public building (a)	Commercial buildings	Industrial buildings (b)
1	*Green*	0	0	0	0
2	*Amber 1*	3	3	2	1 (c)
3	*Amber 2*	4	3	2	2
4	*Red*	6 (d)	5(d)	4	3
5			6(e)	5	4
6				7	6

NOTE *Traffic light indications are taken from NHBC Report no.:10627-RO1 (04) and are mainly applicable to low-rise residential housing[1]. These are for comparative purposes but the boundaries between the traffic light indications and CS values do not coincide.*

a) Public buildings include, for example, managed apartments, schools and hospitals.
b) Industrial buildings are generally open and well ventilated. However, areas such as office pods might require a separate assessment and may be classified as commercial buildings and require a different scope of gas protection to the main building.
c) Maximum methane concentration 20% otherwise consider and increase to CS3.
d) Residential building on higher traffic light/CS sites is not recommended unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g. high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g. in institutional and/or fully serviced contractual situations.
e) Consideration of issues such as ease of evacuation and how false alarms will be handled are needed when completing the design specification of any gas protection scheme

[1] The NHBC guidance and CIRIA C665 guidance refers to low rise housing (which is up to three storeys without lifts) that is constructed with a 150mm ventilated sub-floor void.

BS8485:2007 Table 2 Required gas protection by characteristic gas situation and type of building

Once a score is assigned, a combination of protection systems / elements is chosen from BS8485:2007 Table 3 shown below:
CD37a

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
a) Venting/dilution (See Annex A BS8485)			
Passive sub floor ventilation (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)[A]	Very good performance	2.5	*Ventilation performance in accordance with Annex A (BS8485)*
	Good performance	1	*If passive ventilation is poor this is generally unacceptable and some form of active system will be required.*
Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.)[A]		2.5	*There have to be robust management systems in place to ensure the continued maintenance of any ventilation system. Active ventilation can always be designed to meet good performance.*
Ventilated car park (basement or undercroft)		4	*Mechanically assisted systems come in two forms: extraction and positive pressurization.*
b) Barriers			
Floor slabs			
Block and beam floor slab		0	*It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum. Breaches in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances.*
Reinforced concrete ground bearing slab		0.5	
Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab		1.5	
Reinforced concrete cast in situ suspended floor slab with minimal service penetrations and water bars around all slab penetrations and at joints		1.5	
Fully tanked basement		2	
c) Membranes			
Taped and sealed membrane to reasonable levels of workmanship/in line with current good practice with validation [B,C]		0.5	*The performance of membranes is heavily dependent on the quality of design of the installation, resistance to damage after installation, and the integrity of joints.*
Proprietary gas resistant membrane to reasonable levels of workmanship /in line with good practice under independent inspection (CQA)[B,C]		1	
Proprietary gas resistant membrane installed to reasonable levels of workmanship/in line with current good practice under CQA with integrity testing and independent validation		2	
d) Monitoring and detection (not applicable to non-managed property, or in isolation)			
Intermittent monitoring using hand held equipment		0.5	*Where fitted, permanent monitoring systems ought to be installed in the underfloor venting/dilution system in the first instance but can also be provided within the occupied space as a fail safe.*
Permanent monitoring and alarm system [A]	Installed in the underfloor venting/dilution system	2	
	Installed in the building	1	
e) Pathway Intervention			
Pathway intervention		-	*This can consist of site protection measures for off-site or on-site sources (see Annex A, BS8485)*
NOTE In practice the choice of materials might well rely on factors such as construction method and the risk of damage after installation. It is important to ensure that the chosen combination gives an appropriate level of protection			
A) It is possible to test ventilation systems by installing monitoring probes for post installation validation.			
B) If a 1 200g DPM material is to function as a gas barrier it should be installed according to BRE 212 /BRE 414 being taped and sealed to all penetrations			
C) Polymeric Materials> 1200 g (proportional to thickness) but their physical properties mean that they are more robust and resistant to damage.			

BS8485:2007 Table 3 Solution Scores

Where the gas situation is 4 or more (and for NHBC Red situations) the site requires a comprehensive risk assessment to confirm the scope of protection measures. These are higher risk sites and reliance on Table 2 and 3 alone is not sufficient.

For a site which is impacted by migratory gases from an off site source, the development may be protected by imposing pathway intervention methods, which if successfully validated, could also remove the need for further analysis. It is essential that the gas regime in these circumstances has been fully characterised and that the only source impacting the site is located off site and that the pathway is clearly defined and its interception equally proven before construction commences. Pathway intervention methods may include vertical membrane installations, venting trenches, rows of stone columns, activated trenches and various proprietary systems. These systems are particularly relevant to domestic housing where there is limited scope for foundation type solutions.

CURRENT GUIDANCE ON REMEDIATION

When risk assessment of the site has been completed and it indicates that remedial works are required, the main guidance in managing this process is set out in the DEFRA/EA publication **CLR11 (2004) "Model Procedures for the Management of Land Contamination." The stages of m**anaging remediation are as follows:

(a) Options Appraisal and develop Remediation Strategy;
(b) Develop Implementation Plan and Verification Plan;
(c) Remediation, Verification and Monitoring.

The Remediation Strategy sets out the remediation targets, identifies technically feasible remedial solutions and presents an evaluation of the options so that these can be assessed enabling that the most suitable solution is adopted. An outline of the proposed remedial method should be presented. Agreement should be sought of the appropriate statutory bodies for the Remediation Strategy before proceeding to the next stage.

The Implementation Plan is a detailed method statement setting out how the remediation is to be carried out including stating how the site will be managed, welfare procedures, health and safety considerations together with practical measures such as details of temporary works, programme of works, waste management licences and regulatory consents required. Agreement should again be sought of the appropriate statutory bodies for this Plan.

The Verification Plan sets out the requirements for gathering data to demonstrate that the remediation has met the required remediation objectives and criteria. The Verification Plan presents the requirements for a wide range of issues including the level of supervision, sampling and testing regimes for treated materials, waste and imported materials, required monitoring works during and post remediation, how compliance with all licenses and consents will be checked etc. Agreement should again be sought of the appropriate statutory bodies for the Verification Plan. On completion of the remediation a Verification Report should be produced to provide a complete record of all remediation activities on site and the data collected as required in the Verification Plan. The Verification Report should demonstrate that the remediation has met the remedial targets to show that the site is suitable for the proposed use.

APPENDIX M:

ASSESSMENT OF CONTAMINATION DATA

CC Geotechnical

SUMMARY OF STATISTICAL ASSESSMENT UNDERTAKEN ON SOIL CONTAMINATION DATA - METALS, SEMI-METALS AND NON METALS

Job Number: 09/5514 Site Name: St Micheals School Barnsley
Prepared by: C Highton
Scenario: Residential Without Plant Upts

Sampling Location	Depth (m)	Soil Type	METALS & SEMI METALS: Arsenic	Cadmium	Total Chromium	Lead	Total Mercury	Nickel	Copper	Zinc	Selenium	Water Soluble Boron	pH Value (units)	NON METALS: Total Sulphate	Water Soluble Sulphate	Total Cyanide	Free Cyanide	Complex Cyanide	Sulphide	Elemental Sulphur	Water Soluble Nitrate	Soil Organic Matter (%)	PAH'S: Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Fluoranthene	Pyrene	Benzo(a)anthracene	Chrysene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	Indeno(123-cd)pyrene	Dibenz(ah)anthracene	Benzo(ghi)perylene	Total PAH	SPECIATED TPH'S: AROMATICS: EC5-EC7	EC7-EC8	EC8-EC10	EC10-EC12	EC12-EC16	EC16-EC21	EC21-EC35	ALIPHATICS: EC5-EC6	EC6-EC8	EC8-EC10	EC10-EC12	EC12-EC16	EC16-EC35	TPH (C5 - C40)
Limit of Detection			1	1	1	1	1	1	1	1	1	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
WS2	0.40		14.8	0.5	19.0	52.8	<	12.7	22.5	62.6	1.3	<	7.3	540.0	30.3							6.8	0.9				0.1	0.1	0.1	0.9	0.5	0.3	0.2	0.4	0.3	0.2	0.3	0.1	0.2	2.9						12.4											1.9	14.3
WS4	0.40		6.2		9.7	16.2	<	13.7	10.5	45.3	1.0	<	7.5		23.5							0.3																	0.1	0.1					6.1											1.4	7.5
WS6	0.40		16.4		14.2	59.7	<	13.6	26.1	82.4	1.1	0.7	6.5	260.0	35.5							0.9			0.2	0.1	1.0	0.5	2.0	1.5	0.9	1.0	0.8	0.8	0.6	0.7		0.6	10.7					1.3	14.4										4.1	19.8
WS8	0.40		8.7		10.6	28.7	<	8.0	13.0	36.8	0.7	0.8	6.6		154.0						6.7	0.5				0.1	0.2	0.1	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.2		0.1	2.1						5.2										2.8	8.0
WS9	0.50		5.9		7.1	14.0	<	7.9	9.4	24.5	0.7	<	7.6		24.8							0.4											0.2					0.2	0.3					1.4											1.4	
GAC / SSAC			37.00	30.00	2630	132	1.00	127.00	9000	40400	986.11		N/A										1.64	239.00	157.00	153.00	14.21	7.91	3112	1229	9.39	84.39	9.82	18.84	1.00	9.71	1.24	102.67		259	617	1.84	8.82	46.00	48.70	128000		1.40	4.56	1.84	3.82	18.84	2701	SSAC(s)
Hazardous Waste Threshold			464	536	1520	1667	N/A	1556	25,304	N/A	30,000	43	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1000	1000	1600	1000	1600	1600	1600	1600	1000	1900	1900	1900	1000	1900	1900	1000		1000	1000	1000	1000	1000	1000	1000		1000	1000	1000	1000	1000	1000	1000
WRAS Threshold			10	3	N/A	300	1	N/A	N/A	N/A	3	N/A	N/A		2000	N/A	N/A	25	250	250	5000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A	50
Sample size			5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5		5	5	5	5	5	5	5		5	5	5	5	5	5	5
Sample mean			10.40	0.5	11.51	34.49	0.5	11.17	16.267	51.11	0.9449	0.8056	7.504	220	53.623	1	1	1	2	10	5.48852727	0.62952742	0.1	0.1	0.126	0.108	0.313	0.171	0.579	0.436	0.313	0.336	0.329	0.282	0.222	0.293	0.163	0.227	3.258	0.01	0.01	0.1	1	1	1.062	7.922	0.01	0.01	0.1	1	1	2.228	10.21
Standard deviation			4.92	0	3.568	20.18	0	3.004	7.5236	21.8	0.2535	0.161588	0.75824	191.8333	56.309209	0	0	0	0	0	0.73745448	0.23365708	1E-09	1E-09	0.057	0.008	0.402	0.159	0.806	0.633	0.34	0.391	0.29	0.298	0.202	0.241	0.007	0.199	4.321	0	0	1E-09	0	0	0.14	5.348	0	0	1E-09	0	0	1.227	7.015
95th UCL (mg/kg)			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0		0	0	0	0	0	0	0

NOTES
* BANDED TPH'S COMPARED AGAINST GAC'S FOR THE MOST CONSERVATIVE ALIPHATIC/AROMATIC HYDROCARBON BAND
* SSAC ONLY DERIVED WHERE SOIL CONCENTRATIONS EXCEED GAC

KEY
1.0 = True Outlier | 1.0 = Result exceeding GAC/S | 1.0 = Result exceeding 'Hazardous Waste' threshold | 1.0 = True Outlier exceeding WRAS threshold