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environmental and geotechnical consultants

# Proposed redevelopment
# Richmond Upon Thames College
# Egerton Road
# Twickenham

## Ground Investigation Report

Cedar Barn, White Lodge, Walgrave, Northamptonshire NN6 9PY

**t**: 01604 781877 **e**: mail@soiltechnics.net
**f**: 01604 781007 **w**: www.soiltechnics.net

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# Richmond Upon Thames College
# Egerton Road
# Twickenham
# TW2 7SJ

# GROUND INVESTIGATION REPORT
# Revision 02

**Soiltechnics Ltd. Cedar Barn, White Lodge, Walgrave, Northampton. NN6 9PY.**
**Tel: (01604) 781877 Fax: (01604) 781007 E-mail: mail@soiltechnics.net**

## Report originators

| | | |
|---|---|---|
| Prepared by | Georgina Everest B.Sc, (Hons) FGS | georgina.everest@soiltechnics.net<br>Assistant Geo-environmental Engineer, Soiltechnics Limited |
| Prepared by | Charlotte Murray B.Sc, (Hons) FGS | charlotte.murray@soiltechnics.net<br>Geo-environmental Engineer, Soiltechnics Limited |
| Supervised by | Sarah Drage B.Sc, (Hons) | sarah.drage@soiltechnics.net<br>Senior geo-environmental Engineer, Soiltechnics Limited |
| Supervised by | Seb Crolla B.Sc, (Hons), MIEnvSc., FGS. | seb.crolla@soiltechnics.net<br>Senior geo-environmental Engineer, Soiltechnics Limited |
| Reviewed by | Dr Matthew Hooper<br>B.Sc. (Hons)., M.Sc., Ph.D., MIEnvSc., F.G.S. | matt.hooper@soiltechnics.net<br>Director, Soiltechnics Limited |

Updates from Rev00 to Rev01 are indicated by a solid vertical line in left hand margin
Updates from Rev01 to Rev02 are indicated by a dashed vertical line in the left hand margin

# Aerial photograph of site

# Report status and format

| Report section | Principal coverage | Report status | |
|---|---|---|---|
| | | Revision | Comments |
| 1 | Executive summary | 01 | Updated gas monitoring |
| | | 02 | Updated remediation statement |
| 2 | Introduction | 01 | Updated gas monitoring |
| | | 02 | Updated remediation statement |
| 3 | Desk study information and site observations | | |
| 4 | Fieldwork | | |
| 5 | Ground conditions encountered | | |
| 6 | Laboratory testing | | |
| 7 | Engineering assessment | | |
| 8 | Chemical contamination | | |
| 9 | Gaseous contamination | 01 | Updated gas monitoring |
| | | 02 | Additional gas monitoring |
| 10 | Effects of ground conditions on building materials | | |
| 11 | Classification of waste soils under the Waste Acceptance Criteria | | |
| 12 | Further investigations | 01 | Updated gas monitoring |
| | | 02 | Updated remediation statement |
| 13 | Remediation statement | 02 | Updated remediation statement |
| 14 | Drawings | | |

# List of drawings

| Drawing | Principal coverage | Status | |
|---|---|---|---|
| | | Revision | Comments |
| 01 | Site location plan | | |
| 02 | Plan showing existing site features and location of exploratory points | | |
| 03 | Plan showing site development proposals and location of exploratory points | | |
| 04 | Plot summarising insitu density testing | | |
| 05a | Plot summarising results of pocket penetrometer determinations by location | | |
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| 06 | Section showing construction of combined water & gas monitoring standpipe installed in boreholes BHB, BHD, BHE and DTS114 | | |
| 07a | Plot summarising SPT/CPT data obtained from boreholes, with triaxial data (by location) | | |
| 07b | Plot summarising SPT/CPT data obtained from boreholes, with triaxial data (by geology) | | |

# List of appendices

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|---|---|
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| Q | Copy of desk study information produced by Envirocheck |
| R | Copy of letter report produced by Soiltechnics covering additional chemical testing ref: STM3361D-L003 |

# 1 Executive summary

## General

We recommend the following executive summary is not read in isolation to the main report which follows.

## Site description, history and development proposals

The site currently comprises Richmond upon Thames College which is split in to three sections, northern, central and southern. A residential development is located in between the central and southern areas, outside of the site boundaries. The northern section comprises a car parking area and grass surfaced playing field. The central section of the site comprises college buildings and the southern section of the site is currently used as playing fields.

The site was undeveloped until 1896 when a tramline was identified in the central area of the site. It was no longer recorded beyond 1915. The initial college buildings were first recorded in 1938 and 5 potential air raid shelters were identified from 1961 to 1974 in the north east of the central section of the site.

Development proposals include a five storey building in the northern section of the site along with various smaller buildings and an artificial sports pitch. A residential development will be located in the central area and the southern area will remain as playing fields/ comprise sports pitches.

## Ground conditions encountered

The ground investigation encountered Made Ground overlying Kempton Park Gravel Member and London Clay Formation at depth. Ground water was encountered in most of the excavations at a depth of between 1.4m-2.5m. Full details of the ground conditions are included in Section 5 of this report.

## Foundation solution

Various foundation solutions are provided for the different buildings proposed across the site. In general we understand that the multi-storey building in the north of the site will comprise a piled foundation, ancillary college buildings will comprise pads, strips or a raft as necessary and the residential buildings will comprise strips. Bearing capacities/ preliminary design values are provided in Section 7. CBR values for pavement and sports pitch design are also provided.

It should be noted that several potential construction risks have been identified. These primarily include the potential for buried air raid shelters, buried existing foundations and the possibility of loose/ low strength soils in the south of site by virtue of the former route of the River Crane.

## Chemical and gaseous contamination

For the purposes of contamination evaluation, the site has been divided into three areas. Chemical contamination was identified across the site which is considered to pose a risk to proposed end users of the residential area, construction operatives and vegetation in addition to water receptors. Full details of encountered contamination are included in Section 8 of this report. A full remediation strategy is included in Section 13.

Our gaseous contamination assessment has been updated to account for additional monitoring undertaken. The monitoring indicates that the college area of the site is classified as characteristic situation 2 and therefore requires gas protection measures to be installed. The residential area of the site is classified as 'green' in accordance with NHBC guidance and therefore does not warrant gas protection measures. Gaseous contamination is discussed in Section 9.

## Landfill classification

Three types of Made Ground as well as Kempton Park Gravel Member and London Clay Formation are all considered to be soils likely to require off-site disposal. Made Ground Type A and Type C are classified as non-hazardous and Type B as stable non-reactive. It is possible that with additional testing, elevated PAHs within Type B soils will be zoned and the remainder of the Type C soils could be reclassified.

All naturally deposited soils (Kempton Park Gravel and London Clay) are automatically classified as inert due to being unlikely to be affected by anthropogenic contamination. Full details of landfill classification are included in Section 11.

# 2 Introduction



## 2.1 Objectives

2.1.1 This report describes a ground investigation carried out for the redevelopment of a college site to include both school buildings and residential properties at Richmond Upon Thames College, Egerton Road, Twickenham, TW2 7SJ.

2.1.2 The objective of the ground investigation was to establish ground conditions at the site, sufficient to identify possible foundation solutions for the development and provide parameters necessary for the design and construction of foundations.

2.1.3 The investigation included an evaluation of potential chemical and gaseous contamination of the site leading to the production of a risk assessment in relation to contamination.

2.1.4 The investigation has also been produced to support a planning application for the site by satisfying National Planning Policies Framework sections 120 and 121 or if the project has the benefit of a planning permission, potentially discharge conditions which relate to ground conditions.

2.1.5 Our brief also included investigations and testing to allow classification of soils at the site to be disposed of to landfill.

## 2.2 Client instructions and confidentiality

2.2.1 The investigation was carried out in October 2015 and reported in November 2015 (as Rev00) acting on instructions received from Richmond Upon Thames College. The report was updated in February 2016 (as Rev01) to account for additional gas monitoring results and further updated in May 2016 (as Rev02) to include a remediation statement.

2.2.2 This report has been prepared for the sole benefit of our above named instructing client, but this report, and its contents, remains the property of Soiltechnics Limited until payment in full of our invoices in connection with production of this report.

2.2.3 Our original investigation proposals were outlined in our letter to Fusion Project Management Ltd. The investigation generally followed our original investigation proposals, and was supplemented with additional investigations as the project progressed.

2.2.4 This report follows our original investigation undertaken in 2008, reference STE1297R.

## 2.3 Site location and scheme proposals

2.3.1 The National Grid reference for the site is 515348, 173814. A plan showing the location of the site is presented on Drawing 01.

2.3.2 We understand that the development proposals can be split into three main areas. The north of the site, the central area and the south of the site.

2.3.3 The north of the site will comprise a five storey building, three smaller college buildings, an artificial sports pitch and a car parking area in the north eastern corner. The central area of the site will comprise a residential development of two storey properties all with parking areas and front and back gardens. The southern section of the site will continue to be used as playing fields.

2.3.4 We have received layout drawings of the proposed scheme which is presented on Drawing 03.

## 2.4 Report format and investigation standards

2.4.1 Sections 2 to 6 of this report describe the factual aspects of the investigation with Section 7 presenting an engineering assessment of the investigatory data. Section 8 provides a risk assessment of chemical contamination based on readily available historic records, inspection of the soils and laboratory testing. Section 9 provides a similar risk assessment in relation to gaseous contamination with Section 10, a risk assessment relating to construction materials likely to be in contact with the ground. Section 11 provides a classification of waste soils for off-site disposal under the waste acceptance criteria.

2.4.2 This investigation integrates both contamination and geotechnical aspects. The investigation was carried out generally, and where practical following the recommendations of BS EN 1997:2 2007 '*Eurocode 7 – Geotechnical Design – Part 2: Ground Investigation and Testing*'. The investigation process also followed the principles of BS10175: 2011 *'Investigation of potentially Contaminated Sites – Code of Practice'*. The following elements, defined in BS10175, have thus been completed and incorporated in this report.

a) Phase I Preliminary investigation (desk study and site reconnaissance)
b) Phase II Exploratory and main (intrusive) investigations

2.4.3 The extent and result of the preliminary investigation (Desk Study) is reported in Section 3. Fieldwork combined the exploratory investigation and main investigation stages into one phase with the extent of these works described in Sections 4 and 6 of this report. Any supplementary investigations deemed necessary are identified in Section 12. Section 13 provides information on any remedial strategy and specification if required.

## 2.5 Status of this report

2.5.1 This report is final based on current instructions and supersedes the previous ground investigation report (reference STE1297R, dated 2008).

2.5.2 This investigation has been carried out and reported based on our understanding of best practice. Improved practices, technology, new information and changes in legislation may necessitate an alteration to the report in whole or part after publication. Hence, should the development commence after expiry of one year from the publication date of this report then we would recommend the report be referred back to Soiltechnics for reassessment. Equally, if the nature of the development changes, Soiltechnics should be advised and a reassessment carried out if considered appropriate.

## 2.6 Report distribution

2.6.1 This report has been prepared to assist in the design and planning process of the development and normally will require distribution to the following parties, although this list may not be exhaustive:

**Table summarising parties likely to require information contained in this report**

| Party | Reason |
|---|---|
| Client | For information / reference and cost planning |
| Developer / Contractor / project manager | To ensure procedures are implemented, programmed and costed |
| Planning department | Potentially to discharge planning conditions |
| Environment Agency | If ground controlled waters are affected and obtain approvals to any remediation strategies |
| Independent inspectors such as NHBC / Building Control | To ensure procedures are implemented and compliance with building regulations |
| Project design team | To progress the design |
| Principal Designer (PD) | To advise in construction risk identification and management under the Construction (design and management) regulations |
| Waste recycling operators | For recycling or reducing hazardous properties |

**Table 2.6.1**

# 3 Desk study information and site observations



## 3.1 General

3.1.1 We have carried out a desk study which was limited to a review of readily available information including:

a) Review of published Ordnance Survey maps dating back to 1869 at various published scales

b) Inspection of geological maps produced by the British Geological Survey together with relevant geological memoirs

c) Consultation with Statutory Undertakers

d) Site reconnaissance

e) Other relevant published documents

3.1.2 We have obtained old Ordnance Survey maps using the Envirocheck database system. In addition to retrieval of historical and current Ordnance Survey data, Envirocheck provide information compiled from outside agencies including: -

- Ordnance Survey
- Environment Agency
- Scottish Environment Protection Agency
- The Coal Authority
- British Geological Survey
- Centre for Ecology and Hydrology
- Countryside Council for Wales
- Scottish Natural Heritage
- Natural England
- Health Protection Agency

3.1.3 The study did not extend to research of meteorological information or consultation with other interested parties such as English Heritage (ancient monuments), Ordnance Survey (survey control points), Planning Authorities or Archaeological Units.

3.1.4 A copy of records produced by Envirocheck is presented in Appendix Q. Envirocheck produce a wealth of factual database information. Although we can provide a discussion on each of the database topics, this would produce a very lengthy document, but some of these discussions would not be relevant to the aims of this report. As a consequence we have extracted some of the relevant topics and discussed them in this section of the report.

3.1.5 The data presented in the following report sections has primarily been extracted from the Envirocheck report.

## 3.2 Description of the site

3.2.1 The site is positioned on the floor of a wide and flat bottomed valley carrying the River Crane, the channel of which is located directly south of the site and the Duke of Northumberland's River which is located 300m to the west of the southern end of the site and 20m to the west of the northern end of the site.

3.2.2 The site is occupied by Richmond-Upon-Thames College and can be separated into three distinct areas as follows:-

**3.2.3 Northern - Playing Field and Car Park**

3.2.3.1 The northern area of the site is predominantly flat and occupied by open space surfaced in bituminous bound materials in the north eastern corner and laid to grass in the remaining area, forming a car park and playing field respectively. One masonry building is present in this area and is currently utilised as a sports hall.

Photograph of northern field, showing sports hall in background

### *3.2.4* Central – College Buildings

3.2.4.1 The central area of the site slopes gently to the south (~1:250) and is occupied by numerous buildings of varying age predominantly between one and four stories in height with a six storey tower located to the south of the main building. The college buildings are occupied by numerous departments broadly covering science, arts, social science and vocational disciplines. Ancillary facilities are also present within this area of the site including chemical stores located to the central eastern area of the site.

Photograph of courtyard within college complex

Photograph of parking area within college complex

### *3.2.5* Southern – Hardstanding and Playing Fields

3.2.5.1 The southern area of the site slopes gently to the south (~1:150) and is separated from the central area of the site by Craneford Way and a row of residential properties. This area is occupied by playing fields, laid to grass, and an area of hardstanding (likely former tennis courts) surfaced in bituminous bound materials.

Photograph of southern playing field with hard standing area

### *3.2.6* College environs

3.2.6.1 The northern boundary of the college campus is defined by Chertsey Road with a residential development beyond. Chertsey Road is constructed on a shallow embankment reaching some 2m in height in the north eastern part of the site as the road approaches a bridge to carry it over the Duke of Northumberland River. Much of the eastern boundary of the college is marked by Egerton Road, serving residential properties to the east. Blocks of residential properties are located to the west together with a rugby ground with associated car parking. The southern boundary of the site is defined by residential properties off Craneford Way. Playing fields are located to the south of Craneford Way.

3.2.7 A plan showing observed site features and location of exploratory points is presented on Drawing 02.

## 3.3 Injurious and invasive weeds and asbestos

### 3.3.1 Injurious and invasive weeds

3.3.1.1 The following weeds are controlled under the Weeds Act 1959:

- Common Ragwort,
- Spear Thistle,
- Creeping or Field Thistle,
- Broad leaved Dock
- Curled Dock

3.3.1.2 Whilst it is not an offence to have the above weeds growing on your land, you must:

- Stop them spreading to agricultural land, particularly grazing areas or land used for forage, like silage and hay
- Choose the most appropriate control method for the your site
- Not plant them in the wild

Should you allow the spread of these weeds to another parties land, Natural England could serve you with an Enforcement Notice. You can also be prosecuted if you allow animals to suffer by eating these weeds.

3.3.1.3 In addition to the above, you must not plant in the wild or cause certain invasive and non-native plants to grow in the wild as outlined in the Wildlife and Countryside act 1981. It is an offence under section 14(2) of the act to *'plant or otherwise cause to grow in the wild*' any plants listed in schedule 9, part II. This can include moving contaminated soil or plant cuttings. The offence carries a fine or custodial sentence of up to 2 years. The most commonly found invasive, non-native plants include:

- Japanese knotweed
- Giant hogweed
- Himalayan balsam
- Rhododendron ponticum
- New Zealand pigmyweed

3.3.1.4 You are not legally obliged to remove these plants or to control them. However, if you allow Japanese knotweed to spread to another parties land, you could be prosecuted for causing a private nuisance.

3.3.1.5 The presence of such weeds on site may have considerable effects on the cost / timescale in developing the site. Japanese knotweed can cause significant damage to buildings, roads and pavements following development, if untreated prior to development.

3.3.1.6 Our investigations exclude surveys to identify the presence of injurious and invasive weeds. We recommend specialists in the identification and procedures to deal with injurious and invasive weeds are appointed prior to commencement of any works on site.

### 3.3.2 Asbestos

3.3.2.1 Our investigations exclude surveys to identify the presence or indeed absence of asbestos on site. It should be noted that we did observe potential asbestos containing materials on site in TP103A and TP201 at 0.6m and 0.4m depths respectively. We took precautions to avoid disturbance of these materials during our on-site activities but where encountered took samples which have been sent to the laboratory for testing.

3.3.2.2 The presence of asbestos on site may have considerable effects on the cost / timescale in developing the site. There is good guidance in relation to Asbestos available on the Health and Safety Executive (HSE) web site.

## 3.4 History of the site

3.4.1 An attempt to trace the history of the site has been carried out by obtaining copies of old Ordnance Survey maps provided by Envirocheck. The recent history of the site based on published Ordnance Survey maps is summarised on the following table: -

**Summary description of site history from Ordnance Survey maps**

| Date | Site | Adjacent land use |
|---|---|---|
| 1871 | Open space agricultural land and Marsh Farm<br>Channel of River Crane located in south-west corner of the site | Agricultural land with orchards to the north of the site. Marsh Farm located in the southern area of the site. Railway land located 100m to south. |
| 1874 | As above | As above |
| 1896 | Open Space with tramway running across the central area of the site.<br>Marsh Farm no longer recorded on site. | Marsh Farm been relocated off site to between the southern and central areas. Some of the out buildings do encroach onto, just cross over, the site boundaries. A sewage works is located 200m to the south west<br>Gravel pit located 225m to the south |
| 1898 | As above | As above |
| 1915 | Open space; tramway not recorded<br>Greenhouses on southern and central area of site associated with Marsh Farm | Expansion of the sewage works including filter and sludge beds within 80m of the western site boundary.<br>Football ground located to the north.<br>Rifle range to south of site |
| 1920 | As above | As above |
| 1934 | As above<br>Green houses no longer recorded | Further expansion of the sewage works including filter and sludge beds within 50m of the western site boundary.<br>Rifle Range recorded to west of previous location, allotment gardens recorded on former Rifle Range |
| 1938 | Central area of site occupied by buildings. Northern and southern areas are still recorded as undeveloped open space | Residential development underway to north and east of the site |
| 1946 Aerial Photograph | Suspected allotments to east of southern site area and east of northern site area. Five potential air raid shelters located in the northern section of the site. | |

| Summary description of site history from Ordnance Survey maps | | |
|---|---|---|
| **Date** | **Site** | **Adjacent land use** |
| 1961 | Site recorded as Twickenham Technical College. Tennis courts located in the southern area of the site<br>River Crane channelized and located along southern boundary and no longer on site. | As above |
| 1966 | As above | Sewage works recorded as depot |
| 1973 | Additional buildings developed in the central area of the site | As above |
| 1974 | Air raid shelters no longer recorded | As above |
| 1975 | As above | Sports stadium recorded to west<br>Football ground located to the north recorded as rugby ground |
| 1982 | Building present in area of former air raid shelter | As above |
| 1992 | As above | As above |
| 1992 | As above | As above |
| 2008 | As above | As above |
| **Table 3.4.1** | | |

## 3.5 Geology and geohydrology of the area

### 3.5.1 Geology of the area

3.5.1.1 Envirocheck reproduce geological map extracts taken from the British Geological Survey (BGS) digital geological map of Great Britain at 1:50,000 scale (ref Appendix Q). A summary of the recorded geological information for the site is presented in Table 3.5.1.below:-

| Summary of Geology and likely aquifer containing strata | | | | | |
|---|---|---|---|---|---|
| **Strata** | **Bedrock or superficial** | **Approximate thickness** | **Typical soil type** | **Likely permeability** | **Aquifer designation** |
| Kempton Park Gravel Member | Superficial | 6m | Sands and Gravels | Permeable | Principal aquifer (r) |
| London Clay | Bedrock | 50m | Clays | Impermeable | Unproductive strata (r) |
| **Table 3.5.1** | | | | | |

(r) recorded aquifer designation
(a) assumed aquifer designation

3.5.1.2 Principal aquifers are defined as deposits exhibiting high permeability capable of high levels of groundwater storage. Such deposits are able to support water supply and river base flows on a strategic scale.

3.5.1.3 Unproductive strata are defined as deposits exhibiting low permeability with negligible significance for water supply or river base flow. Unproductive Strata are generally regarded as not containing groundwater in exploitable quantities.

### 3.5.2 Water abstractions

3.5.2.1 Three active groundwater and two active surface water abstraction points are located within 2000m of the site. The closest groundwater abstraction point lies 1504m to the northeast of the site with water abstracted for private (non-industrial) amenity purposes for lake and pond through flow. The closest surface water abstraction point lies 860m to the north of the site with water abstracted for general use The closest drinking water abstraction point is located 1898m north west of the site. The water is taken from a groundwater source and is used for commercial, industrial and public services including drinking, cooking, sanitary and washing.

3.5.2.2 The site is not located within a zone protecting a potable water supply abstracting from a principal aquifer (i.e. a source protection zone).

### 3.5.3 Coal mining and brine extraction

3.5.3.1 The site is not recorded to be within an area affected by past or present coal mining, or minerals worked in association with coal or brine extraction (within the Cheshire Brine Compensation District).

### 3.5.4 Shallow mining and natural subsidence hazards

3.5.4.1 The British Geological Survey present hazard ratings for shallow mining and natural subsidence hazards. The site has the following ratings;

| Table summarising mining and subsidence hazards | |
|---|---|
| **Hazard** | **Rating** |
| Mining hazard in non-coal mining areas | **No hazard** |
| Potential for collapsible ground stability hazard | **Very low** |
| Potential for compressible ground stability hazard | **No hazard** |
| Potential for ground dissolution stability hazard | **No hazard** |
| Potential for landslide ground stability hazard | **Very low** |
| Potential for running sand ground stability hazard | **Very low** |
| Potential for shrinking or swelling clay ground stability hazard | **Moderate** |
| **Table 3.5.4** | |

3.5.4.2 In addition to the above hazard ratings, a report completed by Ove Arup and Partners in December 1991, commissioned by the Department of the Environment (DoE) indicates where mining should be borne in mind when considered planning and development of land. The site has four recorded mineral sites within 1000m of the site, the closest is located 198m south of the site. All four mineral sites are recorded as opencast and have ceased operations. There is no evidence as to whether these sites have been backfilled with material which could cause contamination to migrate on site.

3.5.4.3 The moderate risk of shrinking or swelling of clay is discussed in Section 7.

### 3.5.5 Borehole records

3.5.5.1 The British Geological Survey (BGS) retain records of boreholes formed from ground investigations carried out on a nationwide basis. The location of boreholes with records held by the BGS is recorded on the borehole map contained in Appendix Q. We do not normally obtain copies of these records but can do on further instructions. There is normally a charge made by the BGS for retrieving and copying these records.

## 3.6 Landfill and infilled ground

3.6.1 The following table summarises these landfill sites and potential landfill sites:

**Summary of Landfill sites and potential landfill sites**

| Landfill name | Type | Location | Waste authorised | Licence status |
|---|---|---|---|---|
| Twickenham Gravel Pit | BGS recorded mineral site | 198m S | N/A | Ceased |
| St Margarets | Historical landfill site | 340m N | Deposited waste including Inert waste. | Cancelled 1963 |
| Mogden sand and ballast works | BGS recorded mineral site | 540m NE | N/A | Ceased |
| Isleworth | Historical landfill site | 547m NE | Deposited waste including Inert and industrial waste. | Cancelled 1966 |
| Lampton Road | Historical landfill site | 686m N | Deposited waste including Inert waste. | Cancelled 1935 |
| Mogden sand and ballast works | BGS recorded mineral site | 742m NE | N/A | Ceased |
| Isleworth | Historical landfill site | 815m NW | Deposited waste including Inert waste. | Cancelled 1930 |
| Whitton Dean Gravel Pit | BGS recorded mineral site | 887m NW | N/A | Ceased |
| St Maragrets | Historical landfill site | 894m NE | Not supplied | Cancelled 1961 |
| Area of Made Ground on railway land | Desk study information | Immediately south of site | Not supplied | |

**Table 3.6.1**

## 3.7 Radon

3.7.1 Envirocheck use the British Geological Survey database to review reported radon levels in the area in which the site is located to establish recommended radon protection levels for new dwellings. The database records the site as being located where **no protection** is recommended.

3.7.2 The Building Research Establishment publication applies to all new buildings, conversions and refurbishments whether they be for domestic or non-domestic use. For non-domestic buildings, the guidance supplements the requirements for radon protection at work specified in the Ionising Radiations Regulations 1999, legislation made under the Health and Safety at Work Act administered by the Health and Safety Executive (HSE). Further information is contained in the HSE/BRE guide "*Radon in the Workplace".*

3.7.3 The Building Research Establishment publication applies to all new buildings, conversions and refurbishments whether they are for domestic or non-domestic use.

3.7.4 It is noteworthy that the BRE and BGS / HPA information is based on statistical analysis of measurements made in dwellings in combination with geological units, which are known to emit radon. Therefore there is a risk for actual radon levels at the site to exceed the levels assessed by the BGS / HPA / BRE. Currently, the only true method of checking actual radon levels is by measurement within a building on the site over a period of several months. It should be noted that it is not currently a requirement of the Building Regulations to test new buildings for radon, however the BRE recommends testing on completion or occupation of all new buildings (domestic and non-domestic), extensions and conversions. Should you wish to undertake radon monitoring following completion of the development, we can provide proposals.

## 3.8 Flood risk

3.8.1 The southern section of the site is located **within a fluvial flood plain**. There is a low to medium risk potential for areas, mainly situated in the north of the site, to be affected by surface water flooding. It should be noted that this information does not constitute a site specific Flood Risk Assessment (FRA), and a full FRA may be required for the development to support a planning application or satisfy planning conditions.

## 3.9 Enquiries with statutory undertakers

3.9.1 We have contacted the following Statutory Undertakers (SUs) to obtain copies of their records in order to avoid damaging their apparatus during our fieldwork activities: -

a) BT Openreach Ltd
b) Transco
c) Thames Water
d) UK Power/EDF
e) Virgin
f) National Grid Gas

3.9.2 Copies of responses received prior to publication of this report are presented in Appendix O. These records have been obtained solely for the purposes described above. Some of these records have been obtained from the Internet and from our database without contacting the statutory undertaker direct. Occasionally, SU information is recorded on drawings larger than A3, and thus cannot be easily presented in this report. In such cases we will copy the correspondence but not incorporate the drawing in this report, and maintain the records on our office file.

3.9.3 In addition, we have visited the Linesearch web site (www.linesearch.org) which provides a report on national grid networks (National Gas and Electricity Transmission Networks). Again a copy of their report is presented in Appendix O.

3.9.4 Normally Statutory Undertakers drawings record the approximate location of their services. We recommend further on site investigations be undertaken to confirm the position of the apparatus and thus establish the effect on the proposed development and the necessity or otherwise for the permanent or temporary diversion of the service to allow the construction of the development to safely and successfully proceed.

3.9.5 It should be noted that Thames Water have a foul sewer traversing the southern section of the site from east to west. BT Openreach and Virgin have also recorded two entry points to the college buildings, one enters from the west and one from the east. In addition, National Grid Gas have identified three entry points into the college complex, two from the east and one from the west.

3.9.6 It should be noted that statutory undertakers' records normally exclude private services.

## 3.10 Enquiries with local authority building control and environmental health officers

3.10.1 We have contacted Local Authority Building Control however at the time of issuing the report, had not received a response. Any future correspondence containing relevant information regarding the development will be forwarded onto the relevant parties.

3.10.2 We have contacted the Local Authority Environmental Health Officer who has advised that they can provide information for a fee. Given that we have undertaken a comprehensive, intrusive investigation, in addition to commissioning an Envirocheck search, we do not consider the council search to be necessary at this stage. A copy of their correspondence is included in Appendix P.

# 4 Fieldwork



## 4.1 General

4.1.1 Fieldwork comprised the following activities:-

- Excavation of three exploratory hand dug trial pits
- Excavation of thirteen exploratory trial pits using a tracked mini digger to enable infiltration testing
- Excavation of five exploratory boreholes using cable and tool percussion drilling techniques
- Excavation of fifteen exploratory boreholes formed using driven tube sampling equipment
- Dynamic cone penetration testing in four locations

4.1.2 A plan of the site showing observed/existing site features and position of exploratory points is presented on Drawing 02. The position of exploratory points relative to site development proposals is presented on Drawing 03. The position of exploratory points shown on these plans is approximate only and confirmation of these positions is subject to dimensional surveys, which is outside our brief.

4.1.3 The extent of fieldwork activities and position of exploratory points were originally defined by the Client's Engineer, Gyoury Self Consulting Engineers and were finalised between Soiltechnics, Richmond upon Thames College and Gyoury Self Consulting Engineers at a pre-start meeting.

4.1.4 Exploratory points were positioned to avoid known locations of underground services and were also positioned to provide a reasonable coverage of the site. Prior to commencement of exploratory excavations an electronic cable locating tool was used to scan the area of the excavation. If we received a response to this equipment then the excavation would be relocated.

4.1.5 All soils exposed in excavations were described in accordance with BS EN ISO 14688 *'Identification and Classification of soil'* and BS EN ISO 14689 *'Identification and classification of rock'.*

## 4.2 Site restrictions

4.2.1 During the course of our investigation, several exploratory locations were repositioned due to various factors. These can be summarised as follows:

- TP102 was terminated due to the presence of a land drain at 0.5m depth. TP102A was located adjacent to TP102, which achieved the target depth.

- TP103 was terminated at 1.2m due to the presence of a potential former soakaway/ brickwork obstruction located in the southern end of the pit. TP103A was located adjacent to TP103 however was terminated at 0.9m due to the presence of pea gravel (indicative of buried services) and a piece of potential ACM. Time constraints from the college on the use of the excavator within the courtyard prohibited any further attempts at trial pits in this area. Infiltration testing was undertaken within DTS112, in order to provide an approximate infiltration rate within the courtyard, where machine pits were not possible.

- TP106 was replaced by DTS115, due to access limitations prohibiting the use of the excavator in the courtyard within which DTS115 was located.

- TP107 was excavated using hand tools, in order to limit the surface damage caused within the marked football pitch, compared with a machine excavated pit.

- TP201 was excavated by others during the course of our investigation. The objective was to locate a buried bunker, which we understand was not achieved, despite numerous trenches/ pits across the area.

- TP305 was terminated at 1m depth due to the presence of a foul water pipe which was damaged as part of our investigation. The pipe was repaired, as evidenced by the following photograph:

- DTS114 was added to the original proposals in order to provide a standpipe installation in the south of the site and provide a good coverage of the site for ongoing monitoring purposes.

- HP01 and HP02 were added to the original proposals in order to zone the TPH contamination previously encountered in TP14, as part of our 2008 investigation.

## 4.3 Exploratory trial pits

4.3.1 Trial pits HP01, HP02 and TP107 were excavated using hand tools to a maximum depth of 1m.

4.3.2 The hand pit excavations were backfilled with excavated material, which was compacted using hand held ramming tools. The surface was reinstated to match the original surroundings. A Geotechnical Engineer supervised the excavations.

4.3.3 Trial pits TP101 to TP105, TP108, TP109 and TP201 were excavated to a maximum depth of 1.95m using a tracked mini excavator. The excavations were backfilled with excavated material compacted using the back of the excavator bucket. Whilst we attempted to reinstate the excavation to its original condition some short-term settlement of the backfilling materials may occur. A Geotechnical Engineer supervised the excavations.

4.3.4 Sampling and logging was carried out as trial pit excavations proceeded but were not entered at depths exceeding 1.0m, or where trial pit sides were deemed unstable. The density of granular soils encountered in excavations was gauged by the ease of excavation.

4.3.5 Soil samples for subsequent laboratory determination of concentration of chemical contaminants were taken from the sides of trial pits using clean stainless steel equipment and stored in new plastic containers, which were labelled and sealed. Samples from below access depth into trial pits were taken as a sub sample from soil contained in the excavator bucket, discarding any soil which may have been in contact with the bucket. If as a consequence of visual or olfactory evidence, a sample was suspected to be contaminated by organic material, the sample was stored in an amber glass jar with a PTFE sealing washer.

4.3.6 Soil samples for subsequent or 'physical and classification' laboratory testing were taken from the side of trial pits or from bulk samples taken from the excavator bucket. The sample was placed in a plastic bag and subsequently sealed and labelled.

4.3.7 Soil samples were obtained to meet quality class 3 to 5 as described in BS EN I997-2:2007. Sample sizes were appropriate for the laboratory test being considered.

4.3.8 A pocket penetrometer was used in the cohesive soils encountered. This tool is deemed to measure the apparent ultimate bearing capacity of the soil under test. The pocket penetrometer is calibrated in kg/cm$^2$. The reading can be approximately converted to equivalent undrained shear strength by multiplying the results by a factor of 50. Tests were carried out in the sides of trial pits when access can be safety achieved otherwise testing was carried out on excavated intact clods. The results are reported in columns to the right of trial pit results. The pocket penetrometer is not covered by British Standards. This tool has the advantage that it can be used to determine the approximate insitu undrained shear strength of stony cohesive soils.

4.3.9 A summary of pocket penetrometer results obtained from the cohesive soils encountered in exploratory excavations are presented in graphical format on Drawings 05a and 05b.

4.3.10 Trial pit records are presented in Appendix C.

4.3.11 Soil infiltration tests were carried out across the site between depth of 0.55m and 1.95m. Infiltration tests were carried out to Building Research Establishment (BRE) Digest 365 (2007) "*Soakaway Design*". Where undertaken in a driven tube sample, the test did not strictly follow the procedures outlined in BRE 365, due to the size of the test pit, however an indicative rate has been calculated for these locations. Records of test results and calculations to determine a soil infiltration rate are presented in Appendix F.

## 4.4 Light cable and tool percussion boring

4.4.1 Boreholes BHA to BHE were excavated using light cable percussion boring techniques as described in EN ISO 22475-1:2006 forming 150mm diameter holes. Temporary casing was advanced within the borehole excavation to maintain the stability of the hole. When groundwater was encountered the excavation was temporarily halted to allow for groundwater observations to be made. Following groundwater observations the casing was advanced within the hole and the location of the water strikes recorded. The casing was subsequently advanced to maintain the stability of the borehole and seal off the water to prevent further ingress. Additional records were taken when the casing produced a seal against water ingress.

4.4.2 On completion of excavations the boreholes were backfilled with excavated soils compacted using drilling tools.

4.4.3 Soil samples for subsequent laboratory determination of concentration of chemical contaminants were taken from 'intact' bulk disturbed samples obtained in the cutting shoe of the drilling rig. A sub sample was obtained discarding soil, which would have been in contact with the drilling rig cutting shoe with the subsamples taken using clean stainless steel equipment. If as a consequence of visual or olfactory evidence, a sample was suspected to be contaminated by organic material, the sample was stored in an amber glass jar with a PTFE sealing washer.

4.4.4 Bulk soil samples for identification or subsequent 'classification' laboratory testing were taken from borehole cutting equipment. The sample were placed in a plastic bag and subsequently sealed and labelled. Soil samples were obtained under category A to meet laboratory test quality classes 3 to 5 as described in BS EN ISO 22475-1:2006.

4.4.5 'Undisturbed' 100mm diameter samples were taken in cohesive soils when considered appropriate using a general-purpose open tube sampler. These samples were obtained under category B (A) sampling methods to meet quality class 2 as described in BS EN ISO 22475-1: 2006. The undisturbed sample was obtained in a plastic liner and sealed with wax prior to labelling. The number of blows of the standard driving hammer is required to obtain the sample is recorded on borehole records.

4.4.6 Standard Penetration Testing (SPT) was carried out at regular frequencies in the borehole. The test was carried out in accordance with BS EN ISO 22475-3:2005. Details of the test, as required by BS EN ISO 22475-3 are recorded in borehole records. The drive rods were type AW up to 20m depth and type BW for depths in excess of 20m. Samples taken from the open sampler (SPT) were placed in a plastic bag, sealed and labelled. In coarse granular soils, a solid $60^{o}$ cone may have been used to replace the SPT cutting shoe. This test is reported as SPT(C). A graphical summary of standard penetration testing is presented on Drawing 07.

4.4.7 A pocket penetrometer was used in cohesive soils and is deemed to measure the apparent ultimate bearing capacity of the soil under test. The pocket penetrometer is calibrated in $kg/m^2$. The reading can be approximately converted to an equivalent undrained shear strength by multiplying the result by a factor of 50. Tests were carried out on 'intact' samples recovered from the cutting shoe.

4.4.8 A graphical summary of pocket penetrometer readings is presented on Drawings 05a and 05b.

4.4.9 The borehole excavations were formed by drillers who are NVQ Level 2 qualified in Land Drilling under the Construction Awards Alliance CAA with samples relogged by an experienced Geotechnical Engineer.

4.4.10 Records of boreholes formed by light cable and tool percussion drilling techniques are presented in Appendix D.

4.4.11 Combined gas and groundwater monitoring standpipes were installed in boreholes BHB, BHD and BHE. The standpipes were installed following the recommendations of BS EN ISO 22475-1:2006 '*Geotechnical Investigation and Testing – Sampling methods and groundwater measurements – Part 1: Technical Principles for execution'*. Details of the standpipe installation are recorded on Drawing 06.

4.4.12 Water levels in the standpipes have been measured during a return visit to the site. The water level was measured using a measuring tape calibrated in 1mm intervals with an electronic end piece, which emits an alarm sound in contact with water. Water levels are measured from ground levels at the borehole position. Records of water levels are presented in Section 5.

## 4.5 Driven tube sampling

4.5.1 Boreholes DTS101 to DTS115 were formed using driven tube sampling equipment. Driven tube sampling comprises driving 1m long steel sample tubes which are screw coupled together or coupled to extension rods and fitted with a screw on cutting edge. The sample tubes are of various diameters, generally commencing with 100mm and reducing, with depth, to 50mm and include a disposable plastic liner which is changed between sampling locations in order to limit the risk of cross contamination. On completion of excavation the liner containing the sample is cut open and the soil sample logged by a geo-environmental engineer.

4.5.2 Samples for determination concentration of chemical contaminants are taken from samples obtained in the disposable tubes as sub-samples using stainless steel sampling equipment.

4.5.3 The driven tube sampler obtains samples under category A allowing laboratory test quality classes 3 to 5 as described in BS EN ISO 22475-1:2006.

4.5.4 In each location, except DTS112-115, surface bituminous bound material was broken out prior to excavation of the borehole. The bituminous surface was reinstated on completion. Surfacings at DTS112-115 locations comprised soft landscaping/ grass.

4.5.5 A pocket penetrometer (as described in 4.4.7 above) was used in the cohesive soils retrieved from the borehole. A summary of pocket penetrometer results obtained from the cohesive soils retrieved from the boreholes are presented in graphical format on Drawing 05a and 05b.

4.5.6 A combined gas and groundwater monitoring standpipe was installed in borehole DTS114. The standpipe was installed following the recommendations of BS EN ISO 22475-1:2006 '*Geotechnical Investigation and Testing – Sampling methods and groundwater measurements – Part 1: Technical Principles for execution*'. Details of the standpipe installation are recorded on Drawing 06.

4.5.7 The water level in the standpipe has been measured during a return visit to the site. The water level was measured using a measuring tape calibrated in 1mm intervals with an electronic end piece, which emits an alarm sound in contact with water. Water levels are measured from ground levels at the borehole position. Records of water levels are presented in Section 5 of this report.

4.5.8 Indicative soil infiltration testing was carried out in borehole DTS115 at depths of between 0.73m and 1.94m. The infiltration testing was carried out to following the procedure described in Building Research Establishment (BRE) Digest 365 (2007) "*Soakaway Design*". Records of test results and calculations to determine a soil infiltration rate are presented in Appendix F. It should be noted that testing has not been strictly carried out in accordance with the BRE publication, as the minimum size of the test hole (BRE 365 states that the trial pit should be 0.3 to 1 m wide and 1 to 3 m long and should have vertical sides trimmed square) could not be achieved in the borehole, however the test provides an indication of the likely permeability of the soils under test. A standpipe was temporarily installed in borehole DTS115 to retain stability during infiltration testing.

4.5.9 Records of boreholes formed using driven tube sampling techniques are presented in Appendix E.

## 4.6 Dynamic cone penetration testing

4.6.1 Dynamic Cone Penetration (DCP) testing was carried out in four locations. Dynamic Cone Penetration testing consists of driving a 50mm diameter, 90$^{o}$ cone into the ground, via an anvil and extension rods with successive blows of a freefall hammer. The number of blows required to drive the cone each successive 100mm (N100) is recorded.

4.6.2 Dynamic Cone Penetration testing was carried out following BS EN ISO 22476-2:2005 and the apparatus used was categorised as 'Super heavy' (DPSH-B) in accordance with the standard.

4.6.3 Dynamic cone penetration test data is presented in graphical format on Drawing 04.

## 4.7 Measurement of landfill type gases in gas monitoring standpipes

4.7.1 The concentrations of landfill type gases collected within gas monitoring standpipes installed in boreholes BHB, D, E and DTS114 were measured using a portable infra-red gas analyser (model GA2000 plus, manufactured by Geotechnical Instruments). Initially the gas analyser was connected to the gas valve on the top of the standpipe to allow the flow rate to be measured. Essentially this is a measurement of gas pressure produced in the standpipe, which is compared with atmospheric pressure at the time of measurement to produce an equivalent gas 'flow' in l/hr. The equipment used is capable of measuring to an accuracy of 0.1l/hr; below this the gas analyser records zero flow. Following BS8485:2007 '*British Standard Code of Practice for the Characterisation and remediation from ground gas in affected developments*',(clause 6.1), we assume flows of 0.1l/hr when the gas analyser reads zero, thus producing a pessimistic gas flow rate in our assessment of ground gasses.

4.7.2 Following measurement of 'flow' the gas analyser pumps gases contained in the standpipe through the analyser for a period of about 180 seconds to allow a continuous measurement of landfill type gases. The analyser then measures 'peak' and 'steady' concentrations of the following gases.

- Methane ($CH_4$)
- Carbon dioxide ($CO_2$)
- Oxygen ($O_2$)

4.7.3 The ambient atmospheric temperature and barometric pressure was also recorded at the site.

4.7.4 Methane in concentrations of between 5 to 15% in air is potentially explosive. The 5% methane concentration in air is defined as the Lower Explosive Limited (LEL). The gas analyser measures a percentage of the LEL. For example, 10% LEL equates to 10% of 5%, i.e. 0.5% methane concentration in air.

4.7.5 Records of gas monitoring data are presented in Appendix K.

## 4.8 Sampling strategies

### 4.8.1 Geotechnical

4.8.1.1 In general we adopted a judgemental sampling strategy in relation to geotechnical aspects of the investigation. The location and frequency of sampling was carried out in consideration of the following:-

i) Topography
ii) Geology (including Made Ground)
iii) Nature of development proposals

### 4.8.2 Environmental

4.8.2.1 Details of sampling with respect to contamination issues are described in Section 8.

### 4.8.3 Sample retention

4.8.3.1 Samples are stored for a period of one month following issue of this report unless otherwise required.

# 5 Ground conditions encountered



## 5.1 Soils / Rocks

5.1.1 Each exploratory excavation encountered a similar profile of soils considered to be Made Ground overlying Kempton Park Gravel Member with London Clay Formation at depth.

5.1.2 With the exception of Made Ground, the investigation generally confirmed published geological records and the ground conditions encountered in our 2008 investigation.

5.1.3 **Made Ground** was encountered in all exploratory locations and ranged in depth from 0.3-1.2m below ground level. Surfacings comprised bituminous bound material, grass or soft landscaping.

5.1.4 Made Ground was encountered in three distinct forms;

- Type A- Dark brown, gravelly, very clayey sand with many rootlets and occasional roots up to 40mm in diameter. Gravels consisted of sub-angular to angular quartzite, flint and brick fragments
- Type B- Dark grey sandy gravel. Gravels comprised brick, bituminous bound material, crushed concrete and ceramic.
- Type C- Dark and orange brown sandy clay and clayey sand, with gravels of brick, flint and locally, whole bricks. Occasional pockets of ash observed.

5.1.5 Type A is present in DTS112-115 between depths of approximately 0-0.7m. Type B is located along the northern boundary to depths of between approximately 0.03-0.8m. Type C is located across the site between the depths of 0.15-1.1m.

5.1.5 Suspected ACM was encountered in TP103A and TP201 at 0.6m and 0.4m depths respectively, within Type C material.

5.1.6 **Kempton Park Gravel Member** comprised near surface clays overlying sands and gravels. The near surface cohesive deposits generally extended to some 0.8-1.5m below ground level and comprised firm, medium strength, orange brown, slightly sandy, slightly gravelly clay. The gravel fraction comprised sub-angular to sub-rounded sandstone, flint and quartzite.

5.1.7 Granular deposits of the Kempton Park Gravel Member at depth extended to depths in the range of 6.4m to 10.2m (where the base was encountered). Such deposits generally comprised orange brown, clayey, silty sand and gravel. Gravels consisted of rounded and angular, fine to coarse flint and quartzite.

5.1.8 **London Clay Formation** was encountered in BHA-E beneath the Kempton Park Gravels. The full thickness of the unit was not proven in any location (to a maximum depth of 25m below ground level). London Clay generally comprised stiff to very stiff, high to very high strength, dark grey brown, slightly silty clay with occasional shell and fossil fragments from 9m depth.

## 5.2 Groundwater

5.2.1 Groundwater inflows were observed in many of the exploratory excavations. A summary of our observations is tabulated below. Depths recorded refer to strike depth, unless noted that they refer to monitoring.

**Table summarising groundwater observations**

| Exploratory point | Depth (m) below ground level | Observations |
|---|---|---|
| TP103 | 1.00 | Groundwater level remained constant after 20 minutes |
| DTS101 | 1.80 | Groundwater level remained constant after 15 minutes |
| DTS102 | - Dry - | No groundwater encountered to 2.0 m depth during drilling |
| DTS103 | 1.40 | Groundwater level remained constant after 15 minutes |
| DTS104 | - Dry - | No groundwater encountered to 2.0m depth during drilling |
| DTS105 | 1.80 | Groundwater level remained constant after 15 minutes |
| DTS106 | 1.60 | Groundwater level remained constant after 15 minutes |
| DTS107 | 1.75 | Groundwater level at 1.50m after 30 minutes |
| DTS108 | 1.70 | Groundwater level at 1.55m after 30 minutes |
| DTS109 | 1.70 | Groundwater level at 1.60m after 30 minutes |
| DTS110 | 1.75 | Groundwater level remained constant after 20 minutes |
| DTS111 | 1.70 | Groundwater level at 1.68m after 15 minutes |
| DTS112 | 1.79 | Groundwater level remained constant after 15 minutes |
| DTS113 | 1.80 | Groundwater level remained constant after 10 minutes |
| DTS114 | 2.50 | Groundwater level remained constant after 10 minutes |
| | Monitoring 04.11.15 | No groundwater encountered to 2.76m |
| | Monitoring 18.11.15 | No groundwater encountered to 2.71m |
| DTS115 | - Dry - | No groundwater encountered to 2.0m depth |
| BH-A | -Indeterminable- | Due to addition of water to aid drilling |
| BH-B | -Indeterminable- | Due to addition of water to aid drilling |
| | Monitoring 04.11.15 | 1.45m |
| | Monitoring 18.11.15 | 1.33m |
| BH-C | -Indeterminable- | Due to addition of water to aid drilling |
| BH-D | -Indeterminable- | Due to addition of water to aid drilling |
| | Monitoring 04.11.15 | 1.70m |
| | Monitoring 18.11.15 | 1.55m |
| BH-E | -Indeterminable- | Due to addition of water to aid drilling |
| | Monitoring 04.11.15 | 1.30m |
| | Monitoring 18.11.15 | 1.10m |

**Table 5.2.1**

5.2.2 It should be noted that water levels will vary depending generally on recent weather conditions and only long term monitoring of levels in standpipes will provide a measure of seasonal variations in groundwater levels.

# 6 Laboratory testing



## 6.1 Classification and physical testing

6.1.1 Laboratory testing was carried out in accordance with BS1377: 1990 "*Methods of Test for Soils for Civil Engineering Purposes"* and limited to the following: -

a) Classification tests: (to part 2)

i) Determination of the liquid limit, plastic limit and plasticity index (method 3, 4.4 and 5)
ii) Determination of particle size distribution – wet sieving (method 9.2)

b) Shear strength tests (total stress) (to part 7).

i) Determination of undrained shear strength in triaxial compression without measurement of pore pressure (method 8).

6.1.2 Laboratory testing was carried out by an independent specialist testing house, which operates a quality assurance scheme. Copies of laboratory test result certificates are presented in Appendix G.

## 6.2 Chemical testing

6.2.1 Laboratory testing was carried out as deemed necessary and carried out using the following techniques:

- Using inductively coupled plasma mass spectrometry (ICP-MS), determination of concentration of metals, semi-metals and soluble sulphate
- Using gas chromatography flame ionisation detection methods (GC–FID), determination of concentration of petroleum hydrocarbons (TPH)
- Using gas chromatography flame ionisation detection methods (GC–FID), determination of concentration of polycyclic aromatic hydrocarbons (PAH)
- Using electromagnetic measurement, determination of pH
- Determination of asbestos containing material and asbestos fibres in the soil matrix using Polarised Light Microscopy (PLM) according to the guidance in HSG248 Asbestos: The analysts guide for sampling, analysis and clearance procedures, HSE, 2005.

- Following methods described in the Environment Agency publication *'Guidance on sampling and testing of wastes to meet landfill waste acceptance procedures'* (April 2005) – suite of testing in accordance with Table 2.1.

6.2.2 Laboratory testing was carried out by an independent specialist testing house, which operates a quality assurance scheme. Copies of laboratory test result certificates are presented in Appendix H.

# 7 Engineering assessment



## 7.1 General

7.1.1 The following assessments are made on the investigatory data presented in the preceding sections of this report and are made with reference to specific nature of the development. Should scheme proposals change then it may be necessary to review the investigation and report.

7.1.2 Should the development proposals change then it may be necessary to review the investigation and report.

## 7.2 Development proposals, building foundation, design and construction

7.2.1 Definitions of geotechnical terms used in the following paragraphs are provided in Appendix A.

### 7.2.2 Development proposals

7.2.2.1 The project will comprise a mix of residential and college buildings and can be divided into three distinct development areas. A plan showing the development proposals is included in Drawing 03 and can be summarised as follows:

- The north of the site will form the proposed college with buildings up to five storeys, with associated hardstanding, MUGAs and soft landscaped areas.
- The central area of the site will incorporate the residential development, comprising two storey buildings with associated access roads, parking and garden areas.
- The south of the site will comprise sports pitches and purpose built MUGAs.

### 7.2.3 Proposed foundations

7.2.3.1 We understand that a number of foundation solutions can be utilised across site, which include traditional strip, spread, raft and piled designs, depending on the type and size of development.

### 7.2.4 Geological model

7.2.4.1 We have assumed a relatively uniform geology with Made Ground, onto Kempton Park Gravel and London Clay Formation at depth. Depths of soils are summarised below together with our adopted geological model:

| Geology summary | | | Geological model | |
|---|---|---|---|---|
| **Geological unit** | **Top of unit (m)** | **Bottom of unit (m)** | **Bottom of unit (m)** | **Soil type** |
| Made Ground | 0 | 0.3 – 1.2 | 1m | Clays, sands & gravels |
| Kempton Park Gravel (cohesive) | 0.3 – 1.2 | 0.8 – 1.5 | 1.5m | Clays |
| Kempton Park Gravel (granular) | 0.8 – 1.5 | 6.4 – 10.2 | 8m | Sand & gravel |
| London Clay Formation | 6.4 – 10.2 | >25m | >25m | Clay |

**Table 7.2.4.1**

### 7.2.5 Low rise buildings and floodlights

7.2.5.1 Based on laboratory determination of the plasticity of the near surface cohesive deposits (where encountered), and following National House Building Council (NHBC) Standards Chapter 4.2, foundations would require extending to a minimum depth of 1m below existing or proposed ground levels whichever gives the deeper founding level. In addition, the influence of mature trees will likely give cause for the foundations to extend deeper, to moisture stable soils. As a result, we recommend that all foundations fully penetrate any cohesive Kempton Park Gravels and extend into the granular Kempton Park Gravel deposits. Such soils are not considered susceptible to the moisture demands of local trees.

7.2.5.2 Calculations based on an angle of shearing resistance of 32°, a foundation depth of 0.9m with ground water levels within the zone of influence from founding levels indicate the following bearing values.

| Table of bearing values for strip foundations | | | |
|---|---|---|---|
| **Width of strip (m)** | **Ultimate bearing value kN/m$^2$** | **Presumed bearing value kN/m$^2$** | **Allowable bearing pressure kN/m$^2$** |
| **0.45** | 560 | 190 | 160 |
| **0.6** | 580 | 200 | 170 |
| **0.9** | 610 | 210 | 180 |

**Table 7.2.5.2**

7.2.5.3 Assuming the same parameters as identified for strips above, the following bearing pressures could be achieved for pads.

| Table of bearing values for pad foundations | | | |
|---|---|---|---|
| **Plan size of pad (m)** | **Ultimate bearing value kN/m$^2$** | **Presumed bearing value kN/m$^2$** | **Allowable bearing pressure kN/m$^2$** |
| **1 x 1** | 600 | 210 | 180 |
| **1.5 x 1.5** | 660 | 230 | 190 |
| **2 x 2** | 710 | 240 | 200 |

**Table 7.2.5.3**

7.2.5.4 The presumed bearing value has been derived from the ultimate bearing value by applying a factor of safety of 3, and the allowable bearing pressure derived to limit total settlement.

7.2.5.5 It is difficult to accurately predict the amount of total and differential movement caused by consolidation of the foundations supporting sub soils, however, providing foundation stresses do not exceed allowable bearing pressures provided in the preceding paragraph, it is suggested that total settlement would be small and probably less than 25mm. Differential settlement is totally dependent upon the variation of foundation loads and consistency of the supporting ground. Assuming the foundation loads are reasonably uniform, we suggest that differential settlement is unlikely to exceed say 10mm. With respect to pad foundations, assuming a spacing of say 6m between frame / pad centres the angle of distortion in the building frame would be 10/6000 = 1/600 which is within normally acceptable limits. It is likely settlement will be fully achieved within say 5 years of construction.

7.2.5.6 The granular Kempton Park Gravels encountered in exploratory excavations are consistent and will provide uniform support to foundations. In the unlikely event foundation excavations encounter a soft area, we recommend foundation excavations continue to locate stiffer soils or reinforcement introduced into foundation concrete to span the soft area.

**7.2.6 Raft foundations**

7.2.6.1 Raft foundations potentially have the ability to spread superstructural loads over the footprint of the building thus substantially reducing stresses imparted to the ground compared with spread foundations transferring more concentrated loads to the ground. In our opinion, based on the ground conditions encountered at the site, we recommend the raft be designed to accommodate a loss of ground support of say 1m diameter below any part of the raft. Further information on the design of such raft foundations can be found in "*Structural Foundation Designers' Manual*" – Curtins Consulting Engineers.

7.2.6.2 Should a raft foundation solution be considered then we recommend further insitu density testing is carried out across the footprint of the proposed building to allow an assessment of the likely settlement behaviour of the raft to be made and potentially providing information to allow the stiffness of such a raft to be determined.

**7.2.7 Trench stability and construction constraints**

7.2.7.1 Generally we anticipate trial pits will remain upright and stable throughout excavation, we did observe some minor collapse during infiltration testing but this is considered to be due to the water, rather than very loose soils.

7.2.7.2 Based on our observations of exploratory excavations the risk of some water being encountered in the Kempton Park Gravel Member is high. Groundwater was encountered from depths of between 1m to 2.5m across the site. Instability of trenches due to the presence of water may produce a wider than planned trench width resulting in an increase in the quantity of foundation concrete to fill voids produced by instability of trench sides.

7.2.7.3 We understand that there is an air raid shelter buried towards the centre of the site. A separate investigation, undertaken by others, attempted to locate the shelter, however we understand they were unsuccessful, despite multiple trenches and pits exposing the ground in the area. Should the shelter prove to still be in situ, it should be noted that the shelter will require removing prior to development. It is likely that Made Ground in this area will be significantly deeper than the remainder of the site, resulting in the requirement for extending foundations further through to natural soils at depth.

7.2.7.4 Foundations from existing buildings will be present within the ground following demolition, which will potentially cause obstructions during the rebuilding works. This should be taken into account during the construction phase and where necessary, existing foundations will require removing from the footprint of proposed buildings.

**7.2.8 High rise buildings**

7.2.8.1 Where column loads exceed the allowable bearing capacity for near surface soils, or where groundwater prevents the successful construction of open excavations, then a piled foundation can be adopted. Such a solution would transmit superstructural loads down through the Made Ground into the Kempton Park Gravels and London Clay at depth to obtain end bearing and shaft adhesion support. The difficulty of driving or boring piles through the saturated Kempton Park Gravels and into the London Clay will need to be considered by any specialist piling company and will affect the method of pile installation.

7.2.8.3 Ultimate shaft adhesion values for bored piles in the granular Kempton Park Gravel deposits are derived using the following relationship

$$Qsu = ks \times \sigma v \times \tan \delta$$

7.2.8.4 We have assumed loose density parameters taking into account the likelihood of soil disturbance during excavation of pile bores (refer Tomlinson – *'Foundation design and construction'* – seventh edition) The following parameters must be considered estimates only. Detailed pile design must be undertaken by a specialist piling contractor who is familiar with installation of piles in this geology.

for loose conditions let $\phi = 30$ ° (angle of shearing resistance)

Let $\sigma v = 19kN / m^3$ x depth and assume $\delta = 20$ ° (soil pile friction angle)

Where, $ks = 0.8ko$ Tomlinson, 2001 (p206) $ko = 1 - \sin\phi = 0.5$, then $ks = 0.4$

Then $Qs = 0.4 \times \tan 20 \circ \times \sigma v \times As = 0.145 As \times \sigma v$

Where, $\sigma v$ = average effective overburden pressure over depth of soil layer and $As$ = area of pile shaft.

Utilising the above we can provide the following information for preliminary pile design purposes based on the bored pile solution through the granular Kempton Park Gravel deposits

7.2.8.5 The ultimate shaft adhesion for bored piles in London Clays is determined by the following relationship.

$$Qsu = \overline{Cu} \times \alpha$$

Where;
$\alpha$ = adhesion factor between concrete and the clays soils, and,
$\overline{Cu}$ = average undrained shear strength down the pile shaft in the London Clays (kN/m$^2$).

7.2.8.6 Measured undrained shear strength determinations have been used to 'calibrate' the conversion of standard penetration test data to undrained shear strength with a summary of undrained shear strength data shown on Drawing 07. A suggested relationship between undrained shear strength and depth is also shown on Drawing 07, based primarily on shear strength determinations. This relationship can be used to determine $\overline{Cu}$ .

7.2.8.7 With reference to '*Guidance notes for the design of straight shafted bored piles in London Clay*' (2009) produced by the London District Surveyors Association, the $\overline{Cu} \times \alpha$ value is limited to 110kN/m$^2$, (approximately equates to a maximum undrained shear strength of 220kN/m$^2$).

7.2.8.8 The ultimate end bearing capacity for bored piles terminating in the London Clays is derived from the following relationship.

$$Qbu = Nc \times Cu$$

Where,
$Nc$ = end bearing capacity factor = 9
$Cu$ = undrained shear strength (kN/m$^2$) at the pile toe. (Again, $Cu$ can be obtained from Drawing 07.)

7.2.8.9 The adhesion factor, $\alpha$ of 0.5 in the London Clays has been obtained from guidance provided in '*Guidance notes for the design of straight shafted bored piles in London Clay*' (2009) produced by the London District Surveyors Association (LDSA), and assumes the following:

- There are no major water seepages in the London Clays which are defined as those that wet more than 20% of the pile shaft prior to concreting.
- Piles are not constructed using drilling fluid (eg bentonite) or continuous flight auger
- The pile design is dictated by permanent vertical loads with no significant vertical or lateral cyclical component
- The piles are concreted within 12 hours of start of boring in the London Clays (or 12 hours below casing depth)

7.2.8.10 The published guidance recommends the adhesion is limited to 110kN/$m^{2,}$ which equates to limit on the undrained shear strength of the clays of about 220kN/$m^2$.

7.2.8.11 For Kempton park Gravels, we have assumed loose density parameters taking into account the likelihood of soil disturbance during excavation of pile bores (refer Tomlinson – *'Foundation design and construction'* – seventh edition)

7.2.8.12 Utilising this information we can provide the following information for preliminary pile design purposes based on the bored pile solution. The following parameters must be considered estimates only. Detailed pile design must be undertaken by a specialist piling contractor who is familiar with installation of piles in this geology.

**Table of pile design parameters**

| Strata | Depth (m) | Shaft adhesion (kN/$m^2$) | End bearing (kN/$m^2$) |
|---|---|---|---|
| Kempton Park Gravel | 8m | 6.38 x As | N/A |
| London Clay (α = 0.5) | 8m to 25.0m | Increase linearly from 32.5 x As (@8m) to 95x As (@25m) | Increase linearly from 720 x Ab (@10m) to 1710 x Ab (@25m) |

**Table 7.2.8.9**

Where: As = Area of the pile shaft ($m^2$)
Ab = Area of the pile base ($m^2$)

7.2.8.13 The sum of shaft adhesion and end bearing will need to divided by a factor of safety ranging from 3 to 2 subject to testing of installed piles. It should be noted that Constant Rate of Penetration Testing is no longer considered an appropriate method for determination of pile capacity by LDSA. The following is taken from this guidance publication:

**Table of factors of safety**

| Pile testing | | Factor of safety |
|---|---|---|
| Direction of loading | Load Test requirements | |
| Compression | None | 2.6 |
| | Working tests only | 2.2 |
| | Preliminary pile test(s) and working tests | 2.0 |
| Tension | none | 3.0 |

**Table 7.2.2.10**

**7.2.9 Pile testing**

7.2.9.1 Methods for load testing of piles including the constant rate of penetration test and maintained load test are described in BS 8004:1986 '*British Standard Code of practice for Foundations'*.

7.2.9.2 We recommend pile testing is carried out in advance of the main piling works to verify (or otherwise) pile design parameters and indeed verify ease/difficulty of the selected method of pile installation.

**7.2.10 Pile design and installation**

7.2.10.1 We have endeavoured to provide sufficient information to allow detailed design of piles to be completed. The above pile design guidelines have been produced in good faith based on our current understanding of design procedures for the purposes of producing a preliminary foundation layout by a Structural Engineer. We recommend the design and installation of the piles are determined by a specialist piling contractor who has experience in pile installation in these or similar ground conditions, and may be able to interpret the observed ground conditions in a different and potentially more beneficial manner. We recommend the specialist piling contractor assumes responsibility for the choice, design and installation of the piles.

7.2.10.2 We recommend piling be carried out following the *"Specification for Piling and Embedded Retaining Walls"* produced by the Institution of Civil Engineers.

7.2.10.3 It is likely that a 'piling mat' will have to be constructed in advance of piling operations. This will be designed following the Building Research Establishment publication '*Working Platforms for tracked plant: good practice guide to the design, installation, maintenance and repair of ground supported working platforms'.* We will be pleased to assist in the design and specification of such a platform on further instructions.

## 7.3 Influence of Trees and other major vegetation

### 7.3.1 Soil classification and new foundation design

7.3.1.1 With reference to our engineer assessment above, we have recommended that all foundations extend through the near surface, cohesive deposits into granular Kempton Park Gravels at depth. Granular deposits will not be substantially affected by the moisture demands of trees.

7.3.1.2 In justification for the above; cohesive deposits extend to some 0.8-1.4m below ground level. The results of plastic and liquid limit determinations performed on samples of the Kempton Park Gravel Member indicate the deposits are soils of **medium** and **high** volume change potential when classified in accordance with National House Building Council (NHBC) Standards, Chapter 4.2. As a worst case, **high** volume change potential should be adopted for near surface soils. Foundations taken down onto a depth of 1m will penetrate the zone of shrinkage and swelling caused by seasonal wetting and drying. Trees and other major vegetation extend this zone and will require deeper foundations. Therefore foundations would require extension in accordance with NHBC Standards Chapter 4.2, or indeed can be limited to location upon non-shrinkable soils.

## 7.4 Ground Floor Construction

7.4.1 Ground bearing floor slabs can be adopted at this site where buildings are remote from trees and where Made Ground and Topsoil deposits are fully removed within the footprint of the building. We recommend a blanket of good quality compacted granular material be placed prior to construction of the floor slabs.

7.4.2 In areas close to existing major vegetation at the site (or where ground floors are elevated requiring in excess of 600mm of fills) then we recommend the use of a suspended ground floor with a sub floor void determined following NHBC Standards, Chapter 4.2.

7.4.3 If a piled foundation is selected then a suspended floor could also be adopted supported off piled foundations.

## 7.5 Service Trench Excavations

7.5.1 Generally, the sides of trench excavations will remain stable in the short term. Excavations extending to depths greater than 1m are at an increasing risk of encountering water inflows, which will promote progressive instability in trench sides requiring continuous trench sheet shoring to maintain an open excavation. We anticipate water will be controlled with nominal pumping techniques.

7.5.2 We recommend any trench excavation requiring human entry is shored as necessary to conform with current best practice, and accepted by the Health and safety Executive (HSE) and in particular, following guidance provided in the HSE publication 'Health and safety in construction (HSG 150)' (www.hse.gov.uk).

## 7.6 Infiltration Potential

### 7.6.1 Requirements for use of infiltration systems

7.6.1.1 It is a requirement under H3 (3) of the current building regulations to discharge stormwater collected by a development to soakaways as a priority (as opposed to water courses and sewers).

### 7.6.2 Contamination considerations

7.6.2.1 With reference to Environment Agency (EA) publication '*Groundwater protection: Policy and practice (GP3) Section G,* 2012, outside of SPZ1, the EA will support sustainable drainage systems for new discharges to ground. This is subject to an appropriate risk assessment to demonstrate that ground conditions are suitable and infiltration systems do not present an unacceptable risk of promoting mobilisation of contaminants or creating new pathways for contaminant migration.

7.6.2.2 The permeability of the near surface Kempton Park Gravel Member in combination with the site located over a Principal aquifer suggests the site is sensitive to migration of contaminants. The site is not located within or close to a source protection zone. All discharges to groundwater are subject to compliance with the Water Framework Directive (2000/60/EC) and Groundwater Daughter Directive (2006/118/EC). We have carried out leachate testing of a suite of contaminants with our assessment provided in Section 8.7.9, and a source of chemical contamination has been identified on site, we are of the opinion that the site represents a **moderate** risk of causing harm to water receptors.

### 7.6.3 Infiltration measurements

7.6.3.1 The near surface Kempton Park Gravel Member deposits comprise both cohesive and granular deposits. Granular deposits are considered to be permeable with cohesive deposits exhibiting lower permeability.

7.6.3.2 The permeability of the Kempton Park Gravel Member was measured in two boreholes and eleven trial pits following the principles described in Building Research Establishment (BRE) Digest 365 (2007) "*Soakaway Design*". Records of testing and calculations are presented in Appendix F. It should be noted that testing within the boreholes has not been strictly carried out in accordance with the BRE publication, as the minimum size of the test hole (BRE 365 states that the trial pit should be 0.3 to 1 m wide and 1 to 3 m long and should have vertical sides trimmed square) could not be achieved in the borehole, however the test provides an indication of the likely permeability of the soils under test.

7.6.3.3 The following table shows the calculated infiltration rates. It should be noted that the rate of water dissipating in some excavations was slow and we were not always able to carry out three cycles of the test procedures described in the digest in all test locations.

**Table of Infiltration rates**

| Location | Depth under test | Number of cycles | Calculated rates ($ms^{-1}$) |
|---|---|---|---|
| **DTS112** | 0.9 – 2.0m | 1 | $6.29x\ 10^{-6}$, $4.17x\ 10^{-7}$ and $2.81x\ 10^{-7}$ |
| **DTS115** | 0.73 – 1.94m | 1 | $6.77 \times 10^{-7}$ |
| **TP101** | 1.07 – 1.41m | 3 | $1.45 \times 10^{-5}$, $7.78 \times 10^{-6}$ and $2.22 \times 10^{-5}$ |
| **TP102A** | 1.1 – 1.45m | 1 | Insufficient infiltration |
| **TP104** | 0.89 – 1.06m | 1 | Insufficient infiltration |
| **TP105** | 1.5 – 1.95m | 3 | $2.63 \times 10^{-5}$, $1.16 \times 10^{-5}$ and $1.17 \times 10^{-5}$ |
| **TP107** | 0.65 – 0.95m | 1 | Insufficient infiltration |
| **TP108** | 0.86 – 1.12m | 3 | $1.43 \times 10^{-4}$, $7.83 \times 10^{-5}$ and $5.24 \times 10^{-5}$ |
| **TP109** | 1.32 – 1.6m | 3 | $3.77 \times 10^{-4}$, $1.54 \times 10^{-4}$ and $8.3 \times 10^{-5}$ |
| **TP301** | 0.51 – 0.55m | 3 | $3.74 \times 10^{-5}$, $1.74 \times 10^{-5}$ and $1.2 \times 10^{-5}$ |
| **TP302** | 0.47 – 0.63m | 3 | $6.5 \times 10^{-5}$, $1.72 \times 10^{-5}$ and $9.93 \times 10^{-6}$ |
| **TP303** | 0.47 – 0.68m | 3 | $3.38 \times 10^{-5}$, $1.47 \times 10^{-5}$ and $1.07 \times 10^{-5}$ |
| **TP304** | 0.53 – 0.65m | 3 | $6.23 \times 10^{-5}$, $1.04 \times 10^{-5}$ and $6.92 \times 10^{-6}$ |

**Table 7.6.3.3**

## 7.6.4 Design of infiltration systems

7.6.4.1 The Kempton Park Gravel Member exhibits some variation in permeability. On this basis the use of trench type soakaways will increase the likelihood of locating more permeable soils along its length.

7.6.4.2 As laboratory testing indicates soakaways could promote leaching of chemical contaminants in the soil sufficient to cause a risk to groundwater we recommend that Made Ground is either completely removed from areas of proposed soakaways or is sealed out, with water directly entering the Kempton Park Gravels.

7.6.4.3 If infiltration systems are adopted as a means of stormwater disposal (including permeable pavement construction), we recommend approval for the use of soakaways is sought from the Environment Agency. It should be noted that the Groundwater Regulations 1998 require that list 1 substances (e.g. Hydrocarbons) are to be prevented from entering groundwater receptors and list 2 substances (e.g. metals) are also restricted.

7.6.4.4 Typically, the Environment Agency will require details of the proposed soakaway systems, showing pollution prevention measures. They will also require geological and geo-hydrological information, (contained in this report) as well as the risks of chemical contaminants in the ground affecting water resources. It is also typical requirement that there is an 'unsaturated zone' between the base of the soakaway system and the groundwater table (saturated zone) providing attenuation capacity.

**7.6.5 Code for sustainable homes (credits under Sur1)**

7.6.5.1 The use of infiltration systems for disposal of stormwater collected by the development will assist in achieving credits under Sur 1 which are mandatory under the code for sustainable homes.

## 7.7 Pavement Foundations

7.7.1 It is anticipated that the artificial sports pitches will be located at or about existing ground levels with formation located on cohesive and granular Kempton Park Gravel deposits. We recommend that all Made Ground material is fully removed from within the footprint of the proposed pitch.

7.7.2 Equilibrium CBR (California Bearing Ratio) values (with reference to Transport and Road Research Laboratory (TRRL) Report LR1132 *'Structural design of Bituminous Roads'*) are derived from knowledge of soil classification data (plasticity index for soils exhibiting cohesion (clay type) and particle size distribution for granular soils), the location of the water table pavement thickness, and weather conditions at the time of construction. It is anticipated that excavations to formation levels will encounter a mixture of both granular and cohesive soils. Granular soils will provide numerically high CBR values, but cohesive soils will typically provide significantly lower value. Assuming an average plasticity index of say 27 for cohesive soils, a low water table, a 'thin' pavement the following equilibrium CBR values are derived for varying construction conditions

| Equilibrium CBR values for differing construction conditions | | |
|---|---|---|
| **Poor** | **Average** | **Good** |
| CBR = 3% | CBR = 5% | CBR = 6% |

**Table 7.7.2**

7.7.3 It is possible to derive the 'insitu' CBR value at formation from undrained shear strength data by applying a conversion factor of 23 (refer TRRL laboratory report LR889). Thus adopting an average undrained shear strength of say 60kN/m$^2$ at formation level (based on insitu shear strength measurements) then an equivalent CBR value can be obtained i.e.

Insitu CBR = undrained shear strength C/23 = 2.6%

7.7.4 The 'insitu' CBR derived above, is susceptible to change dependent upon weather conditions during construction. The equilibrium CBR value derived in the paragraph above is an estimate of the CBR value, which will predominate during the life of the pavement. We recommend the insitu CBR of **2.5%** derived from shear strength data be utilised for design purposes and reassessed during construction. The fact that the clay subgrade soils are likely to be deemed frost susceptible will probably be the overriding criteria for pavement foundation design purposes. It should also be noted that the thickness of the pavement foundation also relates to the amount and loading from construction traffic, which is discussed in detail in the Transport and Road Research Laboratory (TRRL) Report LR1132 '*Structural design of Bituminous Roads'.*

7.7.5 Once formation levels have been established it is recommended that the formation be trimmed and rolled following current requirements of the Highways Agency Specification for Highways Works (clause 616) (refer www.specificationforhighways.co.uk). Such a process will identify any soft areas, which we recommend be either excavated out and backfilled with a suitable well compacted material similar to those exposed in the sides of the resulting excavation, or large cobbles of a good quality stone rolled into the formation to stabilise the 'soft' area.

7.7.6 It should be noted that the River Crane to the south of the site was historically re-diverted to avoid the current playing field. There is the potential for loose/ low strength alluvium deposits to be present across the former path of the river and any associated floodplain. If, during construction, any notably soft pockets/ channels are encountered we recommend that Soiltechnics is contacted.

## 7.8 Reuse of excavated soils from the site

7.8.1 Generally soils excavated from the site could be reused as bulk filling, if reused at their natural moisture content. We recommend soils be classified and compacted in accordance with the current Highways Agency '*Specification for Highway Works*' (600 series) – table 6/1 (refer www.dft.gov.uk/ha/standards/mchw/vol1).

# 8 Chemical contamination



## 8.1 Contaminated land, regulation and liabilities

### 8.1.1 Statute

8.1.1.1 Part IIA of the Environment Protection Act 1990 became statute in April 2000. The principal feature of this legislation is that the hazards associated with contaminated land should be evaluated in the context of a site-specific risk based framework. More specifically contaminated land is defined as:

> *"any land which appears to the local authority in whose area it is situated to be in such a condition, by reasons 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".*

8.1.1.2 Central to the investigation of contaminated land and the assessment of risks posed by this land is that:

i) There must be contaminants(s) at concentrations capable of causing health effects (*Sources).*
ii) There must be a human or environmental receptor present, or one which makes use of the site periodically *(Receptor)*; and
iii) There must be an exposure pathway by which the receptor comes into contact with the environmental contaminant *(Pathway).*

8.1.1.3 In most cases the Act is regulated by Borough or District Councils and their role is as follows:

i) Inspect their area to identify contaminated land
ii) Establish responsibilities for remediation of the land

iii) See that appropriate remediation takes place through agreement with those responsible, or if not possible:
- by serving a remediation notice, or
- in certain cases carrying out the works themselves, or
- in certain cases by other powers

iv) keep a public register detailing the regulatory action which they have taken

8.1.1.4 For "special" sites the Environment Agency will take over from the Council as regulator. Special sites typically include:-

- Contaminated land which affects controlled water and their quality
- Oil refineries
- Nuclear sites
- Waste management sites

**8.1.2 Liabilities under the Act**

8.1.2.1 Liability for remediation of contaminated land would be assigned to persons, organisations or businesses if they caused, or knowingly permitted contamination, or if they own or occupy contaminated land in a case where no polluter can be found.

**8.1.3 Relevance to predevelopment conditions**

8.1.3.1 For current use, Part IIA of the Environmental Protection Act 1990 provides the regulatory regime. The presence of harmful chemicals could provide a 'source' in a 'pollutant linkage' allowing the regulator (Local Authority or Environment Agency) to determine if there is a significant possibility of harm being caused to humans, buildings or the environment. Under such circumstances the regulator would determine the land as 'contaminated' under the provision of the Act requiring the remediation process to be implemented.

**8.1.4 Relevance to planned development**

8.1.4.1 The developer is responsible for determining whether land is suitable for a particular development or can be made so by remedial action. In particular, the developer should carry out an adequate investigation to inform a risk assessment to determine:

a) Whether the land in question is already affected by contamination through source – pathway – receptor pollutant linkages and how those linkages are represented in a conceptual model
b) Whether the development proposed will create new linkages e.g. new pathways by which existing contaminants might reach existing or proposed receptors and whether it will introduce new vulnerable receptors, and
c) What action is needed to break those linkages and avoid new ones, deal with any unacceptable risks and enable safe development and future occupancy of the site and neighbouring land?

8.1.4.2 Building control bodies enforce compliance with the Building Regulations. Practical guidance is provided in Approved documents, one of which is Part C, '*Site preparation and resistance to contaminants and moisture'* which seeks to protect the health, safety and welfare of people in and around buildings, and includes requirements for protection against harm from chemical contaminants.

**8.1.5 Pollution of controlled waters**

8.1.5.1 Part IIA of the Environment Protection Act 1990, defines pollution of controlled waters as

> *'The entry into controlled waters of any poisonous, noxious or polluting matter or any solid waste matter'*

8.1.5.2 Paragraphs A36 and A39 of statutory guidance (DETR 2000) further define the basis on which land may be determined to be contaminated land on the basis of pollution of controlled waters.

> *'Before determining that pollution of controlled waters is being, or likely to be, caused, the Local Authority should be satisfied that a substance is continuing to enter controlled waters, or is likely to enter controlled waters. For this purpose, the local authority should regard something as being likely when they judge it more likely than not to occur'*
>
> *'Land should not be designated as contaminated land where:*
>
> *a) A substance is already present in controlled waters:*
> *b) Entry into controlled waters of that substance from the land has ceased, and*
> *c) It is not likely that further entry will take place.*
>
> *Substances should be regarded as having entered controlled waters where:*
>
> *a) They are dissolved or suspended in those waters; or*
> *b) If they are immiscible with water, they have direct contact with those waters, or beneath the surface of the waters'*

8.1.5.3 Controlled waters are defined in statute to be:

> *'territorial waters which extend seawards for 3 miles, coastal waters, inland freshwaters, that is to say, the waters in any relevant lake or pond or of so much of any relevant river or watercourse as is above the freshwater limit, and groundwaters, that is to say, any waters contained in underground strata.'*

**8.1.6 Further information**

8.1.6.1 The above provides a brief outline as regards current statute and planning controls. Further information can be obtained from the Department for the Environment, Food and Rural Affairs (DEFRA) and their Web site www.defra.gov.uk.

## 8.2 Objectives and procedures

### 8.2.1 Objectives

8.2.1.1 This report section discusses investigations carried out with respect to chemical contamination issues relating to the site. The investigations were carried out to determine if there are any liabilities with respect to Part IIA of the Environment Protection Act. As stated in Section 2.4.2, the investigation process followed the principles of BS10175: 2011 *'Investigation of potentially contaminated sites – Code of Practice',* with the investigation combining a desk study (preliminary investigation) together with the exploratory and main investigations (refer BS10175: 2011 for an explanation).

8.2.1.2 This section of the report produces *'Conceptual models'* based on investigatory data obtained to date. The conceptual model is constructed by identification of *contaminants* and establishment of feasible *pathways* and *receptors.* The conceptual model allows a *risk assessment* to be derived. Depending upon the outcome of the risk assessment it may be necessary to carry out remediation and/or further investigations with a view to eliminating, reducing or refining the risk of harm being caused to identified receptors. If appropriate, our report will provide recommendations in this respect.

8.2.1.3 Clearly we must consider the current pre-development condition, establishing risks which may require action to render the site safe to all relevant (current) receptors meeting the requirements of current legislation (Part IIA of the Environmental Protection Act 1990)

8.2.1.4 Definition of terms used in the preceding paragraph and subsequent parts of this section of the report are presented in Appendix B.

### 8.2.2 Procedure to assess risks of chemical contamination

8.2.2.1 For the purposes of presenting this section of this report, we have adopted the following sequence in assessing risks associated with chemical contamination.

| Table outlining sequence to assess risk associated with chemical contamination | | |
|---|---|---|
| **Conceptual model element** | **Contributory information** | **Outcome** |
| Receptor | Development categorisation | Identification of receptors at risk of being harmed<br>Method of analysing test data<br>Criteria for risk assessment modelling |
| Pathways | Geology and ground conditions<br>Development proposals | Identification of critical pathways from source to receptor |
| Source | Previous site history<br>Desk study information<br>Site reconnaissance<br>Fieldwork observations | Testing regime<br>Identification of a chemical source<br>Analysis of test data and other evidence |
| **Table 8.2.2** | | |

8.2.2.2 We have adopted, in general, the procedures described in CIRIA C552 *'Contaminated land risk assessment - a guide to good practice'* in deriving a risk assessment. Initially we have carried out a 'phase 1 assessment' based on Desk Study information and site reconnaissance, to produce an initial conceptual model and thus a preliminary risk assessment. This model / assessment is then used to target fieldwork activities and laboratory testing, with the results of this part of the investigation used to allow a phase 2 assessment to be produced by updating the conceptual model and refining the risk assessment.

## 8.3 Development characterisation and identified receptors

### 8.3.1 Site characterisation

8.3.1.1 The nature of the site has a significant influence the likely exposure pathways between potentially contaminated soils and potential receptors. The following table summarises elements which characterise the site based on site observations and desk study information.

| Summary of site characteristics | | |
|---|---|---|
| **Element** | **Source / criteria** | **Characteristic** |
| Current land use | Observations | Richmond Upon Thames College including playing fields |
| Future land use | Advice | College buildings and residential development which includes domestic gardens. |
| Site history | Desk study | Farm land with railway land ~100m south from 1871. A tramline was introduced from 1896-1915 along with a sewage works which extends within 50m west of the site boundary from 1896-1966. College buildings onsite from 1938. |
| Geology | Desk study and Site investigation | Made Ground overlying Kempton Park Gravel Member and subsequently London Clay Formation. |
| Ground water | Aquifer potential | Principal Aquifer within Kempton Park Gravel Member and unproductive strata in the London Clay Formation |
| | Abstractions | Four active groundwater abstraction points within 2000m, the closest being 1504m NE |
| | Source protection zone | Site not within source protection zone |

| Summary of site characteristics | | |
|---|---|---|
| **Element** | **Source / criteria** | **Characteristic** |
| Surface waters | Location | River Crane located directly south of the site. The Duke of Northumberland's River is located approximately 70m west from the northern boundary of the site and 380m west of the southern boundary. |
| | Abstractions | Six within 2000m of the site, the closest being 860m north of the site. |

**Table 8.3.1**

### 8.3.2 Identified receptors

8.3.2.1 The principal receptors subject to harm caused by any contamination of the proposed development site are as follows.

| Principle Receptor | Detail |
|---|---|
| Humans | Users of the current site |
| | End user of the developed site |
| | Construction operatives and other site investigators |
| Vegetation | Plants and trees, both before and after development |
| Controlled waters | Surface waters (Rivers, streams, ponds and above ground reservoirs) |
| | Ground waters (used for abstraction or feeding rivers / streams etc) |
| Building materials | Materials in contact with the ground |

**Table 5.3.2**

This section of the report assesses those receptors listed above. Section 10 provides a risk assessment in relation to building materials.

### 8.3.3 Human receptors

8.3.3.1 The Contaminated Land Exposure Assessment (CLEA) model can be used to derive guideline values, against which land quality data can be compared to allow an assessment of the likely impacts of soil contamination on humans. The parameters used within the model can be chosen to allow guideline values to be derived for a variety of land uses and exposure pathways. For example, a construction worker is likely to be exposed in different ways and for different durations than an adult in a residential setting.

8.3.3.2 As the current site is accessible to the general public the critical site user (receptor) is considered to be a child under the age of 6 years. Following completion of the residential development the critical site user (receptor) is again considered to be a child under the age of 6 years. This criterion has been used in the conceptual model for the current and future site use. Our assessment also considers construction operatives as adult receptors.

### 8.3.4 Vegetation receptors

8.3.4.1 Soil contaminants can have an adverse effect on plants if they are present at sufficient concentrations. The effects of phytotoxic contaminations include growth inhibition, interference with natural processes within the plant and nutrient deficiencies.

8.3.4.2 Vegetation is considered a potential receptor in both the current and proposed site uses. Mature vegetation is located along the north western border, north eastern border and the south western border. All existing vegetation as well as additional trees in the residential area are included on the proposed layout.

### 8.3.4 Water receptors

8.3.4.1 The site lies in an area designated as a principal aquifer contained in the Kempton Park Gravel Member. In addition the River Crane is located directly south of the southern border of the site and the Duke of Northumberland's River runs parallel to the south western boundary, approximately 70m from the northern corner and 380m from the southern corner. We would consider both groundwater and surface water potential receptors for chemical contamination.

### 8.3.5 Summary of identified receptors

8.3.5.1 Based on the above assessments, the following table summarises identified and critical receptors.

**Table summarising identified (viable) receptors**

| Principle Receptor | Detail | Viable and critical receptors | | |
|---|---|---|---|---|
| | | Viability and justification | | Critical receptor |
| Humans | Users of the current and developed site | Yes | Site accessible to public including children | Child |
| | Construction operatives and other site investigators | Yes | | Adult |
| Vegetation | Current site | Yes | Trees on site | Vegetation |
| | Developed site | Yes | Trees to remain | Vegetation |
| Controlled waters | Surface waters (Rivers, streams, ponds and above ground reservoirs) | Yes | Site 0m from the River Crane to the south and 70m from the Duke of Northumberland River in the west. | Surface waters |
| | Ground waters (used for abstraction or feeding rivers / streams etc) | Yes | Site over principal aquifer | Groundwater |
| Building materials | Materials in contact with the ground | Yes | Assessed in report section 10 | Building materials |

**Table 8.3.5**

## 8.4 Identification of pathways

### 8.4.1 Pathways to human receptors

8.4.1.1 Guidance published by the Environment Agency in Science Report SC050021/SR3 *'Updated technical background to the CLEA model'* provides a detailed assessment of pathways and assessment and human exposure rates to source contaminants. In summary, there are three principal pathway groups for a human receptor:

| Table summarising likely pathways | |
|---|---|
| **Principal pathways** | **Detail** |
| Ingestion through the mouth | Ingestion of air-borne dusts |
| | Ingestion of soil |
| | Ingestion of soil attached to vegetables |
| | Ingestion of home grown vegetables |
| Inhalation through the nose and mouth. | Inhalation of air-borne dusts |
| | Inhalation of vapours |
| Absorption through the skin. | Dermal contact with dust |
| | Dermal contact with soil |

**Table 8.4**

8.4.1.2 The site is currently used as an educational facility. The risk of ingestion of soil attached to vegetables is therefore very low. The site has both areas of hardstanding and soft landscaping which would allow for all other pathways to be considered likely.

8.4.1.3 The site is to be developed for residential and educational use. We will therefore consider all of the above as potential pathways from source to receptor.

8.4.1.4 A summary of our pathway assessment is presented in Section 8.4.4.

### 8.4.2 Pathways to vegetation

8.4.2.1 Guidance published by the Environment Agency in Science Report SC050021/SR (Evaluation of models for predicting plant uptake of chemicals from soil) provides a detailed assessment of plant uptake pathways. In summary, plants are exposed to contaminants in soils by the following pathways:

- Passive and active uptake by roots.
- Gaseous and particulate deposition to above ground shoots.
- Direct contact between soils and plant tissue.

8.4.2.2 All of the above routes of exposure are considered to be present for vegetation.

### 8.4.3 Pathways to controlled waters

8.4.3.1 A number of pathways exist for the transport of soil contamination to controlled waters. A summary of these pathways is presented below:

- Percolation of water through contaminated soils.
- Near-surface water run-off through contaminated soils.
- Saturation of contaminated soils by flood waters.

8.4.3.2 As the Kempton Park Gravel Member deposits are principal aquifers and there are two rivers in close proximity to the site, both percolation of water through the contaminated soils and surface water run-off are considered to be likely pathways. The site is however not located in an area of potential fluvial or tidal flood risk, although there is a risk of some localised surface flooding on site. On this basis generally the risk of saturation of contaminated soils by flood waters is considered unlikely.

### 8.4.4 Summary of identified likely pathways

8.4.4.1 Based on the above assessments, the following table summarises likely pathways of potential chemical contaminants at the site to identified receptors.

**Table of likely pathways**

| Receptor group | Critical receptor | Pathway |
|---|---|---|
| Proposed site users | Child | Ingestion air-borne dusts |
| | | Ingestion of soil. |
| | | Ingestion of soil attached to vegetables |
| | | Ingestion of home grown vegetables |
| | | Inhalation air-borne dusts |
| | | Inhalation of vapours |
| | | Dermal contact with dust |
| | | Dermal contact with soil |
| Current site users and construction operatives | Adult | Ingestion of air-borne dusts |
| | | Ingestion of soil |
| | | Inhalation of air-borne dusts |
| | | Inhalation of vapours |
| | | Dermal contact with dust |
| | | Dermal contact with soil |
| Vegetation | | Root uptake, deposition to shoots and foliage contact. |
| Controlled waters | Groundwater | Percolation of water through contaminated soils |
| | Surface water | Near-surface water run-off through contaminated soils |

Table 8.4.4

## 8.5 Assessment of sources of chemical contamination

### 8.5.1 Introduction

8.5.1.1 Initially, potential sources of contamination are assessed using the following elements of the investigation process.

- History of the site
- Desk study information
- Site reconnaissance
- Geology
- Fieldwork

These elements will dictate a relevant soil/water testing regime to quantify possible risks of any identified contaminative sources which may harm identified receptors.

**8.5.2 Source assessment – History of the site**

8.5.2.1 The history of the site and its immediate surroundings based on published Ordnance Survey maps is described in Section 3.

8.5.2.2 Based on published historical maps the subject site had farm located to the south of the site which was subsequently relocated off-site, and a tramline, recorded between 1896 and 1915 running from east to west across the centre of the northern section of the site. It appears that the periphery of the site was utilised as allotments during the 1940's, prior to development of the educational facility.

8.5.2.3 Again, based on historical maps, a sewage works was recorded approximately 50m west of the northern section of the site from 1896 to 1966. In addition railway land was located approximately 100m south. The risk form the railway as a former site usage is considered very low given that it is not directly adjacent to the site, therefore it has not been considered further. The risk from the sewage works is also considered likely to be low, as we consider it to be down hydraulic gradient from the site. On this basis we have not considered specific contaminants/pathogens associated with this source further.

**8.5.3 Source assessment – Desk study information**

8.5.3.1 Envirocheck presents a detailed database of environmental information in relation to the site including;

- Pollution incidents
- Landfill sites
- Trading activities

8.5.3.2 Based on the Envirocheck data (refer Appendix Q) the site has 29 recorded historical pollution events which could have generated a source of contamination. The closest event was recorded 109m south and was categorised as a category 3- minor incident which occurred in 1994. The most recent event occurred in January 1999, 381m north-east of the site and was classified as a category 2- significant incident. Due to the distance and time since the incidents occurred, none of the recorded pollution events are considered to currently pose a significant threat to the subject site.

8.5.3.3 Five historic landfill sites are recorded within 2000m of the site. In addition, old Ordnance Survey maps indicate some localised quarrying activities which appear to have been backfilled- the closest being located 198m south. Envirocheck reports an area of Made Ground located on the railway line immediately south east of the playing fields in the southern section of the site.

8.5.3.4 Envirocheck report no trading activities within 250m of the site which are considered likely to pose a significant risk to receptors at the subject site. There is one disused filling station located 810m east of the site. Given the distance and the fact that it is no longer operational, this petrol station is not considered to pose a risk to the subject site.

**8.5.4 Source assessment – Site reconnaissance**

8.5.4.1 A full description of the site and observed adjacent land uses is provided in Section 3 of this report. A plan summarising observations made on site during our site reconnaissance visit is presented on Drawing 02.

8.5.4.2 We did not observe any obvious evidence of any current or recent activities on site or adjacent sites, which provide a potential source of chemical contamination.

**8.5.5 Source assessment – Geology**

8.5.5.1 The geological map of the area indicates the topography local to the site is formed in deposits of Kempton Park Gravel Member and London Clays. Typically, and in our experience, the London Clays do not exhibit any abnormal concentrations of naturally occurring chemical contaminants.

**8.5.6 Source assessment - Fieldwork observations**

8.5.6.1 During excavation of Trial pit TP103A and TP201 we did observe potential asbestos containing material. In addition, Made Ground was encountered across the entire site to a maximum depth of 1.4m. No visual or olfactory evidence of TPH contamination was observed in any location.

8.5.6.2 We obtained samples of the potentially chemically impacted soils for subsequent laboratory testing.

### 8.5.7 Source assessment - summary

8.5.7.1 Based on the paragraphs above, we have identified the following potential sources of contamination:

| Table summarising results of source assessment | | | | |
|---|---|---|---|---|
| **Source** | **Origin of information** | **Possible contaminant** | **Probability of risk occurring** | **Likely extent of contamination** |
| **On site** | | | | |
| Asbestos | Site investigation | Asbestos | Likely | Northern section of the site |
| Made Ground from previous development | Site investigation | Inorganics and organics | Likely | Site wide |
| Former tramline (onsite) | Desk study | Inorganics, organics and asbestos | Likely | Northern section of the site |
| **Adjacent sites** | | | | |
| Sewage works | Desk study | Inorganics, organics, microorganisms, asbestos | Unlikely | Unlikely to have migrated upstream/hydraulic gradient |
| **Table reference 8.5.7** | | | | |

## 8.6 Initial Conceptual Model

8.6.1 Based on our assessment of potential contaminative sources, identified receptors and viable pathways to receptors described in preceding paragraphs, we have produced an initial conceptual model in the form of a table which is presented in Appendix J.

8.6.2 Based on the conceptual model there are risks which exceed the low category which in our opinion are unacceptable, and require either remedial action or further investigation by laboratory testing of soil / water samples to refine the risk assessment.

## 8.7 Laboratory testing

### 8.7.1 Testing regime – Human receptors

8.7.1.1 The site is currently occupied by Richmond Upon Thames College. In addition, asbestos and Made Ground were identified on site which are considered potential sources of contamination.

8.7.1.2 Our previous report, issued in 2008 (reference STE1297R), identified hydrocarbon contamination. Two samples, targeting this area were scheduled to measure concentration of TPH contaminants in both the soil and as leachates, to determine the extent of any potential contamination. A further six soil TPH and leachate TPH tests were completed across the site to determine possible contamination more accurately. TPH testing also measured the concentration of BTEX group contaminants.

8.7.1.3 In addition, the precence of a tramline could be inferred to be included in the industrial profile 'Railway Land' produced by the Department of the Environment (now DEFRA) as part of the Industrial Profiles series. The industrial profile suggests that organics, metals and asbestos are commonly occurring contaminants on sites that have been used for railways/tramlines. Clearly, the possibility of potential soil contamination from this industry would be dependent upon past management of the potential contaminants. At this stage we have assumed there is a risk of each of the potential contaminants impacting soils at the site.

8.7.1.4 One sample, targeting potential asbestos containing material encountered in TP103A was scheduled for analysis. 11 further non-targeted asbestos tests were completed across the site to quantify the amount of asbestos free fibres within soil.

8.7.1.5 We have also scheduled testing to measure the concentration of commonly occurring inorganic and organic contaminants on 22 samples. Obviously, additional testing (quantity and types) would allow a more accurate risk assessment to be made.

8.7.1.6 The following table summarises the scheduled testing, in relation to soil types and identified receptors under consideration of the conceptual model.

**Table summarising scheduled testing (HUMAN receptors)**

| Sample origin | Sample type | Strata | Targeted sampling | Non targeted sampling | Scheduled testing | Critical receptor |
|---|---|---|---|---|---|---|
| DTS101 0.25m | Soil | Made Ground | | ✓ | Asbestos | All human receptors |
| DTS101 0.5m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| DTS102 0.5m | Soil | Made Ground | | ✓ | Inorganic & organics & TPH | All human receptors |
| DTS103 0.3m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| DTS104 0.35 | Soil | Made Ground | | ✓ | Inorganic & organics & TPH | All human receptors |
| DTS105 0.5m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| DTS106 0.6m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| DTS107 0.6m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| DTS108 0.5m | Soil | Made Ground | | ✓ | Inorganic, organics & asbestos | All human receptors |
| DTS109 0.5m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| DTS110 0.5m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| DTS111 0.4m | Soil | Made Ground | | ✓ | Inorganic & organics & TPH | All human receptors |

| | | | | | | |
|---|---|---|---|---|---|---|
| DTS112 0.7m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| DTS113 0.6m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| DTS114 0.5m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| DTS115 0.5m | Soil | Made Ground | | ✓ | Inorganic, organics TPH & asbestos | All human receptors |
| HP01 0.3m | Soil | Made Ground | ✓ | | Inorganic & organics & TPH | All human receptors |
| HP02 0.4m | Soil | Made Ground | ✓ | | Inorganic & organics & TPH | All human receptors |
| TP101 0.2m | Soil | Made Ground | | ✓ | Inorganic, organics & asbestos | All human receptors |
| TP102A 0.6m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| TP103 0.2m | Soil | Made Ground | | ✓ | Asbestos | All human receptors |
| TP103 0.6m | Soil | Made Ground | | ✓ | Asbestos | All human receptors |
| TP103A 0.3m | Soil | Made Ground | ✓ | | Asbestos | All human receptors |
| TP103A 0.6m | Soil | Made Ground | ✓ | | Asbestos | All human receptors |
| TP104 0.2m | Soil | Made Ground | | ✓ | Inorganic & organics | All human receptors |
| TP105 0.2m | Soil | Made Ground | | ✓ | TPH | All human receptors |
| TP108 0.5m | Soil | Made Ground | | ✓ | Inorganic, organics & asbestos | All human receptors |
| TP109 0.8m | Soil | Made Ground | | ✓ | Asbestos & TPH | All human receptors |
| TP201 0.1m | Soil | Made Ground | | ✓ | Asbestos | All human receptors |
| TP201 0.6m | Soil | Made Ground | | ✓ | Inorganic, organics & asbestos | All human receptors |

**Table 8.7.1.6**

8.7.1.7 The results of laboratory determination of concentration of chemical contaminants are presented in Appendix H.

### 8.7.2 Testing regime – Water receptors

8.7.2.1 With reference to our source assessment and initial conceptual model, our testing schedule included measurement of leachable TPH (including BTEX MTBE and trimethyl benzene) concentration in eight samples, based on the report dated 2008 (reference STE1297R).

8.7.2.2 In addition to the above, we have scheduled testing to measure the leachable concentration of common inorganic contaminants where they are considered a risk to water resources. In addition, we have also scheduled testing to include the more common organic compounds forming polycyclic aromatic hydrocarbons.

8.7.2.3 It should be noted that we have scheduled 10 samples for laboratory determination of leachable concentrations of contaminants described above. Further laboratory testing would increase the accuracy of the risk assessment. The following table summarises the testing scheduled for water receptors:

**Table summarising scheduled testing (WATER receptors)**

| Sample origin | Sample type | Strata | Targeted sampling | Non targeted sampling | Scheduled testing | Critical receptor |
|---|---|---|---|---|---|---|
| DTS101 0.5m | leachate | Made Ground | | ✓ | Inorganic & organics | All water receptors |
| DTS103 0.3m | leachate | Made Ground | | ✓ | Inorganic & organics | All water receptors |
| DTS104 0.35 | Leachate | Made Ground | | ✓ | TPH | All water receptors |
| DTS105 0.5m | leachate | Made Ground | | ✓ | Inorganic & organics | All water receptors |
| DTS107 0.6m | leachate | Made Ground | | ✓ | Inorganic & organics | All water receptors |
| DTS109 0.5m | leachate | Made Ground | | ✓ | Inorganic & organics | All water receptors |
| DTS111 0.4m | Leachate | Made Ground | | ✓ | TPH | All water receptors |
| DTS115 0.5m | Leachate | Made Ground | | ✓ | Inorganic & organics & TPH | All water receptors |
| HP01 0.3m | leachate | Made Ground | ✓ | | Inorganic & organics & TPH | All water receptors |
| HP02 0.4m | Leachate | Made Ground | ✓ | | TPH | All water receptors |
| TP101 0.2m | Leachate | Made Ground | | ✓ | Inorganic & organics | All water receptors |
| TP104 0.2m | leachate | Made Ground | | ✓ | Inorganic & organics | All water receptors |
| TP105 0.2m | leachate | Made Ground | | ✓ | TPH | All water receptors |
| TP108 0.5m | Leachate | Made Ground | | ✓ | Inorganic & organics | All water receptors |
| TP109 0.8m | Leachate | Made Ground | | ✓ | TPH | All water receptors |
| BH-B 1.61m | Water | - | | ✓ | Inorganic & organics | All water receptors |
| BH-D 1.70m | Water | - | | ✓ | Inorganic & organics | All water receptors |
| BH-E 1.30m | Water | - | | ✓ | Inorganic & organics | All water receptors |

**Table 8.7.2.3**

**8.7.3 Criteria for assessment of test data – Human receptors**

8.7.3.1 Assessment of laboratory test data has been carried out with reference to current nationally recognised documents listed in the final page of Appendix B. Due to changes in guidance on contaminated land, items 6-8 and item 10 in the document listing above have been withdrawn. In the absence of alternative guidance however we have used these documents. Where new guidance is available, this has been followed in preference to superseded guidance.

8.7.3.2 Soil guideline values (SGVs) are used as a screening tool to assess the risks posed to health of humans from exposure to soil contamination in relation to land uses. Where published SGVs are not available, we have adopted Generic Assessment Criteria (GAC) and Soil Screening Values (SSV) derived by Soiltechnics and by Atkins ($SSV^{ATK}$). GACs have been derived by Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH) and presented in *'Generic Assessment Criteria for Human Health Risk Assessment'*. GACs have been prepared for a number of metals and polycyclic aromatic hydrocarbons (PAH) and are used in preference to values produced by Soiltechnics and Atkins. The CLEA model has been used with toxicology data presented by the EA, LQM/CIEH and Atkins (in that order of preference) to derive SSVs by Soiltechnics. SSVs produced by Atkins are presented on their $ATRISK^{SOIL}$ website.

8.7.3.3 SGVs, GACs, SSVs and $SSV^{ATK}$s represent 'intervention values'; indications to an assessor that soil concentrations above these levels might present an unacceptable risk to the health of site users. These soil guideline values have been produced using conceptual exposure models, which use assumptions and are applied to differing end uses of land. If the values are exceeded, it does not necessarily imply there is an actual risk to health and site-specific circumstances should be taken into account. Conversely, where a critical pathway or chemical form of the contaminant has not been evaluated, a risk may be present even if the SGV/GAC has not been exceeded.

8.7.3.4 For evaluation of test data in relation to polycyclic aromatic hydrocarbon (PAH) contamination, we have compared measured concentrations with corresponding GACs. The GAC fractions are dependent on the Soil Organic Matter (SOM) content of the soils. We have adopted the lowest GAC as an initial screening value.

8.7.3.5 For evaluation of total petroleum hydrocarbon (TPH) and BTEX contamination we have compared measured concentrations directly to the relevant SGV or GAC.

8.7.3.6 We have followed procedures outlined by the CIEH to compare measured concentrations of metals and PAH contaminants against guideline values. TPH contamination results are compared directly with the relevant guideline values. The guidance presents an approach to data analysis and includes the examination of data for potential outliers, assessment of the normality of the test data and the calculation of a 95% Upper Confidence Limit (UCL). The UCL provides an estimate of the population mean, based on test data, with a 95% confidence that the actual mean does not exceed this value. The UCL is compared to the guideline value for the site.

8.7.3.7 We have adopted a residential without plant uptake land use for current site users (college usage) and a residential without uptake (for proposed college area) as an initial screening value. For the proposed residential area we have adopted a residential with plant uptake land use.

8.7.3.8 Where necessary, we have derived a site specific value for the proposed collage areas, using the CLEA model. Parameters have been altered to 195 days present at the site (accounting for 13 weeks off per year, and assuming a 5 day week). The age **classes** considered are 17 and 18, due to the nature of the site (a college). We have assumed 6 hours inside and 2 hours outside every day that the receptors are present at the site. The spreadsheets in Appendix I are marked accordingly where site specific guideline values have been determined using the CLEA model parameters described above.

**8.7.4 Criteria for assessment of test data – Construction operatives**

8.7.4.1 In the absence of guidelines we have adopted industrial guideline values for assessment of construction operatives.

**8.7.5 Criteria for assessment of test data – Vegetation**

8.7.5.1 Guidance published by Forest Research in "*BPG Note 5 - Best Practice Guidance for Land Regeneration*" suggests that a residential without plant uptake or industrial/commercial CLEA model should be adopted for this receptor although specific guideline values are provided for copper and zinc at 130mg/kg and 300mg/kg respectively. As a practice we have adopted the industrial / commercial CLEA model for assessment of test data for vegetation.

8.7.5.2 It is difficult to quantify the phytotoxity of a contaminant as large variations exist between plant tolerances, soil effects and synergistic/antagonistic reactions between chemicals. Due to the complexities of the effects of soil contamination on different plant species, we recommend that the test results presented in this report are passed to a landscape architect for the selection of suitable planting.

**8.7.6 Criteria for assessment of test data – Controlled waters**

8.7.6.1 For interpretation of test data in relation to water receptors we have directly compared measured values with the Environmental Quality Standards (EQS) and UK Drinking Water Standards (UKDWS). In the absence of EQS or UKDWS we have adopted World Health Organisation Drinking Water Guidelines (WHODWG)

8.7.6.2 EQS values are published by the Environment Agency in their publication, "*Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part 11A of the Environmental Protection Act 1990*". EQS values for most inorganic contaminants in freshwater are dictated by the hardness of the receiving watercourse. The hardness of water is a measure of the concentration of calcium carbonate in the water. Thames Water report that the local area has a water hardness value of 259mg/l.

8.7.6.3 Using this information for List II substances (DOE Circular 7/89) we have compared the measured values with the EQS values relative to the hardness of the receiving watercourse assuming a worst case scenario of the watercourse supporting 'sensitive' aquatic life.

8.7.6.4 UKDWS are presented in the Water Supply (Water Quality) Regulations.

8.7.6.5 Following our receptor assessment (outlined in Section 8.3 above), we have adopted EQS values in preference to alternative guidelines where possible.

### 8.7.7 Evaluation of test data – Human receptors

8.7.7.1 As the proposed site will incorporate both a residential development and buildings associated with the College, the site has been split into two sections (residential and college use) both with independent chemical analysis. The following table summarises the analysis tables included in Appendix I.

**Table Summarising analysis tables in Appendix I**

| Analysis table | Main coverage |
|---|---|
| 1 | College area (current and proposed) inorganics |
| 2 | College area (current and proposed) organics |
| 3 | Residential area (proposed) inorganics |
| 4 | Residential area (proposed) organics |
| 5 | Construction operatives inorganics |
| 6 | Construction operatives and vegetation organics |
| 7 | Vegetation inorganics |
| 8 | Leachable concentration of organics, inorganics and TPH |
| 9 | Concentration or organics and inorganics in water |
| 10 | Concentration of TPH in soil |

Table 8.7.7.1

#### *8.7.7.2 College area of the site*

8.7.7.2.1 Both the current and proposed land uses are residential without uptake. Tables summarising and analysing test data are presented in Appendix I. The following table summarises the outcome of the analyses.

**Table Summarising assessment of test data for Human receptors**

| Analysis tables | Receptor group | Critical receptor | CLEA model | Inorganic contaminants | Organic contaminants |
|---|---|---|---|---|---|
| 1 and 2 | Current and proposed site users | Child | Residential without plant uptake | No exceedances | Refer paragraph 8.7.7.3.3 below |
| 5 and 6 | Construction operatives | Adult | Industrial / commercial | No exceedances | Refer paragraph 8.7.7.3.3 below |

Table 8.7.7.2.1

8.7.7.2.2 With reference to table 1 and 5 in Appendix I, analysis of chemical test data with respect to critical (child) receptors for proposed site uses and construction operatives, indicates all measured concentrations of selected inorganic contaminants and 95 percentile upper confidence limits (UCL) are below relevant adopted guideline values. It should be noted that methyl mercury has been used as the initial screening value which has a guideline value of 11mg/kg compared to elemental mercury which is 1mg/kg. We have adopted methyl mercury due to there being no historical records indicating the use of mercury based products on site.

8.7.7.2.3 It should be noted that the CLEA model has been used to produce guideline values for all PAH contaminants which takes into account the current and proposed critical receptor's exposure to the contaminant (refer paragraph 8.7.3.8 above).

8.7.7.2.4 Table 2 and 6 in Appendix I indicate that Benzo(a)pyrene is above the guideline values of 10.1mg/kg for current and proposed users and 14mg/kg for construction operatives. The calculated UCL for benzo(a)pyrene is 30.7mg/kg. When analysing the results, it is clear that DTS111 is an outlier in all contaminants with and exception of Phenols. The reasoning for classification as an outlier is that the sample contained gravels of bituminous coated material, which were not within any other sample tested. We consider the PAH contamination in this sample to be related to gravels of bituminous coated material.

8.7.7.2.5 With reference to table 10 in Appendix I, TPH contamination has been identified in DTS111 at 0.4m. All other measured concentrations are below the guideline values for TPH contamination.

### *8.7.7.3 Residential land use*

8.7.7.3.1 It should be noted that testing results obtained for the previous report, dated 2008, have been used within the statistical analysis of the residential area. Under the CLEA guidance, the proposed land use will be 'residential with plant uptake'. Tables summarising and analysing test data are presented in Appendix I. The following table summarises the outcome of the analyses.

**Table Summarising assessment of test data for Human receptors**

| Analysis tables | Receptor group | Critical receptor | CLEA model | Inorganic contaminants | Organic contaminants |
|---|---|---|---|---|---|
| 3 and 4 | Proposed site users | Child | Residential with plant uptake | Refer paragraph 8.7.7.2.2 below | Refer paragraph 8.7.7.2.3 below |
| 5 and 6 | Construction operatives | Adult | Industrial / commercial | No exceedances | No exceedances |

**Table 8.7.7.3.1**

8.7.7.3.2 Referring to table 3 in Appendix I, all measured values of inorganic contaminants were below guideline values with exception of lead. Three out of seven samples were over the guideline value of 276mg/kg. These samples were located in DTS03, DTS12 and DTS13, all of which were taken from the previous report dated 2008.

8.7.7.3.3 With reference to table 4 in Appendix I, analysis of chemical test data with respect to critical (child) receptors for proposed site uses, indicates all measured concentrations of selected inorganic contaminants and 95 percentile upper confidence limits (UCL) are below relevant adopted guideline values with the exception of benzo(a)pyrene, once DTS05 has been taken out as an outlier. The calculated mean value for Benzo(a)pyrene is 1.3mg/kg compared to a GAC guideline value of 0.83mg/kg. It should be noted that DTS05 is considered an outlier in all PAH contaminants which we consider to be associated with the clinker which was encountered at this depth. It has therefore been removed from the statistical analysis.

8.7.7.3.4 The results of all asbestos- free fibres and bulk ID tests were negative.

8.7.7.3.5 Based on the above evaluation, we are of the opinion that the near surface soils do exhibit contamination from a perspective of human receptors.

**8.7.8 Evaluation of test data – Vegetation**

8.7.8.1 Comparison of test data with guideline values is presented in Appendix I in Tables 6 and 7. Benzo(a)pyrene was the only measured concentration which exceeded the adopted guideline values in both areas of the site. On this basis, we are of the opinion that measured concentrations exhibit contamination with respect to vegetation.

8.7.8.2 It is difficult to quantify the phytotoxity of a contaminant as large variations exist between plant tolerances, soil effects and synergistic/antagonistic reactions between chemicals. Due to the complexities of the effects of soil contamination on different plant species, we recommend that the test results presented in this report are passed to a landscape architect for the selection of suitable planting.

**8.7.9 Evaluation of test data – Controlled waters**

***8.7.9.1 Inorganic contaminants***

8.7.9.1.1 With reference to Table 8 in Appendix I, the measured values of leachable inorganic contaminants fall well below the relevant guideline (outlined in Section 8.7.6) with the exception of copper, lead, mercury and zinc.

8.7.9.1.2 Values for copper were exceeded in four locations, DTS107, HP01, TP104 and TP108. The recorded concentrations were 82µg/l, 30µg/l, 33µg/l and 57µg/l respectively compared to a guideline value of 28µg/l. Values for lead were exceeded in 7 out of 11 samples. The guideline value for mercury was exceeded in one location, DTS109, however the measured concentration was equal to the guidance limit and we would therefore not consider this to be a significant risk to end users. Zinc also only exceeded the limit in DTS107 with a result of 190µg/l compared to the guideline of 125µg/l.

8.7.9.1.3 With reference to Table 9 in Appendix I, all measured values of inorganic contaminants in water samples taken from BHB, BHD and BHE fall below the relevant guideline values.

***8.7.9.2 Organic contaminants PAH (polycyclic aromatic hydrocarbons)***

8.7.9.2.1 For the analysis of PAH contamination, the sum of the following contaminants has been compared to a UKDWS.

- Benzo(b)fluoranthene
- Benzo(k)fluoranthene
- Benzo(ghi)perylene
- Indeno(1,2,3-cd)pyrene

8.7.9.2.2 The summed concentration of the PAH 'suite' exceeds the UKDWS in location DTS111. In addition the leachable concentration of benzo(a)pyrene and naphthalene exceed their respective guideline values. The concentration of benzo(a)pyrene also exceeds the guideline value in DTS102.

8.7.9.2.3 With reference to Table 9 in Appendix I, all measured values of organic contaminants in water samples taken from BHB, BHD and BHE fall below the relevant guideline values.

***8.7.9.3 Organic contaminants TPH (total petroleum hydrocarbons)***

8.7.9.3.1 The measured values of TPH contaminants fall below the relevant guideline (outlined in Section 8.7.6) with the exception of hydrocarbons in locations DTS104 and DTS111.

**8.7.10 Summary**

8.7.10.1 Based on the above evaluation, we are of the opinion that the proposed residential area exceeds guideline values for PAH contaminants andlLead. DTS05 is a clear outlier for PAH contamination as clinker was encountered in the borehole and as such, it has been removed from the statistical analysis. Benzo(a)pyrene and lead both exceed the guideline values for residential land use.

8.7.10.2 Benzo(a)pyrene is above guideline values for both current and proposed site users and construction workers in the proposed college area. DTS111 has been removed from the statistical analysis due to bituminous coated material encountered, which we consider to be linked to the exceedance in PAH contamination.

8.7.10.3 The near surface soils are likely to exhibit significant contamination with respect to water resources. It should be noted that the current layout of the site restricts the pathway for leachable contamination to reach water receptors due to all location being surfaced with bituminous bound material, with exception of HP01 and TP108. If this surfacing is to be removed during the development, remediation will be necessary.

## 8.8 Updated conceptual model

8.8.1 Having now completed analysis of laboratory testing, we can now update our conceptual model which is presented in appendix J.

8.8.2 Based on the conceptual model there are risks which exceed the low category with respect to residential end-use which in our opinion is unacceptable, and require either remedial action or further investigation by laboratory testing of soil / water samples to further refine the risk assessment.

## 8.9 Remedial action

8.9.1 Based on the above we recommend the following action is taken:-

a) Stripping and removal of Made Ground soils including all bituminous bound material and any soils with bituminous coated material incorporated in the gravels (especially around the area local to DTS111).

b) Provision of a capping in garden and soft landscaping areas. Details of this remediation (in the form of a statement / specification) is provided will be provided following determination of the extent of contamination.

c) Adoption of adequate hygiene precautions for construction operatives.

## 8.10 Risk assessment in relation to use of infiltration systems

8.10.1 With reference to Environment Agency publication '*Groundwater protection: Policy and practice (GP3)* 2012, outside of SPZ1, the EA will support sustainable drainage systems for new discharges to ground. This is subject to an appropriate risk assessment to demonstrate that ground conditions are suitable and infiltration systems do not present an unacceptable risk of promoting mobilisation of contaminants or creating new pathways for contaminant migration.

8.10.2 The permeability of the near surface Kempton Park Gravel Member in combination with the site located over a Principal aquifer suggests the site is sensitive to migration of contaminants. The site is not located within or close to a source protection zone.

8.10.3 We have carried out leachate testing of a suite of contaminants with our assessment provided in Section 8.7.9 above. In general, measured concentrations of leachable contaminants **exceed EQS and UKDWS values** for the local environment and on this basis the risk of infiltration systems promoting mobilisation of contaminants at the site is considered moderate to high if infiltration systems are adopted in the Made Ground.

8.10.4 On this basis we recommend that Made Ground is either completely removed from areas of proposed soakaways or soakaways are sealed through this deposit, with water directly entering the Kempton Park Gravels. All discharges to groundwater are subject to compliance with the Water Framework Directive (2000/60/EC) and Groundwater Daughter Directive (2006/118/EC).

## 8.11 Risk assessment summary and recommendations

8.11.1 Based on our assessments described above, we can provide the following summary and recommendations for each identified receptor.

**8.11.2 Current site users**

8.11.2.1 Contamination has been identified across the site however the current site users are considered to be at low risk due to the majority of the locations being situated in an area surfaced with bituminous bound material. There are a few exceptions to this; DTS104 and TP104 are located in areas of soft landscaping and recorded values exceeded guideline values for PAHs. We therefore recommend additional testing be undertaken in this area to define the extent of the contamination and provide an appropriate remedial strategy.

**8.11.2 End users**

8.11.2.1 Chemical contamination has been identified across the site however it is most significantly concentrated in the locations along the northern boundary of the site. PAH contamination is present in DTS111, DTS05 and TP104. These locations are situated on the boundary between areas of hardstanding and soft landscaping. Assuming a worst case, there is the risk that elevated contamination is present in soft landscaping areas. We therefore recommend that additional testing is undertaken to determine the extent of the contamination and allow an appropriate remediation strategy to be derived.

**8.11.3 Construction operatives and other site investigators**

8.11.3.1 The risk of damage to health of construction operatives and other site investigators is, in our opinion moderate and would be minimised by taking adequate hygiene precautions on site. Such precautions would be:-

- Wearing protective clothing particularly gloves to minimise ingestion from soil contaminated hands.
- Avoiding dust by dampening the soils during the works.
- Wearing masks if processing produce dust.

8.11.3.2 Guidance on safe working practices can be obtained from the following documents

- The Health and Safety Executive Publication *"Protection of Workers and the General Public during the Development of Contaminated Land"* (HMSO) and
- *"A Guide to Safer Working on Contaminated Sites"* (CIRIA Report 132).

8.11.3.3 In addition, reference should be made to the Health and Safety Executive. In all cases work shall be undertaken following the requirements of the Health and Safety at Work Act 1974 and regulations made under the Act including the COSHH regulations.

8.11.3.4 If during the course of excavations hydrocarbon type odours become evident we recommend works are halted, and the air quality measured to determine if the excavation can be safely entered. If the air quality is unacceptable then appropriate personal protective equipment, will be required for human entry into the excavation. If elevated concentrations of airborne hydrocarbons / vapours are detected on site, we recommend Soiltechnics are advised to determine an appropriate course of action with respect to building construction.

### 8.11.4 Controlled waters

8.11.4.1 Leachable concentrations of inorganic, organic and TPH contaminants exceeding the guideline values have been identified across the entire site, however, it is notably concentrated along the northern boundary. Leachable copper and mercury are present in the area local to the proposed permeable paving. This would create a pathway from source to receptor and we would therefore consider there to be a risk to water receptors, therefore we recommend that further leachate testing is undertaken to determine the extent of this area of Made Ground to determine its extent for removal.

### 8.11.5 Vegetation

8.11.5.1 A significant source of PAH contamination has been identified in DTS111 at 0.4m which is considered to be a significant risk to vegetation on site.

## 8.12 Statement with respect to National Planning Policy Framework

8.12.1 Providing the recommendations described above are satisfactorily completed, we are of the opinion the proposed development will be safe and suitable for use for the purpose for which it is intended, thus meeting the requirements of the National Planning Policy Framework section 121, and compliant with the Building Regulations Part C, '*Site preparation and resistance to contaminants and moisture*'

## 8.13 On Site Monitoring

8.13.1 We have attempted to identify the potential for chemical contamination on the site, however, areas, which have not been investigated at this stage, may exhibit higher levels of contamination. If such areas are exposed at any time during construction we will be pleased to re-attend site to assess what action is required to allow the development of safely proceed.

# 9 Gaseous contamination



## 9.1 Legislative framework

9.1.1 There is currently a complex mix of documentation relating to legislative and regulatory procedures on the issue of contamination and it is not considered a purpose of this report to discuss the detail of these regulations. Essentially, Government Policy is based on *'suitable for use approach',* which is relevant to both the current and proposed future use of land. For current use Part IIA of the Environmental Protection Act 1990 provides the regulatory regime (see Section 8.1 above). The presence of harmful soil gases could provide a 'source' in a 'pollutant linkage' allowing the regulator (Local Authority) to determine if there is a significant possibility of harm being caused to humans, buildings or the environment. Under such circumstances the regulator would determine the land as 'contaminated' under the provision of the Act requiring the remediation process to be implemented with the Environment Agency responsible for enforcement.

9.1.2 The Town and Country Planning (General Development Procedure) Order 1995, requires the planning authority to consult with the Environment Agency before granting planning permission for development on land within 250 metres of land which is being used for deposit of waste, (or has been at any time in the last 30 years) or has been notified to the planning authority for the purposes of that provision.

9.1.3 Building control bodies enforce compliance with the Building Regulations. Practical guidance is provided in Approved documents, one of which is Part C, '*Site preparation and resistance to contaminants and moisture'* which seeks to protect the health, safety and welfare of people in and around buildings and includes requirements for protection against harm from soil gas.

## 9.2 General

9.2.1 The following assessment relates to the potential for, and the effects of, gases generated by biodegradable matter. A separate, but related class of problem involves migration of vapour phase of hydrocarbons resulting from spillages of petroleum and solvents, but this is addressed under organic contamination in Section 8. The potential for the development to be affected by radon gas is considered in Section 3 above. The principal ground gases are carbon dioxide ($CO_2$) and methane ($CH_4$). The following table provides a summary of the effects of these gases when mixed with air.

| Significant gas concentrations in air | | |
|---|---|---|
| **Gas** | **Concentration by volume** | **Consequence** |
| Methane | 0.25% | Ventilation required in confined spaces |
| | 5 - 15% | Potentially explosive when mixed with air |
| | 30% | Asphyxiation |
| | 75% | Death after 10 minutes |
| Carbon Dioxide | 0.5% | 8 hour long term exposure limit (LTEL) (HSE workplace limit) |
| | 1.5% | 15 min short term exposure limit (STEL) (HSE workplace limit) |
| | >3% | Breathing difficulties |
| | 6 – 11% | Visual distortion, headaches, loss of consciousness, possible death |
| | >22% | Death likely to occur |

**Table 9.2.1**

9.2.2 Following the current Building Regulations Approved Document C1, Section 2 '*Resistance to Contaminants*' (2004 incorporating 2010 and 2013 amendments) a risk assessment approach is required in relation to gaseous contamination based on the source-pathway-receptor conceptual model procedure. We have adopted procedures described in the following reference documents for investigation and assessments of risk of the development being affected by landfill type gases (permanent gases) and if appropriate the identification of mitigation measures.

- BS10175:2011 *'Investigation of potentially contaminated sites- Code of Practice'*
- BS8576:2013 '*Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)'*
- BS8485:2015 '*Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'*
- CIRIA Report C665 '*Assessing risks posed by hazardous ground gases to buildings*' (2007)
- CL:AIRE Research Bulletin RB17 *'A pragmatic approach to ground gas risk assessment'* (November 2012)
- The NHBC report No 10627-R01(04) '*Guidance on development proposals on sites where methane and carbon dioxide are present'* (January 2007) will only be relevant for the residential properties.

9.2.3 Whilst we have followed the guidance and recommendations of BS8576, we have used BS8485:2015 to derive recommendations for protective works and where considered necessary supplemented by NHBC report No 10627-R01(04).

9.2.3 An assessment of the risk of the site being affected by ground gases is based on the following aspects:

a) Source of the gas
b) Investigation information
c) Migration feasibility
d) Sensitivity of the development and its location relative to the source

## 9.3 Assessment of source of gases

### 9.3.1 General sources

9.3.1.1 The following table summarises the common sources of ground gases and parameters affecting the generation of ground gases:

| Source and control of gases | nditions, pH, temperatu |
|---|---|
| **Type** | **Parameters affecting the rate of gassing** |
| Landfills | Portion of biodegradable material, rate reduces with time |
| Mineworkings | Flooding reduces rate of gassing |
| Dock silt | Portion of organic matter |
| Carbonate deposits | Ground / rainwater (acidic) reacts with some carbonates to produce carbon dioxide. |
| Made Ground | Thickness of Made Ground and proportion of degradable organic matter |
| Naturally deposited soils/rocks | Thickness of Made Ground and proportion of degradable organic matter |

**Table 9.3.1.1**

9.3.1.2 As the site is not within a dockland environment or an area affected by mineworkings, and near surface soils do not exhibit high carbonate content, then potential gas sources are limited to landfills and/or soils with a high proportion of organic matter.

### 9.3.2 Landfill and infilled ground sources

9.3.2.1 Waste Management Paper 27 (1991) produced by the Department of the Environment '*Control of Landfill Gases*' contains the recommendation to avoid building within 50m of a landfill site actively producing large quantities of landfill type gases and to carry out site investigations within a zone 250m beyond the boundary of a landfill site. No distinction is made between sites of differing ground conditions, but the paper does not advocate the site is safe beyond the 250m zone, dependant, of course, upon the type of landfill and potential for migration of landfill gases.

9.3.2.2 Envirocheck reports five historical landfill sites located between 340m and 890m to the north of the site. Records indicate the sites were licenced for receipt of inert wastes with one of them also accepting industrial waste and the licences have now lapsed. Such materials are unlikely to generate any significant quantities of landfill type gases.

9.3.2.3 Envirocheck reports four BGS recorded mineral sites within 1000m of the subject site. The closest site is recorded 198m to the south of the site and was licenced for the extraction of sand and gravel and operations have ceased. The source of backfill (if any) is unknown. In addition to this Envirocheck report both Infilled and Made Ground and Worked Ground, associated with railway line, some 100m off the southern site boundary. Although the composition of the Made Ground is unknown and may comprise material capable of producing landfill type gases, due to their distances they are not considered viable sources.

### 9.3.3 Soil conditions

9.3.3.1 None of the soils observed in exploratory excavations, in our opinion, exhibit significant concentrations of organic matter which are likely to produce elevated quantities of carbon dioxide and / or methane gas. Elevated organic matter was noted in DTS101 at 0.5m and DTS111 at 0.4m, likely due to a partially decomposed plant remains. This is not characteristic of the site and not in significant concentrations to produce elevated quantities of carbon dioxide and / or methane gas.

9.3.3.2 Based on an assessment of 'deep' geological conditions we are of the opinion that it is unlikely that the subject site would be affected by significant quantities of carbon dioxide and methane generated by soils/rocks at depth.

### 9.3.4 Source assessment summary

9.3.4.1 The following table summarises the possibility of a source of landfill type gases.

**Source assessment summary**

| Potential source origin | Viability of source | Evidence |
|---|---|---|
| Landfills, infilled ground and sewage works | Unlikely | Desk study information<br>BGS recorded mineral site with unknown fill material located 198m south<br>Historic Sewage Works and Filter Beds are recorded some 180m off the south-western site boundary |
| Mineworkings | Unlikely | Desk Study information<br>Geological conditions not amenable |
| Dock silt | Unlikely | Site remote from dockland environment |
| Carbonate deposits | Unlikely | Recorded and observed soil conditions do not indicate high concentrations of carbonates |
| Made Ground | Unlikely | Made Ground <1.1m thick and locally elevated TOC |
| Soils / rocks | Unlikely | Soils exposed in exploratory excavations do not exhibit high concentrations of organic matter |

**Table 9.3.4**

## 9.4 Summary

9.4.1 Based on the above there is no evidence to demonstrate that there is a potential source rendering the site at a significant risk of being affected by ground gases (carbon dioxide / methane) sufficient to cause significant harm to human end users of the site, construction operatives or indeed buildings.

9.4.2 In order to provide a quantitate assessment of the site we have scheduled six return monitoring visits to measure landfill type gases. This initial assessment will be reviewed pending the results of our monitoring observations. As an initial programme, we will undertake six visits at approximately 2 week intervals to determine if there is a significant risk of gaseous contamination at the site and whether any additional monitoring is considered necessary. In addition, the gas monitoring should confirm the above assessment.

## 9.5 Development categorisation

9.5.1 With reference to BS8485:2015 (table 3), the proposed building types would be classified as *'Type A - Private'* in the proposed residential area (outlined in purple on Drawing 03) and *'Type B - Private or commercial/public, possibly multiple'* in the proposed college area (outlined in orange on Drawing 03).

## 9.6 Monitoring observations

9.6.1 Four standpipes have been installed at the site (within DTS114, BHB, D and E) in accordance with BS9576:2013, Section 9 (refer Drawing 06). Following BS8576:2013 (Figure 6) and CIRIA Report C665 (Tables 5.5a and 5.5b) we have provisionally assessed the site as very low risk of generation potential of source.

9.6.2 We attended site for six initial monitoring visits. Following this, we returned to site for an additional three visits. We have obtained measurements of landfill type gases at atmospheric conditions in the range of 1008mb to 1028mb and temperatures in the range of 11°C to 14°C. Essentially we did not detect methane concentrations above 0.1% in all locations and concentrations of carbon dioxide were recorded in the range of 0.6% to 7.9% (steady rate). If flows were detected during our monitoring visits then these are recorded, but where no flow is detected then we have assumed flow at the detection limit of the monitoring equipment at 0.1l/s.

9.6.3 Gas monitoring results obtained to date are summarised in Appendix K.

## 9.7 Classification of site characteristic gas situation

9.7.1 Using test data obtained to date, and with reference to Table 2 of BS8485:2015, the site is classified as characteristic gas situation two (for the college area of the site) and traffic light colour 'Green' (for the residential area of the site) in accordance with NHBC report No 10627-R01(04). This is based on testing over a five month period. Following our initial testing, undertaken between November 2015 and January 2016, BH-B (within the college area) produced all characteristic situation one results, with the exception of the last result. Further to this, we undertook additional testing between March and April 2016 to determine whether this was a peak value or whether the trend was increasing. The results of the additional testing, presented in Appendix K, indicate that the college area of the site is classified as Amber 1.

## 9.8 Assessment of gas protective measures

9.8.1 With the residential site being classified as green following NHBC report No 10627-R01(04), no gas protection measures are required in this area. The college/ school area of the site is classified as characteristic situation two in accordance with BS8485:2015. As such, gas protection measures are considered necessary and, with reference to Table 3 and 4 in BS8485:2015, the site development is classified as a Type B property (assuming there will be caretakers to manage the buildings). The guidance indicates that a gas protection score of 3.5 will be required. Methods of achieving such a score are included in Tables 5, 6 and 7. It should be noted that only one method of protection can be used from each table in order to achieve the overall score of 3.5.

## 9.9 Flammability

9.9.1 Methane is a flammable gas. When the concentrations of methane in air (oxygen 20.9% by volume) are between the limits of 5% and 15% by volume, then an explosive mixture is formed. The lower explosive limit (LEL) of methane is 5% which is equivalent to 100% LEL. The 15% limit is known as the upper explosive limit (UEL), but concentrations above this level cannot be assumed to represent safe concentrations. The flammability of gas mixtures is affected by their composition, presence of an ignition source, temperature, pressure and nature of the surroundings. The explosive hazard of a flammable mixture arises from the speed of propagation of the flame in a confined space and the ability of the container to absorb the associated shock wave. The flammability range can vary depending upon differing circumstances, for example:

- When carbon dioxide concentrations of greater than 25% are present, methane is rendered non-flammable, and
- If the oxygen concentration is reduced, the limits of flammability are reduced. For example at 13.45% oxygen the LEL and UEL for methane are altered to 6.5% and 7% respectively, whilst at 13.25% oxygen the mixture is incapable of propagating a flame (refer CIRIA report 130)

9.9.2 From measurements taken to date, a limited number of air, methane and carbon dioxide mixtures are potentially explosive. For an explosion to occur however, an enclosed space together with an ignition source is required. Clearly a sub-floor void could produce a confined space, and thus in order to minimise risks, the use of a positively pressurised clean air blanket to alter the gas mix, may produce the required solution. We recommend a specialist who provides this design and installation service is consulted to establish an appropriate solution.

## 9.10 Statement with respect to National Planning Policy Framework

9.10.1 Providing the recommendations described above are satisfactorily completed, we are of the opinion the proposed development will be safe and suitable for use for the purpose for which it is intended, thus meeting the requirements of the National Planning Policy Framework section 121, and compliant with the Building Regulations Part C, '*Site preparation and resistance to contaminants and moisture'.*

# 10 Effects of ground conditions on building materials



## 10.1 General

10.1.1 Building materials are often subjected to aggressive environments which cause them to undergo chemical or physical changes. These changes may result in loss of strength or other properties that may put at risk their structure integrity or ability to perform to design requirements. Aggressive conditions include:-

- Severe climates
- Coastal conditions
- Polluted atmospheres
- Aggressive ground conditions

This report section only considers aggressive ground conditions, with other items considered outside our brief and scope of investigations.

10.1.2 In aggressive ground conditions, the potential for contaminant attack depends on the following:-

- The presence of water as a carrier of chemical contaminants, (except free phase organic contamination)
- The availability of the contaminant in terms of solubility, concentration and replenishment rate
- Contact between the contaminant and the building material
- The nature of the building materials and its capability of being attacked by contaminants

In general the thicker the building material the less likelihood there is for contaminant attack to cause damage to the integrity of the structure.

## 10.2 Reference documents

10.2.1 Following the Environment Agency publication *'Model Procedures for the Management of Land Contamination'* (Contaminated Land Report 11) the following documents have been referred to in production of the following report paragraphs.

- *'Performance of Building Materials in Contaminated Land'* report BR255 (Building Research Establishment 1994).
- *'Risks of Contaminated Land to Buildings, Building Materials and Services. A Literature Review'* - Technical Report P331 (Environment Agency 2000).
- *'Guidance on assessing and managing risks to buildings from land contamination'* - Technical Report P5 035/TR/01).
- Building Regulations Approved document C - site preparation and resistance to contaminants and moisture (Office of the Deputy Prime Minister, 2004).
- *'Concrete in aggressive ground'* Special Digest 1: 2005 (Building Research Establishment).

## 10.3 Hazard identification and assessment

10.3.1 The identification of hazards is based on the findings of this investigation primarily relating to former land uses (potential for chemical contamination, and likely type of contamination) and laboratory determination of concentration of chemical contaminants. Clearly, the scope of laboratory testing is determined with respect to former land uses, contaminants which may cause harm to human health and water resources.

10.3.2 Based on the above, the scope of our testing regime is described in Sections 8. We have utilised this test data in production of the following risk assessments in relation to building materials, in conjunction with test data targeting the effects of chemical attack on concrete in contact with the ground, as described in BRE Special Digest 1.

10.3.3 The identification of hazards from contamination and subsequent assessment of risks is based on the following:-

- The contaminants present on site.
- The nature of the contaminant (i.e. calcium sulphate is much less soluble than sodium or magnesium sulphate and is, therefore, less of a concern with regards sulphate attack).
- The concentration of contaminants - in general the higher the concentration the greater the hazard.
- The solubility of the contaminants - contaminants which are not soluble will not generally react with materials.
- The permeability of the soils - i.e. case by which fluids can transport contaminants to the building.

10.3.4 The process of risk assessment for building materials is concerned with identification of the hazard (contaminants at the site - a source) and subsequently how the contaminants can reach the building (pathway) and how they can react with the building (receptor). Thus the risk assessment is produced based on the source - pathway - receptor model.

## 10.4 Provision of test data to specifiers/manufacturer/installer

10.4.1 The following risk assessments are based on current published data. We strongly recommend, however, that information gained from this investigation are provided to specifiers/manufacturers/installers of building materials/service ducts/apparatus who may have more up to date research to confirm the ability of the product to resist the effects of chemical contaminants at the site for the desired lifespan of the product.

## 10.5 Risks assessments for individual building materials

10.5.1 The following/typical sections contain risk assessments for various building materials likely to be incorporated in developments. Other materials which we are not aware of may also be used in developments and in contact with the ground and, therefore, recommend the suppliers are consulted with respect to ground conditions at this site and their opinion sought as to the ability of the product to resist chemical conditions determined at the site.

## 10.6 Concrete - General mechanisms of attack

10.6.1 There are a number of mechanisms by which contaminants attack concrete including the following:-

- Hydrolysis of the hardened concrete.
- Degradation as a result of exchange reactions between calcium in calcium hydroxide (free lime hydrate) and ions in aggressive solutions.
- Expansive reactions as a result of chemical reaction or salt crystallisation.

## 10.7 Concrete - Sulphate attack

### 10.7.1 Hazard

10.7.1.1 Sulphate attack on concrete is characterised by expansion, leading to loss of strength, cracking, spalling and eventual disintegration. There are three principal forms of sulphate attack, as follows:-

- Formation of gypsum through reaction of calcium hydroxide and sulphate ions.
- Ettringite formation through reaction of tricalcium alluminate and sulphite irons.
- Thaumasite formation as a result of reactions between calcium silicate hydrates, carbonate ions (from aggregates) and sulphate ions.

### 10.7.2 Assessment

10.7.2.1 The hazard of sulphide attack is addressed by reference to procedures described in Building Research Establishment (BRE) Special Digest 1: 2005 '*Concrete in Aggressive Ground*' to establish a design sulphate class (DS) and the '*aggressive Chemical Environment for Concrete*' (ACEC). These procedures have been followed during our investigation and are described in the following paragraphs.

### 10.7.3 Desk Study Information

10.7.3.1 The first step in the procedure is to consider specific elements of the desk study. These are tabulated below.

| Summary of desk study information | | | | |
|---|---|---|---|---|
| **Element** | **Soil strata** | **Interrogation** | **Outcome** | **SD1: 2005 reference** |
| Geology | Made Ground | Likelihood of soils containing pyrites | **Unlikely** | Box C6 |
| | Kempton Park Gravel Formation | | **Unlikely** | |
| | London Clay Formation | | **Likely** | |
| Past industrial uses | Made Ground | Brownfield site? | **No** | C2.1.2 |
| | Natural soils | | **No** | |

**Table 10.7.3.1**

10.7.3.2 A brownfield site is defined in SD1: 2005 as a site, or part of a site which has been subject to industrial development, storage of chemicals (including for agricultural use) or deposition of waste, and which may contain aggressive chemicals in residual surface materials, or in ground penetrated by leachates. Where the history of the site is not known, it should be treated as brownfield until there is evidence to classify it as natural.

10.7.3.3 Based on the above it is necessary to follow the procedures described in figure C4 for Made Ground and Kempton Park Gravel *('natural ground sites except where soils may contain pyrite')*.

10.7.3.4 Based on the above it is necessary to follow the procedures described in figure C5 for London Clay Formation (*'sites or locations where disturbance of pyrite bearing natural ground could result in additional sulphate'*).

**10.7.4 Assessment of Design Sulphate Class**

10.7.4.1 The sulphate concentration in a 2:1 water/soil extract was measured in one sample of Made Ground, one sample of Kempton Park Gravel and one sample of London Clay. The highest test result has been used as the characteristic value (refer to table 10.7.7).

10.7.4.2 The sulphate concentration (mg/l $SO_4$) was measured on three groundwater samples obtained from the Kempton Park Gravel. The highest determined value has been used as the characteristic value (refer to table 10.7.7).

10.7.4.3 Again following the recommendations of SD1: 2005, we have scheduled additional testing on the sample of London Clay Formation to include:

- Determination of total sulphate content (% $SO_4$)
- Determination of total sulphate present (% S)

10.7.4.4 Using this test data we have calculated the Total Potential Sulphate content (TPS, % $SO_4$) and the amount of Oxidisable Sulfides (OS % $SO_4$), again following the procedures described in SD1: 2005. As the amount of Oxidisable Sulfides exceeds 0.3% $SO_4$ in a significant number of samples, pyrite is probably present.

10.7.4.5 The characteristic total potential sulphate content has been based on the highest TPS value (rounded to 0.1% $SO_4$, refer to table 10.7.7). With reference to table C1 of SD1: 2005, the design sulphate class has been based on considering both the initial characteristic value and characteristic total potential sulphate content and adopting the more onerous of these two values.

10.7.4.6 If excavations are to be formed for foundations in potentially pyritic ground, and total potential sulfates (TPS) are not used, any backfill with pyritic material should not be placed in proximity to foundations.

**10.7.5 Assessment of groundwater mobility**

10.7.5.1 With reference to SD1: 2005, Section C3.1, we are of the opinion that the cohesive London Clay soils at the site generally have a low permeability and thus 'static' groundwater conditions are considered characteristic of the site.

10.7.5.2 With reference to SD1: 2005, Section C3.2, we are of the opinion that the Made Ground and Kempton Park Gravels at the site suggest 'mobile groundwater' conditions.

### 10.7.6 Assessment of pH

10.7.6.1 Following SD1: 2005, Section C5.1.1 (step 4) only a 'small number' of samples have been tested and thus the characteristic value for pH within Made Ground, Kempton Park Gravel and London Clay equates to the lowest measured value (refer Table 10.7.7).

10.7.6.2 Following SD1: 2005, Section C5.1.1 (step 4) the characteristic value for pH with groundwater at the site equates to the lowest measured value (refer Table 10.7.7).

### 10.7.7 Assessment of aggressive chemical environment for concrete (ACEC)

10.7.7.1 Based on the design sulphate class, characteristic value of pH and assessment of groundwater mobility, and with reference to table C1 of SDI: 2005, the ACEC class for each soil type is presented in Table 10.7.7 below.

**Summary of concrete classification**

| Soil type | No. of samples | Characteristic pH | Groundwater mobility | Characteristic TPS | Characteristic sulphate (mg/l) | DS class | ACEC class |
|---|---|---|---|---|---|---|---|
| Made Ground | 1 | 8.1 | Mobile | N/A | 23 | DS-1 | AC-1 |
| Kempton Park Gravel | 1 | 7.7 | Mobile | N/A | 70 | DS-1 | AC-1 |
| London Clay Formation | 1 | 8.8 | Static | N/A | 140 | DS-1 | AC-1s |
| London Clay Formation (disturbed) | 1 | 8.8 | Static | 2.01 | 140 | DS-4 | AC-3s |
| Groundwater samples | To be confirmed | | | | | | |

**Table 10.7.7**

10.7.7.2 If more than one soil/groundwater source has been tested at the subject site, the more onerous of design sulphate class and ACEC class should be adopted.

## 10.8 Concrete - Chloride attack

### 10.8.1 Hazards

10.8.1.1 There are a number of ways in which chlorides can react with hydrated cement compounds in concrete. These are as follows:-

- Chlorides react with calcium hydroxide in the cement binder to form soluble calcium chloride. This reaction increases the permeability of the concrete reducing its durability.

- Calcium and magnesium chlorides can react with calcium aluminate hydrates to form chloroaluminates which result in low to medium expansion of the concrete.

- If concrete is subject to wetting and drying cycles caused by groundwater fluctuations, salt crystallisation can form in concrete pores. If pressure produced by crystal growth is greater than the tensile strength of the concrete, the concrete will crack and eventually disintegrate.

**10.8.2 Risk assessment**

10.8.2.1 Chlorides of sodium, potassium, and calcium are generally regarded as being non-aggressive towards mass concrete; indeed brine containers used in salt mines have been known to be serviceable after 20 years service. Depending upon the type of concrete, and the cement used up to 0.4% chloride is allowed in BS8110: Part 1.

10.8.2.2 In view of the past use of the site we consider the likelihood of elevated concentrations of chlorides in the ground is not likely to occur and on this basis have not specifically measured concentrations of chlorides and, in our opinion, the risk of buried concrete being affected by chlorides is considered low.

## 10.9 Concrete - Acid attack

**10.9.1 Hazards**

10.9.1.1 Concrete being an alkaline material is vulnerable to attack by acids. Prolonged exposure of concrete structures to acidic solutions can result in complete disintegration.

**10.9.2 Risk assessment**

10.9.2.1 The rate of acid attack on concrete depends upon the following:-

- The type of acid
- The acid concentration (pH)
- The composition of the concrete (cement/aggregate)
- The soil permeability
- Groundwater movement

British Standard BS8110: Part 1 classifies extreme environment as one where concrete is exposed to flowing groundwater that has a pH<4.5. The standard also warns that Portland Cement is not suitable for acidic conditions with a pH of 5.5 or lower.

10.9.2.2 The pH of the soil/groundwater was measured exceeding 5.5 and on this basis the risk of concrete being affected by acidic conditions is considered low.

## 10.10 Concrete - Magnesium attack

### 10.10.1 Hazards

10.10.1.1 Magnesium salts (excepting magnesium hydrogen carbonate) are destructive to concrete. Corrosion of concrete occurs from cation exchange reactions where calcium in the cement paste hydrates and is replaced with magnesium. The cement loses binding power and eventually the concrete disintegrates.

### 10.10.2 Risk assessment

10.10.2.1 In practise 'high' concentrations of magnesium will be found in the UK only in ground having industrial residues. Following BRE Special Digest 1:2005, measurement of the concentration of magnesium is recommended if sulphate concentrations in water extract or groundwater exceed 3000mg/l. Once measured the concentration of magnesium is considered further in BRE Special Digest in establishing the concrete mix to resist chemical attack.

10.10.2.2 We are not aware the site has been subject to any manufacturing processes which would have included magnesium containing compounds, and in addition sulphate concentrations did not exceed 3000mg/l, on this basis we have not measured the concentration of magnesium in soils at the site, and would consider the risk of soils at the site promoting attack on concrete is considered low.

10.10.2.3 BS EN 206-1:2000 '*Concrete - Part 1: Specification, performance, production and conformity*' does, however, provide exposure classes for concrete in contact with water, with varying concentrations of magnesium for the design/specification for concrete mixes. As there is a possibility that concrete for the building may be in contact with groundwater during its life, we will measure the concentration of magnesium in groundwater samples. This section will be updated to include the results once the samples have been collected during a monitoring visit to the site.

## 10.11 Concrete - Ammonium attack

### 10.11.1 Hazards

10.11.1.1 Ammonium salts, like magnesium salts act as weak acids and attack hardened concrete paste resulting in softening and gradual decrease in strength of the concrete.

### 10.11.2 Risk assessment

10.11.2.1 UK guidance is not available on the concentration of ammonium which may affect concrete. BS EN 206-1: 2000 '*Concrete - Part 1: Specification, performance, production and conformity*' does, however, provide exposure classes for concrete in contact with water with varying concentrations of ammonia for the design/specification for concrete mixes.

10.11.2.2 The concentration of ammonia in groundwater samples will be measured once water samples have been collected during the next monitoring visit. There is a potential possibility that concrete for the building may be in contact with groundwater during its life. This section will be updated once the results have been analysed.

## 10.12 Concrete blocks

### 10.12.1 Hazards

10.12.1.1 Precast aggregate concrete blocks and autoclaved aerated concrete blocks are commonly used in the construction of shallow foundations. Concrete blocks are potentially attacked by the same contaminants and ground conditions which affect dense concrete.

### 10.12.2 Risk Assessment

10.12.2.1 In general, the mechanism of attack on concrete blocks is the same for hardened concrete. We recommend parameters for ground conditions for concrete described in the preceding paragraphs for concrete blockwork in contact with the ground/groundwater and the blockwork manufacturers confirmation sought for applicability of their product.

## 10.13 Clay Bricks/Pipes

10.13.1 Clay Bricks are highly durable materials which have been used in buildings for many centuries. Fire clay pipe material can also be considered similarly resistant to contaminants.

### 10.13.2 Hazards

10.13.2.1 Dissolution of clay brick in a potentially serious cause of deterioration. The extent of dissolution depends upon the solubility of the glassy material (produced by firing of the clay) contained in the brick. The acidic nature of the glass phase will produce low solubility in a neutral and acidic environment, but can be soluble in a basic environment.

10.13.2.2 A potentially more serious hazard for brickwork is the crystallisation of soluble salts within the brick pore structure. Salts are transported by water to the interior of the brick originating from the external environment or by rehydration, however, are only likely to occur when there is a gradient from a wet interior to a drying surface. The potential, therefore, for salt crystallisation in the ground is, therefore, low.

### 10.13.3 Risk Assessment

10.13.3.1 There seems to be little published information as regards the resistance to clay bricks/pipes in aggressive ground conditions, however, clay bricks are generally considered very durable. We recommend manufacturers' advices are sought with respect to their resistance to ground conditions encountered at this site.

10.13.3.2 Some basic guidance is provided in BS5628-3: 2005 '*Code of Practice for the Use of Masonry - Part 3: Materials and components, design and workmanship'* with regards to resistance of masonry to resist the effects of sulphate attack.

## 10.14 Mortar

10.14.1 Mortars are based on building sands mixed with cement and/or lime as a binder. In the UK Portland cements and masonry cement are commonly used. Masonry cements are a mixture of Portland Cements and fine mineral filler (i.e. Limestone) with an air entraining agent.

### 10.14.2 Hazards

10.14.2.1 Mortar is subject to the same agents for deterioration as concrete with the major cause of deterioration being sulphate attack.

### 10.14.3 Risk assessment

10.14.3.1 Sulphates can originate from soils/groundwater or from the bricks themselves. Calcium, magnesium, sodium and potassium sulphates are present in almost all fired-clay bricks. Water can dissolve a fraction of these sulphates and transport them to the mortar.

10.14.3.2 Currently, we are not aware of any guidance on the resistance of mortars to sulphate attack. The Building Research Establishment report that the sulphate resistance of mortar was improved by the use of sulphate resisting Portland cements and lime. Some guidance is also provided in BS5628-3: 2005 '*Code of Practice for the use of Masonry - Part 3: Materials and components, design and workmanship'.*

10.14.3.2 Based on ground conditions determined at the site the risk of significant sulphate attack on mortars (Based on testing/analysis of sulphates in relation to concrete - refer Section 10.7) is considered low.

## 10.15 Metals - general

10.15.1 There are a number of metals which are used in buildings either as piles, services, non-structural and, indeed, structural components. The most common metals used in buildings are steel, stainless steel, copper, lead, zinc, aluminium and cast iron. All these metals can deteriorate through corrosion process. Corrosion can affect metals in a variety of ways depending upon the nature of the metal and the environment to which it is subjected. In most common forms of corrosion are:-

- Electrochemical - the most common form of corrosion in an aqueous solution
- Chemical corrosion - occurs when there is a direct charge transfer between the metal and the attacking medium (examples are oxidation, attack by acids, alkalis and organic solvents)
- Microbial induced corrosion

## 10.16 Metals - Cast iron

10.16.1 Cast iron is a term to describe ferrous metals containing more than 1.7% carbon and is used extensively in the manufacture of pipes.

**10.16.2 Hazards**

10.16.2.1 Generally, cast iron has a good resistance to corrosion by soils, however, corrosion can occur due to the following mechanisms:-

1) Generation of large scale galvanic cells caused by differences in salt concentrations, oxygen availability or presence of stray electrical currents.

2) Hydrochloric acid will cause corrosion at any concentration and temperature. Dilute sulphuric, nitric and phosphoric acids are also aggressive as also are well aerated organic acids.

**10.16.3 Risk assessment**

10.16.3.1 Testing can be carried out on site to measure the resistivity and redox potential of soils which can assist in deriving recommendations for protection of cast iron components using coatings, burial trenches, or isolation techniques. Currently, however, there is no specific guidance and we recommend advice is sought from manufacturers.

10.16.3.2 Guidelines produced by the Water Research Centre (WRc) on the use of ductile iron pipes, state that highly acidic soils (pH <5) are corrosive to cast iron pipe even when protected by a zinc coating or polythene sleeving. WRc also indicate that groundwater containing >300ppm chloride may corrode even protected cast iron pipes.

10.16.3.3 The pH of soils at the site are not less than 5 however groundwater is likely to be in contact with cast iron elements. We would therefore consider the risk of ductile cast iron pipes being affected by acid/chloride attack is considered moderate. We have not carried out any redox/resistivity testing (considered outside our brief) and thus we cannot comment further with regards to the risks of galvanic action.

## 10.17 Metals - Steel piles

**10.17.1 Hazards**

10.17.1.1 The corrosion of steel requires the presence of both oxygen and water. In undisturbed natural soils the amount of corrosion of driven steel piles is generally small. In disturbed soils (made ground) however, corrosion rates can be high and normally twice as high as those for undisturbed natural soils.

**10.17.2 Risk Assessment**

10.17.2.1 Guidance on the use of steel piles in different environments is provided in British Steel's piling handbook which includes calculating the effective life of steel piles. There is no specific guidance, however, for contaminated soils in this publication. Coatings can be provided to the pile surface but experience has shown that some coatings can be damaged during driving, particularly in ground which can contain hard materials such as brick/concrete/stone.

## 10.18 Metals - Stainless steel

**10.18.1 Hazards**

10.18.1.1 Stainless steel is used in a number of building components including services, pipework, reinforcement bars and wall ties. There is little knowledge, however, of the performance of stainless steel in aggressive environments.

**10.18.2 Risk assessment**

10.18.2.1 Stainless steel can withstand pH of 6.5 to 8.5, but the chlorine content of a soil increases the risk of corrosion. At concentrations of 200mg/l type 304 stainless steel can be used, but for concentrations of 200 to 1000mg/l type 316 should be used in preference to type 304, but for concentrations greater than 1000mg/l type 316 should always be used.

10.18.2.2 At this site the pH of the soils was near neutral (within the range of 6.5 to 8.5) and it is considered unlikely that groundwater will be in contact with stainless steel components (unless we are advised otherwise) thus the risk of ground conditions at the site affecting stainless steel is considered low.

## 10.19 Metals - Galvanised steel

**10.19.1 Hazards**

10.19.1.1 Galvanising steel is a means of protecting steel from aggressive environments; however, zinc galvanising can be corroded by salts and acids.

**10.19.2 Risk assessment/remedial action**

10.19.2.1 There is no current specific guidance on the effects of aggressive ground conditions on galvanised steel, however, some research indicates zinc alloys are generally more resistant than pure zinc coatings in aggressive conditions.

## 10.20 Metals - Copper

### 10.20.1 Hazards

10.20.1.1 Copper is commonly used for gas and water supplies. Copper is generally resistant to corrosion in most natural environments, but in contaminated ground copper can be subject to corrosion by acids, sulphates, chlorides and ground containing cinders/ash. Wet peat (pH 4.6) and acid clays (pH 4.2) are considered aggressive conditions to promote corrosion to copper.

### 10.20.2 Risk assessment

10.20.2.1 There is no specific published guidance on what constitutes aggressive conditions to copper except very acid/peaty conditions.

10.20.2.2 There are no significantly acidic or peaty conditions in near surface soils at the site or, indeed, significant concentrations of ash/cinders. On this basis the risk of significant corrosion to copper in contact with the ground is considered low.

## 10.21 Metals - Lead

### 10.21.1 Hazards

10.21.1.1 Lead is used in tanking, flashings, damp proof courses, etc. Lead is a durable material which is resistant to corrosion in most environments. Lead damp proof courses can be subject to attach from the lime released by Portland Cement based mortar and concrete. In the presence of moisture, a slow corrosive attack is initiated on lead sheet. In such cases a thick coat of bitumen should be used to protect the lead damp proof course.

### 10.21.2 Risk assessment

10.21.2.1 There is no current guidance on the performance of lead in contact with contaminated soils, however, acids and alkalis (lime) could be aggressive towards lead.

10.21.2.2 At the site pH conditions are not considered significantly extreme however it is considered likely that ground conditions at the site could affect lead.

## 10.22 Plastics - General

10.22.1 The range of plastics in construction is wide and increasing. The deterioration of plastics varies with the individual material and the environment to which it is exposed. In general, plastics deteriorate through degradation of their polymer constituent, but loss of plasticizer and other additives can render plastics ultimately unserviceable.

## 10.23 Plastic membranes and geotextiles

10.23.1 Plastic membranes and textiles are used in the construction industry as damp proof courses, gas resistant membranes, cover systems and liners. They are typically used to restrict the movement of gas or water into buildings, building materials or components or to separate differing soil types. Typically materials used for membranes are polyethylene (PE) and poly vinyl chloride (PVC).

### 10.23.2 Hazards

10.23.2.1 Membranes of PE and PVC are attacked by a variety of acids and solvents. PE has a poor corrosion resistance to oxidising acids (nitric and sulphuric) at high concentrations. Hydrochloric acid (HCl) does not chemically attack PE but can have a detrimental effect on its mechanical properties. Alkalis, basic salts, ammonia solutions and bleaching chemicals such as chlorine will cause deterioration of PE. PE is resistant to non oxidising salt solutions.

10.23.2.2 PVC is degraded by the action of oxidising acids. Nitric acid is particularly aggressive towards PVC. PVC does not deteriorate under the action of neutral or alkaline solutions.

### 10.23.3 Risk assessment

10.23.3.1 There is no published guidance on quantitative assessment of the risks to PE or PVC although there is a lot of advice on how contaminants react with these plastics. In general, the more concentrated the contamination the greater the risk to plastic membranes/geotextiles.

10.23.3.2 Based on the investigatory data obtained to date, and in consideration of the hazards described above, there is no evidence of significant concentrations of acids or alkalis, indicating the risks of ground conditions at the site affecting PE and PVC materials are considered low.

## 10.24 Plastic Pipes

### 10.24.1 Hazards

10.24.1.1 Plastic pipes are predominantly manufactured from PVC and PE but other materials can be used. In general they perform well but it is known that chemical attack and permeation of contaminants through the pipes can result from use in contaminated land. A published review on plastic pipes reports the following:-

- Polyethylene (PE) - good resistance to solvents, acids and alkalis
- Poly vinyl chloride (PVC) - most common form of pipe. Good general resistance to chemical attack but can be attacked by solvents such as ketones, chlorinated hydrocarbons and aromatic polypropylene (PP) - chemically resistant to acids, alkalis and organic solvents but not recommended for use with storing oxidising acids, chlorinated hydrocarbons and aromatics.
- Poly vinylidene fluoride (PVDF) - inert to most solvents, acids and alkalis as well as chlorine, bromide and other halogens

- Polytetrafluoroethylene (PTFE) - one of the most inert thermoplastics available. PTFE has good chemical resistance to solvents, acids and alkalis

**10.24.2 Assessment**

10.24.2.1 A survey carried out by the Water Research Centre (WRc) on reported incidents of permeation (more than 25), only two involved PVC with these incidents relating to spillages of fuel.

10.24.2.2 The UK Water Industry research (UKWIR) have published a document entitled *'Guidance for the selection of Water supply pipes to be used in Brownfield sites'.* The publication defines brownfield sites as

*'Land or premises that have been used or developed. They may also be vacant, or derelict. However they are not necessarily contaminated'*

10.24.2.3 The subject site has previously been developed and on this basis could potentially be considered brownfield in accordance with the UKWIR document. Following the preliminary risk assessment procedures described in the UKWIR document, (paragraph 2.4.2) there is evidence to indicate that chemicals have been used or stored on site in the chemical store located towards the central eastern section of the site.

10.24.2.4 Whilst we have not carried out a full investigation set out in guidance in the UKWIR document, the subject site does exhibit a degree of localised hydrocarbon (PAH) contamination. The UKWIR document advises a trigger concentration of 0.125mg/kg for their 'extended VOC (Volatile Organic Carbons) suite' which includes the PAH suite which we have results for. The measured concentration of individual contaminates forming part of the PAH suite exceeds the trigger value of 0.125mg/kg, however, we have recommended that the area is remediated and on this basis it is considered likely that barrier pipes will have to be installed at this site. We recommend Thames Water however is consulted on this to gain their opinion and requirements.

## 10.25 Electrical cables

**10.25.1 Hazards**

10.25.1.1 Electrical cables are generally protected by plastic sleeves. These sleeves are potentially subject to chemical and permeation in similar modes as plastic pipes. Medium and low voltage cables are often laid directly into the ground and are thus at risk of attack by contaminants. High voltage cables tend to be laid in trenches backfilled with 'clean' materials.

**10.25.2 Risk assessment/remedial action**

10.25.2.1 The selection of appropriate sheathing material is important to provide resistance to ground conditions at the site and recommend manufacturers' advices are sought.

## 10.26 Rubbers

### 10.26.1 Hazards

10.26.1.1 Rubbers are crosslinked polymeric materials containing a number of additives such as carbon black, fillers, antioxidant and vulcanising agents. The corrosion resistance of rubber is dependent upon the polymeric constituent. The mechanisms by which rubbers deteriorate when placed in aggressive chemical environments are similar to those described for plastics. Oxidation is the principal form of degradation. Whilst rubbers are resistant to strong acids and alkalis, they are rapidly attacked by oxidising agents such as nitric acid and oxidising salts such as copper, manganese and iron.

10.26.1.2 Rubber is also susceptible to attack by certain hydrocarbons and oils. The absorption of these liquids causes the rubber to smell.

### 10.26.2 Risk assessment/remedial action

10.26.2.1 Information on the effect of a range of chemicals on the physical properties of various rubbers has been produced by the Rubber and Plastics Research Association. This was based on observations carried out following immersion tests using undiluted chemicals, but this has limitations such as the effects of combined chemicals and the effects of dilution.

10.26.2.2 We recommend manufacturers of the rubber materials likely to be in contact with the ground at the site are consulted to confirm, or otherwise, the applicability of their product.

# 11 Classification of waste soils under the Waste Acceptance Criteria



## 11.1 The Landfill Directive

11.1.1 The Landfill Directive represents an important change in the way we dispose of waste. It encourages waste minimisation by promoting increased levels of recycling and recovery. The Landfill Directive became law in 1999 and transcribed into the Landfill (England and Wales) Regulations which came into force in 2002. These Regulations were amended in 2005 by introducing criteria to classify soils for disposal to landfill. It is the duty of the waste producer (the client) to classify the soils for this purpose.

## 11.2 Classification of soil types

11.2.1 Our investigations consider two soil types which may be generated as wastes as part of construction operations, potentially contaminated soil and uncontaminated soil. A full hazard assessment and subsequent testing for waste acceptance criteria is undertaken on soils which are not considered to be naturally deposited or are likely to be affected by artificial contamination. For soils that are unlikely to be affected by artificial contamination (such as natural soils), specific testing in relation to the classification process is not necessary.

## 11.3 Waste acceptance criteria (WAC)

11.3.1 The Environment Agency publication, *'Framework for the classification of contaminated soils as hazardous wastes'* (July 2004), provides an appropriate procedure for establishing if the soils are hazardous or non-hazardous and applies to soils that are identified as potentially contaminated. Uncontaminated, natural soils are considered separately (see Section 11.6).

**11.3.2 Primary classification**

11.3.2.1 The first stage is classifying a potentially 'contaminated' soil for disposal to landfill is to establish its chemical status by first identifying potential sources/types of chemical contamination (desk study) followed by intrusive site investigations to obtain samples for undefined testing of soil samples to measure concentrations of chemical contaminants. Such data provides information to partly complete the basic characteristic checklist.

11.3.2.2 Laboratory test data is then compared with the Environment Agency publication '*hazardous waste – Interpretation of the definition and classification of hazardous waste (second edition, version 2.1)'.* Where the waste is suspected to contain oil, we have referred to the Environment Agency draft consultation paper *'How to Find Out if Waste Oil and Wastes that Contain Oil are Hazardous'* (Draft Version 2.5 – October 2006). With reference to these documents a hazard assessment has been carried out to enable categorisation of the material as hazardous or non-hazardous and to subsequently establish the European Waste Catalogue (EWC) code (ref Section 11.3.4 below).

**11.3.3 Secondary classification**

11.3.3.1 If the soil is deemed hazardous then measurement of organic contaminants and leachable inorganic contaminants is necessary for comparison with values listed in the Environment Agency publication '*Guidance on sampling and testing of wastes to meet landfill waste acceptance procedures'* (April 2005) Table 5.1. Similarly should the soil be deemed as non-hazardous then such testing may also be undertaken to determine if it is potentially inert. This document also provides guidance on sampling materials and frequency as well as test procedures and quality assurance of testing.

11.3.3.2 The above procedures are described with respect to the subject site in the following sections Section 11.4 (primary) and 11.5 (secondary), leading to basic characterisation of soils for disposal. Subject to the results of the categorisation and anticipated development methodology, consideration should be given by the developer to reduce volumes of disposal or treatment to allow reclassification.

**11.3.4 European waste catalogue (EWC) coding**

11.3.4.1 The EWC 2002 is a catalogue of all wastes, grouped according to generic industry, process or waste type. It is divided into twenty main chapters, each with a two digit code between 01 and 20. Following the EWC, in our opinion, soils considered as part of this investigation would be categorised within 'Group 17' of the EWC catalogue, which comprises 'Construction and Demolition Wastes (including excavated soils from contaminated sites)'.

11.3.4.2 The Catalogue further categorises the waste, such that soils considered as part of this investigation would be classified as either 17 05 04 defined as *'soil and stones (other than those mentioned in 17 05 03)';* or 17 05 03* defined as soil or stones containing dangerous substances (where hazardous wastes are described by entries followed by an asterisk).

## 11.4 Primary classification

### 11.4.1 Soil types

11.4.1.1 Based on soils exposed in exploratory excavations, in combination with anticipated construction works, we assume soils requiring off-site disposal will comprise Made Ground (three types A-C), Kempton Park Gravels and London Clay.

### 11.4.2 Classification as hazardous or non-hazardous waste

11.4.2.1 The Environment Agency publication '*Framework for the classification of contaminated soils as hazardous wastes*' (July 2004) provides the following procedure for establishing if the soils are hazardous or non-hazardous. The first stage in classifying a potentially 'contaminated' soil for disposal is to establish its chemical status by first identifying potential sources/types of chemical contamination (desk study) followed by intrusive site investigations to obtain samples for laboratory testing of soil samples to measure concentrations of chemical contaminants.

11.4.2.2 An assessment of potential source of contamination is presented in Section 8 of this report. Laboratory testing has been set as deemed appropriate to our source assessment.

11.4.2.3 We have carried out an analysis of test data for each chemical contaminant considered in this investigation. A conservative approach has been adopted for the analysis whereby the maximum test value for each contaminant has been adopted as a preliminary screening process to determine if the soils are hazardous or non-hazardous. Should the analysis indicate potentially hazardous properties then a process of zoning by further analysing the site history, geological conditions and analytical data may be undertaken.

11.4.2.4 Laboratory test data measures the concentration of anions, which are unlikely to exist in the pure metallic form in the soil, but probably exist as a compound. Following guidance provided in the Environment Agency Technical Guidance WM3 *'Interpretation of the definition and classification of hazardous waste,* we have reviewed a variety of compounds for each of the metallic and semi metallic elements we have tested.

11.4.2.5 To determine the hazardous waste properties for each element, we have reviewed chemical compounds listed in Table 3.2 of Annex VI of the European Regulation (1272/2008) for Classification, Labelling and Packaging (CLP) of chemicals which has now superseded the Approved Supply List (Published by the Health and Safety Executive) for the classification of hazardous chemicals in the UK. In order to provide a 'worst case' scenario, initially we adopt the most severe hazardous properties (risk phrases) associated with the various compounds for each element under review. If measured concentrations produce a hazardous outcome then the element or elements are reassessed on a site specific basis. For review of organic contamination, we have directly adopted the threshold concentrations for the appropriate organic compounds listed in Table 3.2.

11.4.2.6 The compound or compounds adopted for each element is used to convert the measured metallic concentration to the substance concentration using their respective molecular weights. This derived conversion factor is then used in the threshold concentration spreadsheet (refer paragraph 11.4.2.8 below).

11.4.2.7 Our assessment of each of the chemical substances is maintained on our files and is available for confidential review/audit by the Environment Agency.

11.4.2.8 Three spreadsheets detailing the hazard assessment following the procedures described in *'framework for the classification of contaminated soils as hazardous wastes'* is presented in Appendix L.

11.4.2.9 The spreadsheet indicates the Made Ground, A (composite sample 1) and C (composite sample 3) soils are **non-hazardous** and that the Type B (composite sample 2) soils are **hazardous**. It should be noted that the Type B Made Ground is classified as hazardous due to elevated TPH and PAHs and further testing may enable the extent of such contamination to be zoned and potentially enable the remainder of the Type B soils to be reclassified.

## 11.5 Secondary assessment

11.5.1 Following *'Guidance on sampling and testing of wastes to meet landfill waste acceptance procedures'* produced by the Environment Agency (Version 1, April 2005) we have scheduled testing of **three** samples to measure the parameters listed in table 5.1 (landfill waste acceptance criteria) included in the above publication. A copy of the test result certificates are presented in Appendix H. The sources of the composite samples are detailed below:

**Composition of soil samples for classification testing**

| Strata | Source | Soil Type |
|---|---|---|
| Made Ground- Type A | BHA- 0.2m, TP101- 0.2m, TP104- 0.2m, TP108- 0.5m, DTS113- 0.3m, DTS115- 0.5m | Dark brown, gravelly, very clayey sand. Gravels comprise quartzite, flint and brick fragments. |
| Made Ground- Type B | DTS101- 0.5m, DTS103- 0.3m, DTS104- 0.1m, DTS108- 0.3m, DTS111- 0.4m | Dark grey sandy gravel. Gravels comprise brick, bituminous bound material, crushed concrete and ceramic. |
| Made Ground- Type C | TP103- 0.2, 0.6, 1.0m TP103A- 0.3, 0.6m TP105- 0.6m | Dark and orange brown sandy clay and clayey sand, with gravels of brick, flint and locally, whole bricks. Occasional pockets of ash observed. |

**Table 11.5.1**

11.5.2 The samples were deemed representative of Made Ground soils as described in Section 5. The samples were formed by combining individual samples taken from exploratory excavations within the Made Ground. The combined samples were then quartered in the laboratory to produce a representative sample for subsequent testing.

11.5.3 Laboratory test data has been compared with the landfill waste acceptable criteria (table 5.1) to allow the secondary assessment to be completed. A copy of table 5.1 is presented in Appendix M with test result data added for ease of comparison.

11.5.4 Comparison of test data with landfill waste acceptance criteria indicates that:

- Made Ground - Type A soils are suitable for disposal as **non-hazardous waste** and cannot be classified as inert by virtue of elevated Total Organic Carbon and Loss on Ignition
- Made Ground - Type B soils are suitable for disposal as **stable non-reactive waste** by virtue of elevated PAHs. It is possible that the extent of such contamination could be defined with additional testing and enable the remainder of the Type B soils to be reclassified.
- Made Ground - Type C soils are suitable for disposal as **non-hazardous waste** and cannot be classified as inert by virtue of elevated Total Organic Carbon

## 11.6 Naturally deposited soils not affected by artificial contaminants

11.6.1 With reference to the European Waste Catalogue and table 5.1 of the Environment Agency publication *'a better place – guidance for waste destined for disposal in landfills – version 2 June 2006'*, naturally occurring soils not likely to be affected by contamination can be classified as inert waste, with a EWC code of 17 05 04. Should any of the naturally deposited soils be suspected to contain contamination (by virtue of visual of olfactory evidence) upon excavation, then such soils should be stockpiled appropriately and additional testing carried out as considered necessary. Based on evidence obtained during our investigations, we are of the opinion that Kempton Park Gravels and London Clay formation at the site are not likely to be affected by chemical contamination and thus can be classified as **inert waste.**

## 11.7 Basic categorisation

11.7.1 Based on the preceding assessment, we have produced **five** basic categorisation schedules relating to the three types of Made Ground, Kempton Park Gravels and London Clay deposits, which are presented in Appendix N. These schedules should be provided together with a copy of this report to an appropriately licensed landfill facility to demonstrate the material can be deposited at this facility.

11.7.2 We understand that some landfill sites have licences which have restrictions on concentrations of chemical contaminants and thus we recommend this report is provided to the selected landfill facility to confirm (or otherwise) it can accept the waste. Please be aware that landfill sites are obligated to undertake in house quality assurance tests and thus may require further WAC testing for any soils encountered as part of this investigation. There is no obligation on any landfill operator to accept waste if they choose not to and waste operators may require additional testing of untested waste soils prior to acceptance at landfill in accordance with the landfill regulations.

## 11.8 Treatment of waste

11.8.1 Treatment of wastes is now a requirement of the landfill directive applied by the Landfill (England and Wales) Regulations 2002. Landfill cannot accept untreated waste (be it hazardous or non-hazardous), thus waste producers have the choice of treating it themselves on site or treating it elsewhere prior to disposal to landfill. The regulations require:

> *'10 – (1) The operator of a landfill shall ensure that the landfill is only used for landfilling waste which is subject to prior treatment unless:*
>
> *a) It is inert waste for which treatment is not technically feasible; or*
>
> *b) It is waste other than inert waste and treatment would not reduce its quantity or the hazards which it poses to human health or the environment.'*

11.8.2 Regulation 2 defines treatment as: *'physical, thermal, chemical or biological processes (including sorting) that change the characteristics of waste in order to reduce its volume or hazardous nature, facilitate its handling or enhance recovery.'*

11.8.3 A treatment option must comply with the definition of treatment. This involves a 'three point test' against which treatment is assessed i.e.

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

**11.8.4 Treatment of inert wastes**

11.8.4.1 Inert waste does not need to be treated if it is not technically feasible however treatment should reduce the amount of waste which goes to landfill and enhance its recovery (by re-use or recycling). Inert wastes are often suitable for recycling, for example as an aggregate or an engineering fill material. A fact sheet on treatment of inert wastes is available on the following website www.environment-agency.gov.uk

11.8.4.2 Clearly, excavations in the naturally deposited Kempton park Gravels and London Clay will generate inert wastes which could be reused on site or off site for bulk filling, subject of course to maintenance of an acceptable water content and provided that it is fit for its intended purpose.

**11.8.5 Treatment of non-hazardous waste**

11.8.5.1 Guidance and indeed examples of treatment is provided in the Environment Agency publication '*Treatment of non-hazardous wastes for landfill – your waste – your responsibility,'* again available on the EA website.

**11.8.6 Landfill operators**

11.8.6.1 It is a requirement of the landfill operator to check if the waste soils taken to the facility have been treated.

## 11.9 Reuse of Soils - Materials Management Plans

11.9.1 Where soils are to be moved and reused onsite, or are to be imported to the site, a Waste Exemption or an Environmental Permit is required.

11.9.2 An alternative is the use of a Materials Management Plan (MMP) to determine where soils are and are not considered to be a waste. By following *'The Definition of Waste: Development Industry Code of Practice'* published by CL:AIRE (produced in 2008 and revised in March 2011), soils that are suitable for reuse without the need for remediation (either chemical or geotechnical) and have a certainty of use, are not considered to be waste and therefore do not fall under waste regulations. In addition, following this guidance may present an opportunity to transfer suitable material between sites, without the need for Waste Exemptions or Environmental Permits.

11.9.3 MMPs offering numerous benefits, including maximising the use of soils onsite, minimising soils going to landfill and reducing costs and time involved in liaising with waste regulators.

11.9.4 We can provide further advice on this and provide fees for producing a Materials Management Plan on further instructions.

# 12 Further investigations

## 12.1 Further investigations

12.1 Although we have endeavoured to provide a comprehensive investigation for the proposed development within budgetary constraints there are areas, which we recommend further investigations be carried out. These are as follows: -

- Additional testing to define extent of hazardous waste, and potentially allow reclassification of remainder of Type B Made Ground soils (currently classified as stable-non-reactive).

12.2 We would be pleased to carry out the above investigations upon further instruction.

# 13 Remediation strategy and specification



The entire section which follows has been updated from rev01 to Rev02. As such, the vertical line has been omitted from the remainder of the section.

## 13.1 Introduction

13.1.1 This remediation statement has been produced with a view to isolating and clarifying remedial measures outlined in our main ground investigation report for the site. The objective of remediation works described in this report is to render the site '*fit for purpose'* in relation to the proposed development.

13.1.2 We understand that the development proposals can be split into three main areas; The north of the site, the central area and the south of the site. **The north** of the site will comprise a five storey building, three smaller college buildings, an artificial sports pitch and a car parking area in the north eastern corner. **The central area** of the site will comprise a residential development of two storey properties all with parking areas and front and back gardens. **The southern section** of the site will continue to be used as playing fields. A plan showing the proposals is included in Drawing 03.

13.1.3 This remediation statement only considers the process of remedial action in terms of addressing contamination recognised to date. If during development, contamination not previously identified, is found to be present at the site, then an addendum method statement will be required, and the appropriate measures taken on site.

13.1.4 All sampling and laboratory analysis associated with the recommended remediation will be undertaken following nationally recognised guidelines and standards that are appropriate at the point of investigation. Laboratory analysis must be commissioned with testing houses that are suitably experienced and are MCERTS accredited with a quality assurance system.

13.1.5 This statement has been prepared to assist in the process of the proposed development, and it normally will require distribution to the following parties prior to implementation, although this list may not be exhaustive:

| Table summarising parties likely to require information contained in this section of the report | |
|---|---|
| **Party** | **Reason** |
| Client | For information / reference and cost planning |
| Developer / Contractor / project manager | To ensure procedures are implemented, programmed and costed |
| Planning department | Potentially to discharge planning conditions |
| Independent inspectors such as NHBC / Building control | To ensure procedures are implemented and compliance with building regulations |
| Project design team | To allow for remedial measures in the design |
| Project landscape consultant | To ensure compatibility of cover system proposed in this document with landscape requirements |
| Supplier of remediation materials | To ensure compliance with specification. |

## 13.2 Summary of results of investigations leading to recommendations for remediation.

13.2.1 Investigations and assessment of chemical contamination is described primarily in section 8. A summary of chemical contamination at the site is detailed below.

**13.2.2 Evaluation of contamination - human receptors**

13.2.2.1 The site has been split into three areas, as described in 13.1.2 above. Each of the areas were investigated initially to determine the broad condition of the site; reported in Section 8 of this report. Subsequent further testing was undertaken in December 2015, which is reported in STM3361D-L003 and included in Appendix R of this report for ease of reference. Construction operatives are also considered as part of the assessment.

- **School (soft landscaped areas)**

Based on the results of the original and additional testing, outlined in L003 (appended), none of the results exceed the adopted guideline levels. The CLEA model was used to derive site specific values, the justification and details of which are outlined in L003. On this basis, we consider the soils in proposed soft landscaping areas of the school to not pose a significant risk to the proposed end users' health and therefore, **no remediation is considered necessary in these areas.**

- **Residential (Public open space areas)**

Based on the results of the original and additional testing, outlined in L003, all of the measured results and UCL values are below the adopted guideline values for each contaminant. Open Space S4ULs were adopted for these areas, and the justification for this use is included in L003. On this basis, **no remediation is considered necessary for the proposed public open space areas of the residential portion of the site.**

- **Residential (garden areas)**

The following summary is based on the results of the original and additional testing, outlined in L003. We have adopted the S4UL residential with plant uptake model for all productive garden areas of the proposed residential development. When compared to the guideline values, the majority of the measured and UCL values are well within the limits, with the exception of the following, benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene and pyrene. All of these contaminants produced at least one elevated result. When the mean of all tested locations was calculated, both dibenzo(a,h)anthracene and pyrene both produced mean results greater than the guideline value.

Due to the spread of individual test locations which recorded elevated results, and the relative homogeneity of the soils, we cannot identify any single localised area of contamination and therefore **recommend that any productive garden space is remediated to make the area fit for proposed purpose.**

- **Construction operatives**

By virtue of marginally elevated levels of contamination with reference to industrial/commercial land use (refer Section 8), we recommend that **adequate hygiene precautions are adopted for all construction operatives**. Full details of such precautions are included in Section 13.3 below.

**13.2.3 Evaluation of contamination - water receptors**

13.2.3.1 Based on analysis of test data (reported in Section 8 of this report), the near surface soils are considered likely to exhibit significant contamination with respect to water resources. It should be noted that the current layout of the site restricts the pathway for leachable contamination to reach water receptors due to all location being surfaced with bituminous bound material, with exception of HP01 and TP108. If this surfacing is to be removed during the development, remediation will be necessary. **In the areas where permeable paving is proposed, remediation is considered necessary.**

**13.2.4 Evaluation of contamination - vegetation receptors**

13.2.4.1 Benzo(a)pyrene was the only measured contaminant which exceeded the adopted guideline values in both the residential area and the school area of the site. On this basis, we are of the opinion that measured concentrations exhibit contamination with respect to vegetation. **As such, we recommend that an appropriate planting scheme is derived by a qualified Arboriculturalist.**

## 13.3 Remediation strategy

13.3.1 The provision of buildings and hardstanding areas across the site will sever the pathway to end-users by preventing human access to contaminated soils.

### 13.3.2 Human end users

13.3.2.1 Based on the above summary, with respect to human end users, the only areas requiring remediation are proposed residential gardens. In these areas, an imported capping layer (cover system) of chemically 'clean' soils will be introduced to sever the pathway between contaminants and end-users, thus minimising the risk of human contact with soils containing contaminants which have the potential to cause harm to human health. The capping layer will be a minimum of 600mm thick in any productive garden areas, and areas likely to be accessible to young children (considered the critical human receptor) on a regular (daily basis). In our opinion, this may be reduced to 300mm in landscaped areas.

13.3.2.2 Whilst the capping solution is widely accepted regulating Local Authorities (Environmental Health Departments) have differing views as to the minimum thickness required which range from 300mm to 600mm. The Building Research Establishment publication *'cover systems for land regeneration - thickness cover for systems for contaminated land'* indicates that 600mm of capping would be required at the site, though in our opinion this could be reduced to 300mm in non-productive garden areas, however this needs to be approved by the Local Authority.

13.3.2.3 Following installation of the cover system described above, the capping thickness will require independent measurement to validate the correct thicknesses have been provided in landscaped/garden areas.

### 13.3.3 Construction operatives

13.3.3.1 With respect to construction operatives, we recommend that adequate hygiene precautions are adopted. The risk of damage to health of construction operatives and other site investigators is, in our opinion moderate and would be minimised by taking adequate hygiene precautions on site. Such precautions would be:-

- Wearing protective clothing particularly gloves to minimise ingestion from soil contaminated hands.
- Avoiding dust by dampening the soils during the works.
- Wearing masks if processing produce dust.

13.3.3.2 Guidance on safe working practices can be obtained from the following documents

- The Health and Safety Executive Publication *"Protection of Workers and the General Public during the Development of Contaminated Land"* (HMSO) and

- *"A Guide to Safer Working on Contaminated Sites"* (CIRIA Report 132).

13.3.3.3 In addition, reference should be made to the Health and Safety Executive. In all cases work shall be undertaken following the requirements of the Health and Safety at Work Act 1974 and regulations made under the Act including the COSHH regulations.

**13.3.4 Water receptors**

13.3.4.1 Elevated levels of contamination considered capable of causing harm to water receptors were encountered below areas of proposed hardstanding or buildings. If these plans alter, Soiltechnics should be advised such that a suitable strategy for the removal of such soils can be achieved. Within the footprint of the proposed permeable paving the Made Ground deposits should be fully removed and replaced with chemically clean subsoils.

**13.3.5 Vegetation receptors**

13.3.5.1 Plants on the site generally appeared in good health at the time of our investigation. Although the majority of tested contaminants were well below the guideline values, benzo(a)pyrene was elevated. As such, we recommend that a qualified Arboriculturalist is consulted in order to provide a plant scheme to include plants not susceptible to such contamination. Alternatively, within the areas of proposed planting, soils can be excavated and replaced with chemically clean topsoil.

## 13.4 Specification for imported capping materials

**13.4.1 General**

13.4.1.1 All imported capping materials (cover systems) shall be sampled and tested to demonstrate they are '*fit for purpose*' **before being brought onto site**.

**13.4.2 Capping materials**

13.4.2.1 Capping materials shall comprise topsoil to a minimum thickness of 150mm, over subsoil; alternatively the entire capping thickness can comprise topsoil.

13.4.2.2 Topsoil shall comprise a material which will allow plants to grow healthily. Topsoil shall be general purpose grade in accordance with BS3882:2015 '*Specification for topsoil*' unless otherwise specified by the consultant landscape architect for the project. Testing shall be carried out to demonstrate compliance for general purpose topsoil (or other topsoil specified by others) with test criteria provided in table 2 of BS3882 with at least one sample tested per source. Topsoil shall be stored, handled and place following the recommendations of BS3882.

13.4.2.3 Subsoils shall be granular (sands / gravels) or clays / silts of natural origin, which shall be classified, placed and compacted in accordance with the current Specification for Highway works, Volume 1, 600 series, available on www.standardsforhighways.co.uk

**13.4.3 Rate of testing / sampling**

13.4.3.1 If different sources are to be utilised for topsoil/capping, each source shall be investigated.

13.4.3.2 Capping materials shall be from a source where at least 3 representative soil samples have been taken, subject to a minimum rate of at least 1 sample per 250m$^3$

**13.4.4 Testing regime**

13.4.4.1 Human receptors

13.4.4.1.1 The testing regime really is dependent upon the history of the site where the capping materials are sourced. Past historical uses (from a potential chemical contamination viewpoint) of the source site will dictate the required testing regime potentially requiring additional testing to target / investigate concentrations of contaminants used at the source site where they are harmful to human health. At this stage we cannot specify the scope and indeed the need for such site specific testing as the source of the imported fills is not known.

13.4.4.1.2 As a minimum testing shall be scheduled to measure the concentrations of commonly occurring inorganic and organic contaminants (listed in Table 13.4.7 below where guideline values are available).

**13.4.4.2 Water receptors**

13.4.4.2.1 The materials forming the cover system, may exhibit a degree of permeability, and thus the potential for any chemical contaminants contained in the soils to leach and thus migrate towards groundwater resources, although the risk of this occurring is dependent upon the location of the water table and indeed the permeability of the soils above the water table. Conversely, leachable contaminants could migrate laterally from cover system towards surface water resources. In order to minimise this risk, the soils forming the cover system shall be tested to determine leachable concentrations of potential contaminants. As with testing regimes associated with human health, the testing regime really is dependent upon the history of the site where the capping materials are sourced. At this stage we cannot specify the scope and indeed the need for such site specific testing as the source of the imported fills is not known.

13.4.4.2.2 As a minimum testing shall be scheduled to measure the leachable concentrations of commonly occurring inorganic and organic contaminants where they are considered a risk to harming water receptors (listed in Table 13.4.7 below where leachate guideline values are available).

**13.4.5 Maximum concentrations (Human receptors)**

13.4.5.1 The Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH) have derived Suitable for Use Levels (S4ULs) which are presented in *'The LQM/CIEH S4ULs for Human Health Risk Assessment'* (2015). S4ULs have been used as a screening tool to assess the risks posed to the health of humans from exposure to soil contamination in relation to appropriate land uses. Where published S4ULs are not available, we have adopted C4SLs (Category 4 Screening Levels) produced by DEFRA or SGVs (Soil Guideline Values) as appropriate. In the absence of any of these criteria we have adopted Soil Screening Values (SSV) derived by Soiltechnics and by Atkins ($SSV^{ATK}$). The CLEA model used to derive SSVs has been used with toxicology data presented by the EA, LQM/CIEH and Atkins (in that order of preference). SSVs produced by Atkins are presented on their $ATRISK^{SOIL}$ website.

13.4.5.2 S4ULs, C4SLs, SGVs, SSVs and $SSV^{ATK}$s represent 'intervention values'; indications to an assessor that soil concentrations above these levels might present an unacceptable risk to the health of site users. These guideline values have been produced using conceptual exposure models, which use assumptions and are applied to differing end uses of land. If the values are exceeded, it does not necessarily imply there is an actual risk to health and site-specific circumstances should be taken into account. Conversely, where a critical pathway or chemical form of the contaminant has not been evaluated, a risk may be present even if the adopted guideline value has not been exceeded.

13.4.5.3 For evaluation of test data in relation to polycyclic aromatic hydrocarbon (PAH) and phenol contamination, we have compared measured concentrations with corresponding S4ULs. The S4UL fractions are dependent on the Soil Organic Matter (SOM) content of the soils. We have adopted the lowest S4UL (1% SOM) as an initial screening value.

**13.4.6 Maximum concentrations (water receptors)**

13.4.6.1 For interpretation of test data in relation to water receptors measured concentrations of leachable contaminants shall be directly compared with the Environmental Quality Standards (EQS) as published by the Environment Agency. In the absence of EQS UK Drinking Water Standards shall be adopted.

### 13.4.7 Maximum concentrations (summary)

13.4.7.1 The following table summarises the maximum concentrations of chemical contaminants which shall not be exceeded in imported capping materials.

**Table summarising maximum concentration of contaminants in soils used for capping**

| Contaminant | Maximum allowable concentration and test criteria (Human Receptors) (Total concentration) | | Maximum concentration (µg/l) (leachate concentration) |
|---|---|---|---|
| | C4SL (mg/kg) | S4UL (mg/kg) | |
| **Inorganic contaminants** | | | |
| Arsenic | - | 37 | 50 |
| Barium | - | - | 700 |
| Boron | - | 290 | 2000 |
| Beryllium | - | 1.7 | - |
| Cadmium (pH to 7.4) | - | 11 | 5 |
| Copper | - | 2400 | 1 |
| Chromium | - | 910 | 5 |
| Cyanide (total) | - | 34 | 50 |
| Lead | 82 | - | 4 |
| Mercury | - | 1.2 | 1 |
| Nickel | | 180 | 50 |
| Nitrate | - | - | 50000 |
| Selenium | - | 250 | 10 |
| Sulfate | - | - | 400000 |
| Sulfide | - | - | 0.25 |
| Vanadium | - | 410 | 20 |
| **Organic contaminants** | | | |
| Acenaphthene | - | 210 | |
| Acenaphthylene | - | 170 | |
| Anthracene | - | 2400 | |
| Benzo(a)anthracene | - | 7.2 | |
| Benzo(a)pyrene | - | 2.2 | |
| Benzo(b)fluoranthene | - | 2.6 | |
| Benzo(g,h,i)perylene | - | 320 | |
| Benzo(k)fluoranthene | - | 77 | |
| Chrysene | - | 15 | |
| Dibenzo(a,h)anthracene | - | 0.24 | |
| Fluoranthene | - | 280 | |
| Fluorene | - | 170 | |
| Indeno(1,2,3-cd)pyrene | - | 27 | |
| Naphthalene | - | 2.3 | |
| Phenanthrene | - | 95 | |
| Phenols | - | 280 | |
| Pyrene | - | 620 | |

**Table 13.4.7**

**13.4.8 Information required**

13.4.8.1 It is critically important that the imported capping material will minimise the risks of causing harm to human end users of the site. It is necessary to demonstrate the imported capping materials are 'fit for purpose', and relevant and current test result certificates are an important part of the necessary compliance documentation. Compliance documentation will be provided to other interested parties such as:-

- Local Authority planning department to discharge planning permissions
- Checking bodies such a NHBC and Building Control (For compliance with building regulations)
- Potential purchasers of the buildings (and their legal advisors)
- Environment Agency (controlling body for ground / surface water resources)

13.4.8.2 **Based on the above it is important to provide compliance documentation prior to importation to site, thus avoiding abortive works and delays to the construction programme with its potential financial penalties**.

13.4.8.3 Compliance documentation shall include the following

- Copies of test result certificates signed by a MCERTS accredited laboratory which is signed and dated.
- Source and supplier of the capping material.
- Delivery notes confirming the material originates from the stated source (will form part of the subsequent validation reporting )
- Export notes showing Made Ground soils being removed from the site

## 13.5 Verification report

13.5.1 The thickness of the completed cover system will require verification by an independent consultant. We can carry out such investigations on further instructions.

13.5.2 Following completion of remedial works detailed above, a closure report which provides details of all work undertaken as part of the remediation process will have to be prepared. The closure report will include details of imported materials to form the cover system, its thickness and thus verification of its fitness for purpose. All compliance documentation listed above will also be included into the report as well as photographic evidence of the capping thickness.

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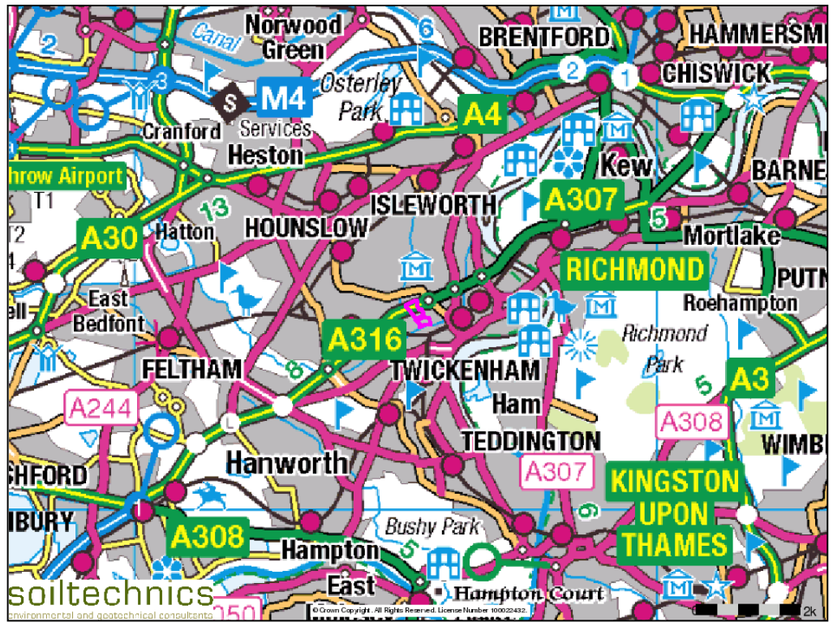
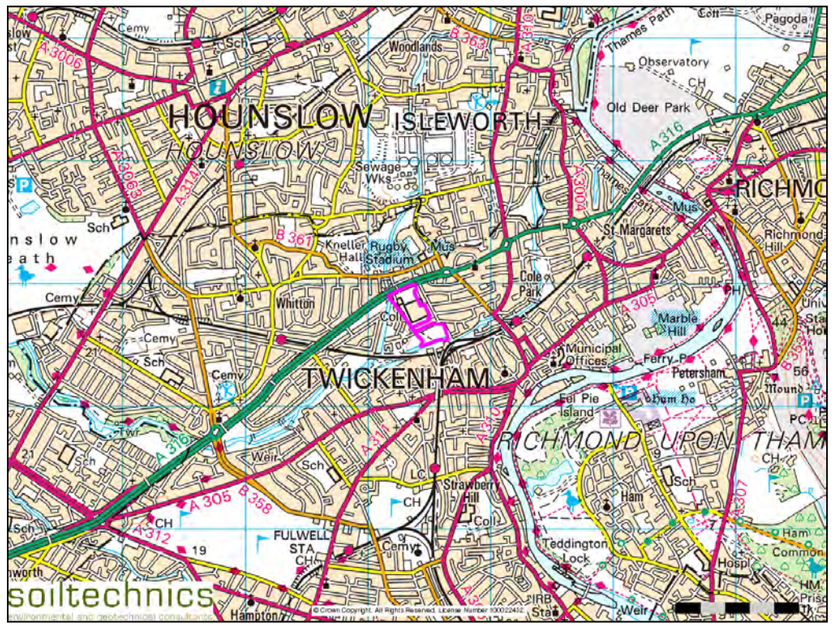
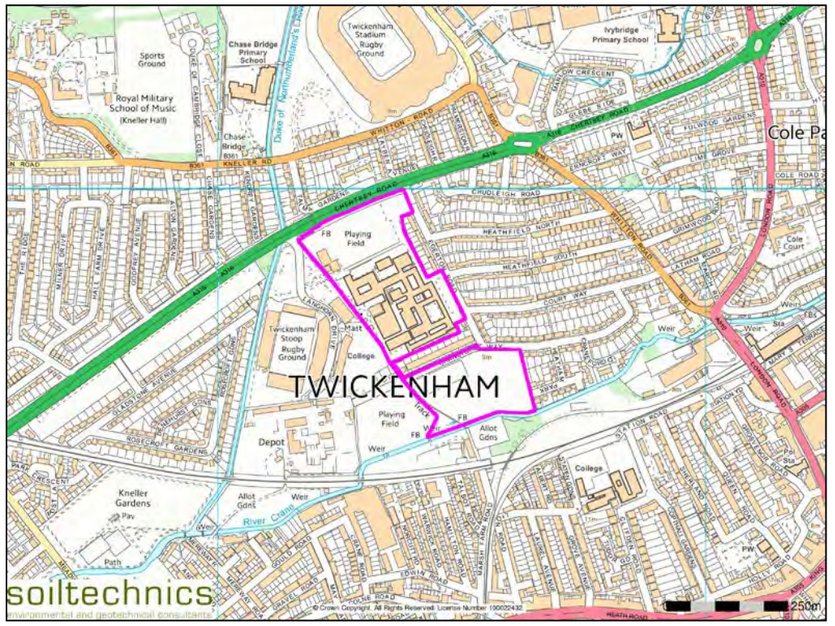



Locality extract from Ordnance Survey map




Neighbourhood extract from Ordnance Survey map




Town extract from Ordnance Survey map

| Title | Scale | Drawing number |
|---|---|---|
| Site location plan | Not to scale | 01 |

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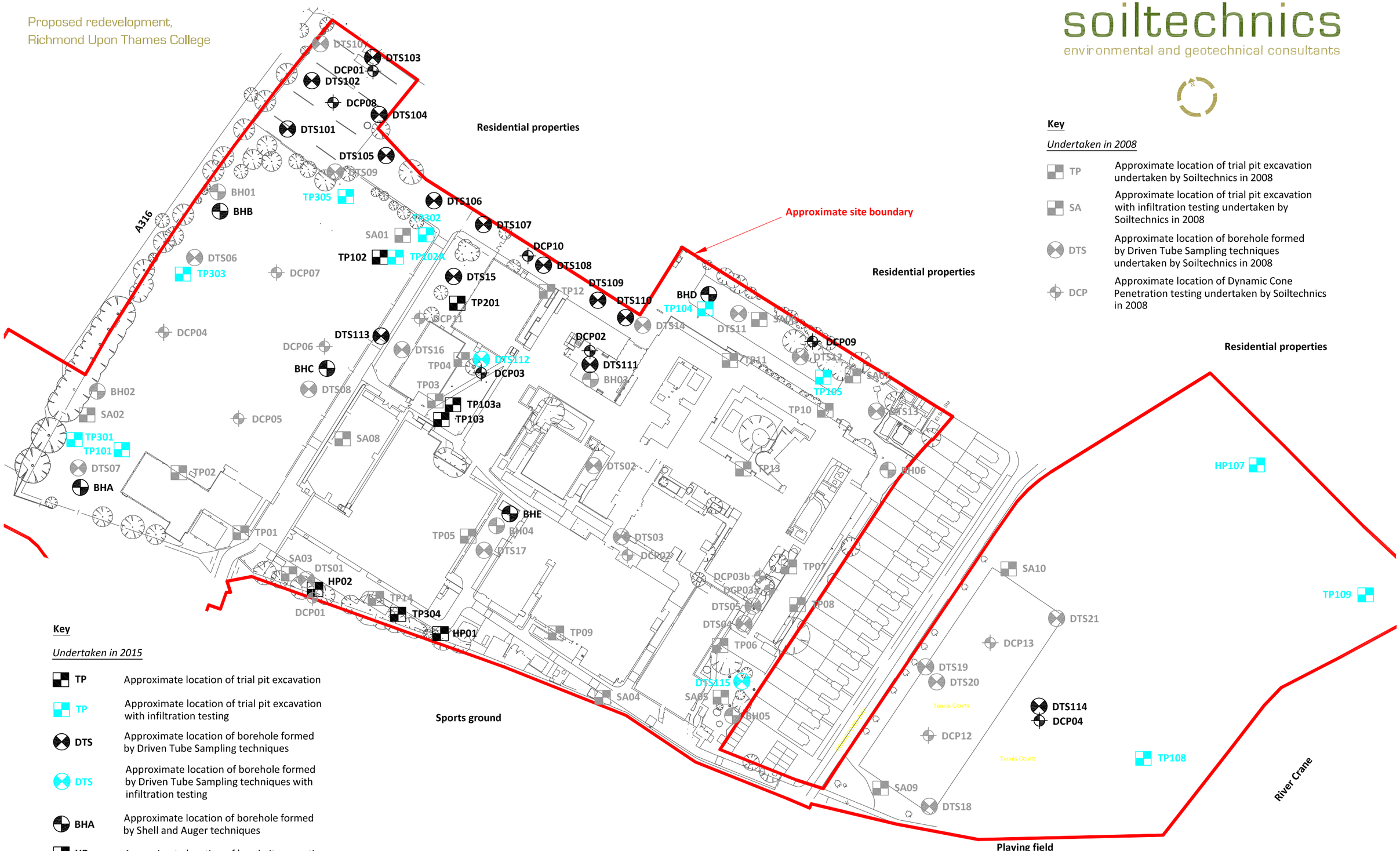


**Key**

*Undertaken in 2008*

| | |
|---|---|
| TP | Approximate location of trial pit excavation undertaken by Soiltechnics in 2008 |
| SA | Approximate location of trial pit excavation with infiltration testing undertaken by Soiltechnics in 2008 |
| DTS | Approximate location of borehole formed by Driven Tube Sampling techniques undertaken by Soiltechnics in 2008 |
| DCP | Approximate location of Dynamic Cone Penetration testing undertaken by Soiltechnics in 2008 |

**Key**

*Undertaken in 2015*

| | |
|---|---|
| TP | Approximate location of trial pit excavation |
| TP | Approximate location of trial pit excavation with infiltration testing |
| DTS | Approximate location of borehole formed by Driven Tube Sampling techniques |
| DTS | Approximate location of borehole formed by Driven Tube Sampling techniques with infiltration testing |
| BHA | Approximate location of borehole formed by Shell and Auger techniques |
| HP | Approximate location of hand pit excavation |
| HP | Approximate location of hand pit excavation with infiltration testing undertaken |
| DCP | Approximate location of Dynamic Cone Penetration testing |

| Title | Scale | Drawing number |
|---|---|---|
| Plan showing existing site features and location of exploratory points | 1:1500 at A3 | 02 |

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**Key**

*Undertaken in 2008*

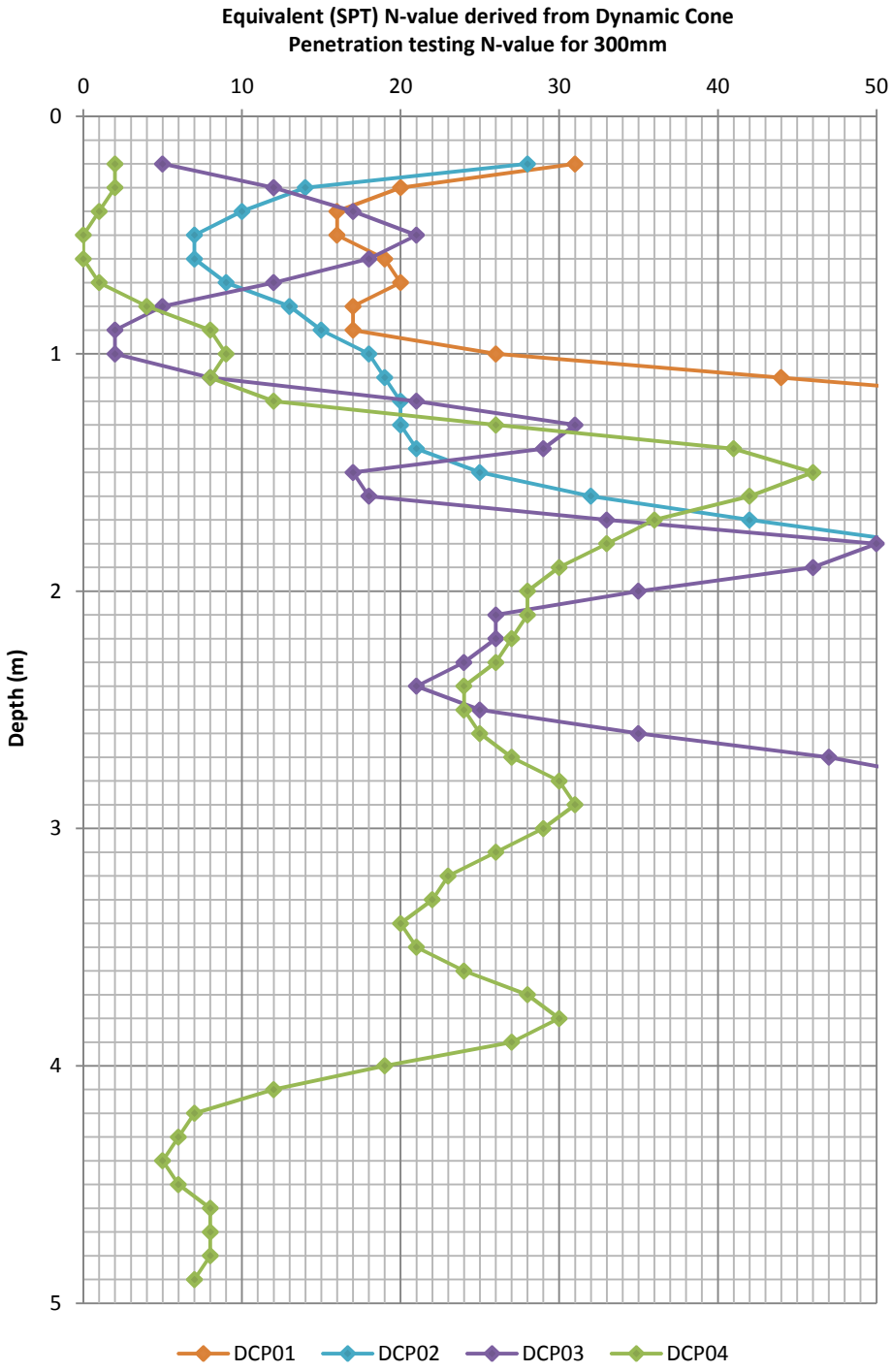
| | |
|---|---|
| TP | Approximate location of trial pit excavation undertaken by Soiltechnics in 2008 |
| SA | Approximate location of trial pit excavation with infiltration testing undertaken by Soiltechnics in 2008 |
| DTS | Approximate location of borehole formed by Driven Tube Sampling techniques undertaken by Soiltechnics in 2008 |
| DCP | Approximate location of Dynamic Cone Penetration testing undertaken by Soiltechnics in 2008 |

**Key**

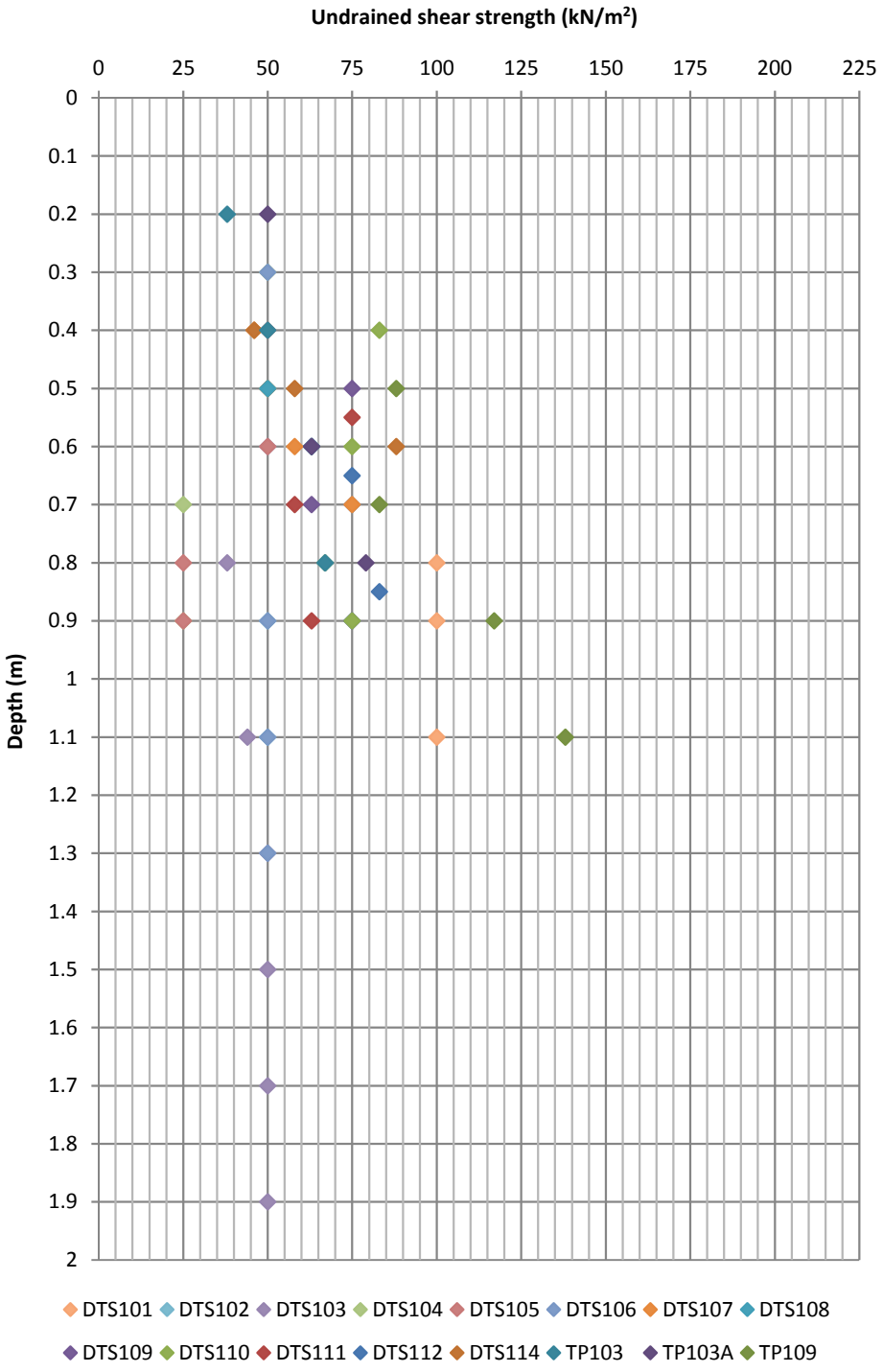
*Undertaken in 2015*

| | |
|---|---|
| TP | Approximate location of trial pit excavation |
| TP | Approximate location of trial pit excavation with infiltration testing |
| DTS | Approximate location of borehole formed by Driven Tube Sampling techniques |
| DTS | Approximate location of borehole formed by Driven Tube Sampling techniques with infiltration testing |
| BHA | Approximate location of borehole formed by Shell and Auger techniques |
| HP | Approximate location of hand pit excavation |
| HP | Approximate location of hand pit excavation with infiltration testing undertaken |
| DCP | Approximate location of Dynamic Cone Penetration testing |

| Title | Scale | Drawing number |
|---|---|---|
| Plan showing development layout and location of exploratory points | Not to scale | 03 |



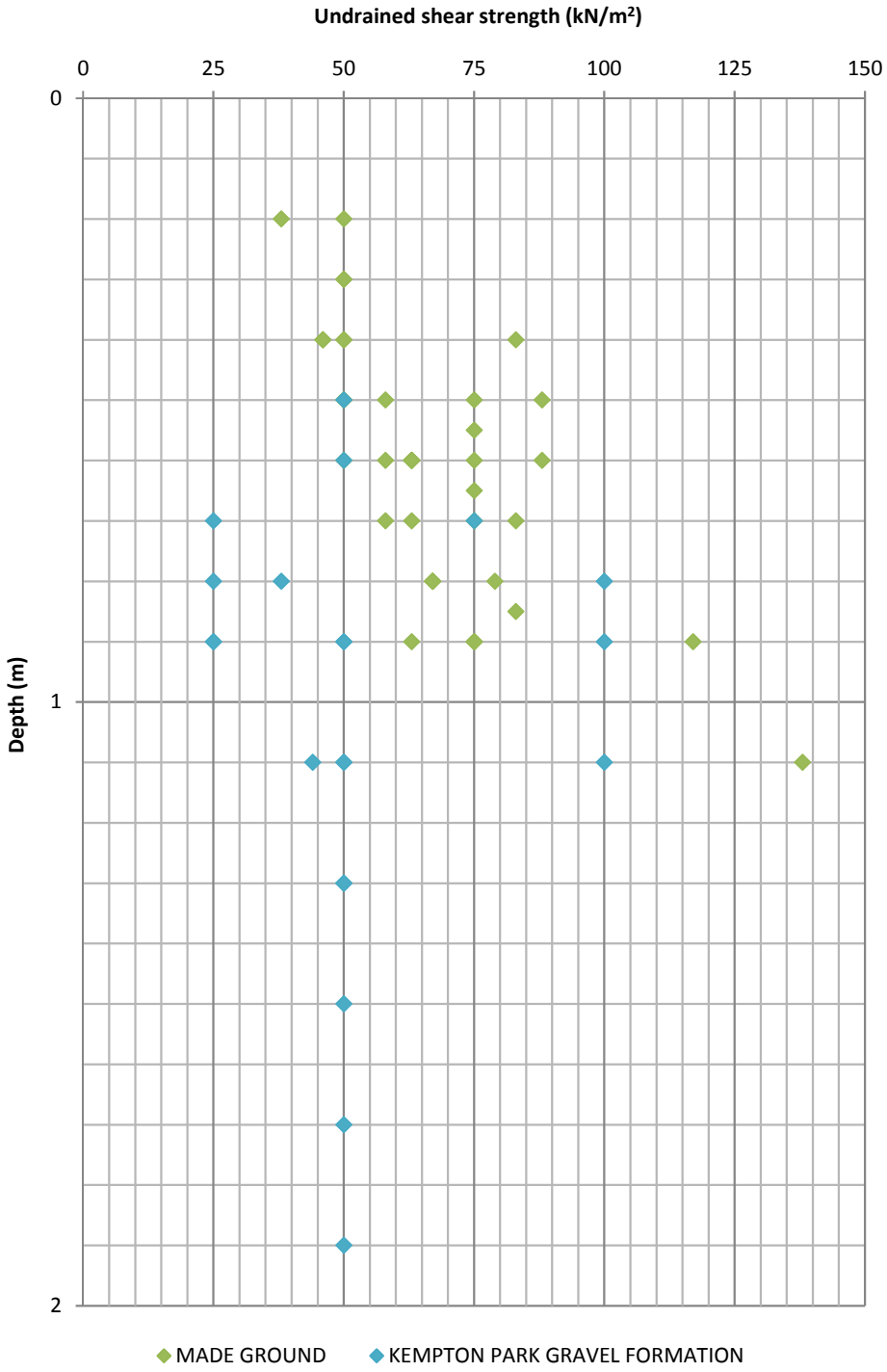

| Title | Scale | Drawing number |
|---|---|---|
| Plot summarising insitu density testing utilising dynamic cone penetration (DCP) techniques | As shown | 04 |




Notes

1) Equivalent undrained shear strength derived by multiplying Pocket Penetrometer (PP) results by 50

| Title | Scale | Drawing number |
|---|---|---|
| Plot summarising results of pocket penetrometer determinations by location | As shown | 05a |




Notes

1) Equivalent undrained shear strength derived by multiplying Pocket Penetrometer (PP) results by 50
2) Granular deposits excavated below 2m in trial pits and boreholes therefore pockets penetrometers

| Title | Scale | Drawing number |
|---|---|---|
| Plot summarising results of pocket penetrometer determinations by geology | As shown | 05b |

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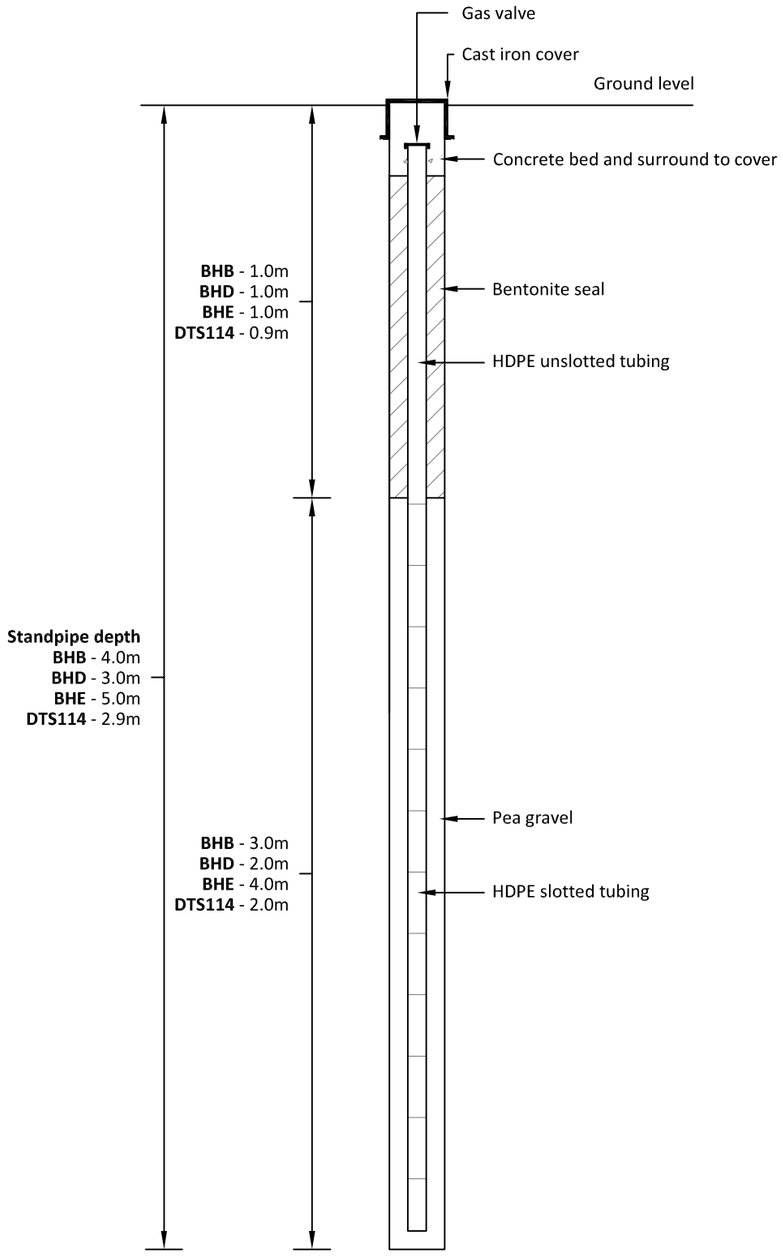
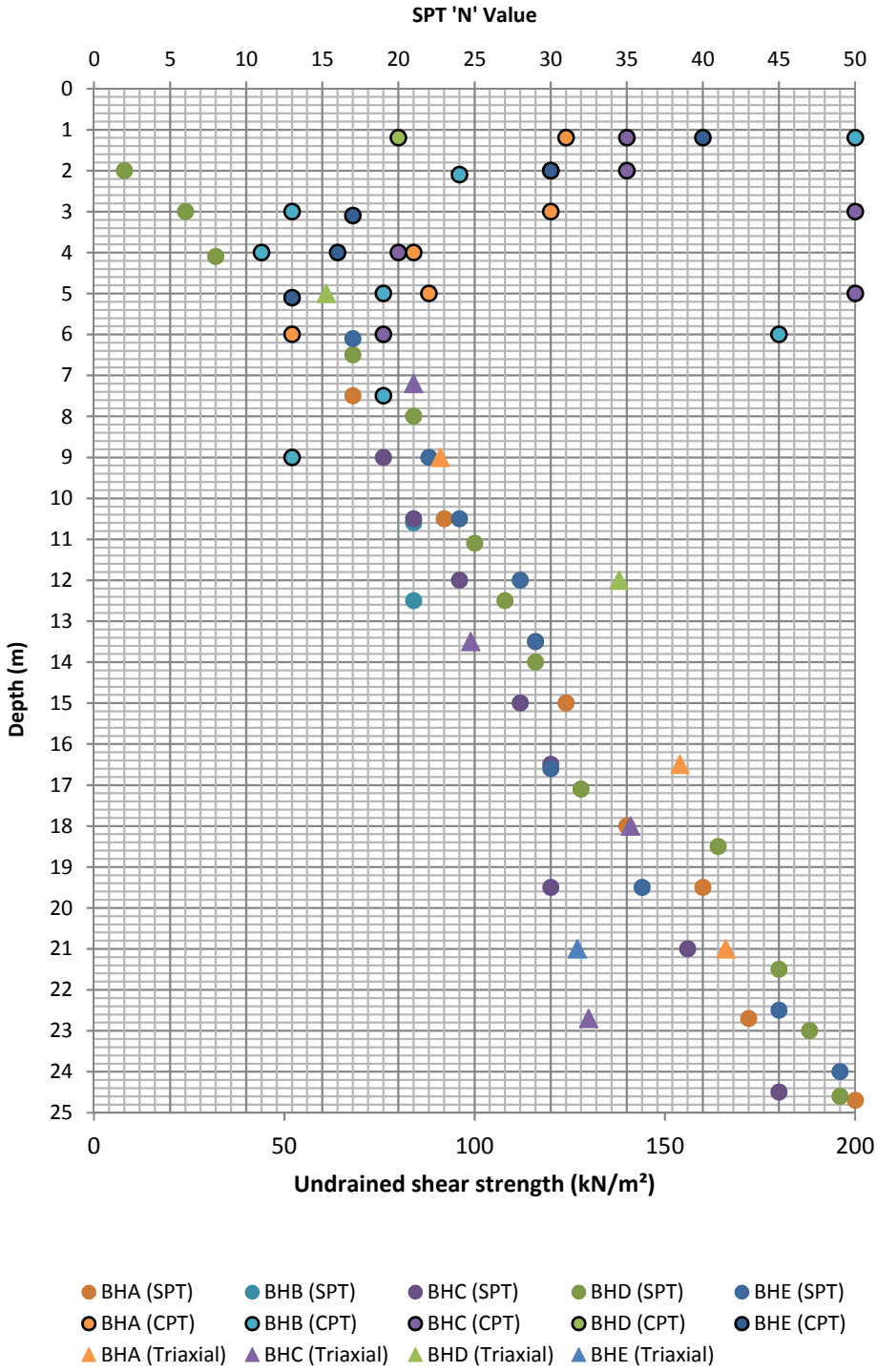



**Table summarising groundwater observations**

| Exploratory point | Depth (m) below ground level | Observations |
|---|---|---|
| TP103 | 1.00 | Groundwater level remained constant after 20 minutes |
| DTS101 | 1.80 | Groundwater level remained constant after 15 minutes |
| DTS102 | - Dry - | No groundwater encountered to 2.0 m depth during drilling |
| DTS103 | 1.40 | Groundwater level remained constant after 15 minutes |
| DTS104 | - Dry - | No groundwater encountered to 2.0m depth during drilling |
| DTS105 | 1.80 | Groundwater level remained constant after 15 minutes |
| DTS106 | 1.60 | Groundwater level remained constant after 15 minutes |
| DTS107 | 1.75 | Groundwater level at 1.50m after 30 minutes |
| DTS108 | 1.70 | Groundwater level at 1.55m after 30 minutes |
| DTS109 | 1.70 | Groundwater level at 1.60m after 30 minutes |
| DTS110 | 1.75 | Groundwater level remained constant after 20 minutes |
| DTS111 | 1.70 | Groundwater level at 1.68m after 15 minutes |
| DTS112 | 1.79 | Groundwater level remained constant after 15 minutes |
| DTS113 | 1.80 | Groundwater level remained constant after 10 minutes |
| DTS114 | 2.50 | Groundwater level remained constant after 10 minutes |
| | Monitoring 04.11.15 | No groundwater encountered to 2.76m |
| | Monitoring 18.11.15 | No groundwater encountered to 2.71m |
| DTS115 | - Dry - | No groundwater encountered to 2.0m depth |
| BH-A | -Indeterminable- | Due to addition of water to aid drilling |
| BH-B | -Indeterminable- | Due to addition of water to aid drilling |
| | Monitoring 04.11.15 | 1.45m |
| | Monitoring 18.11.15 | 1.33m |
| BH-C | -Indeterminable- | Due to addition of water to aid drilling |
| BH-D | -Indeterminable- | Due to addition of water to aid drilling |
| | Monitoring 04.11.15 | 1.70m |
| | Monitoring 18.11.15 | 1.55m |
| BH-E | -Indeterminable- | Due to addition of water to aid drilling |
| | Monitoring 04.11.15 | 1.30m |
| | Monitoring 18.11.15 | 1.10m |

**Table 5.2.1**

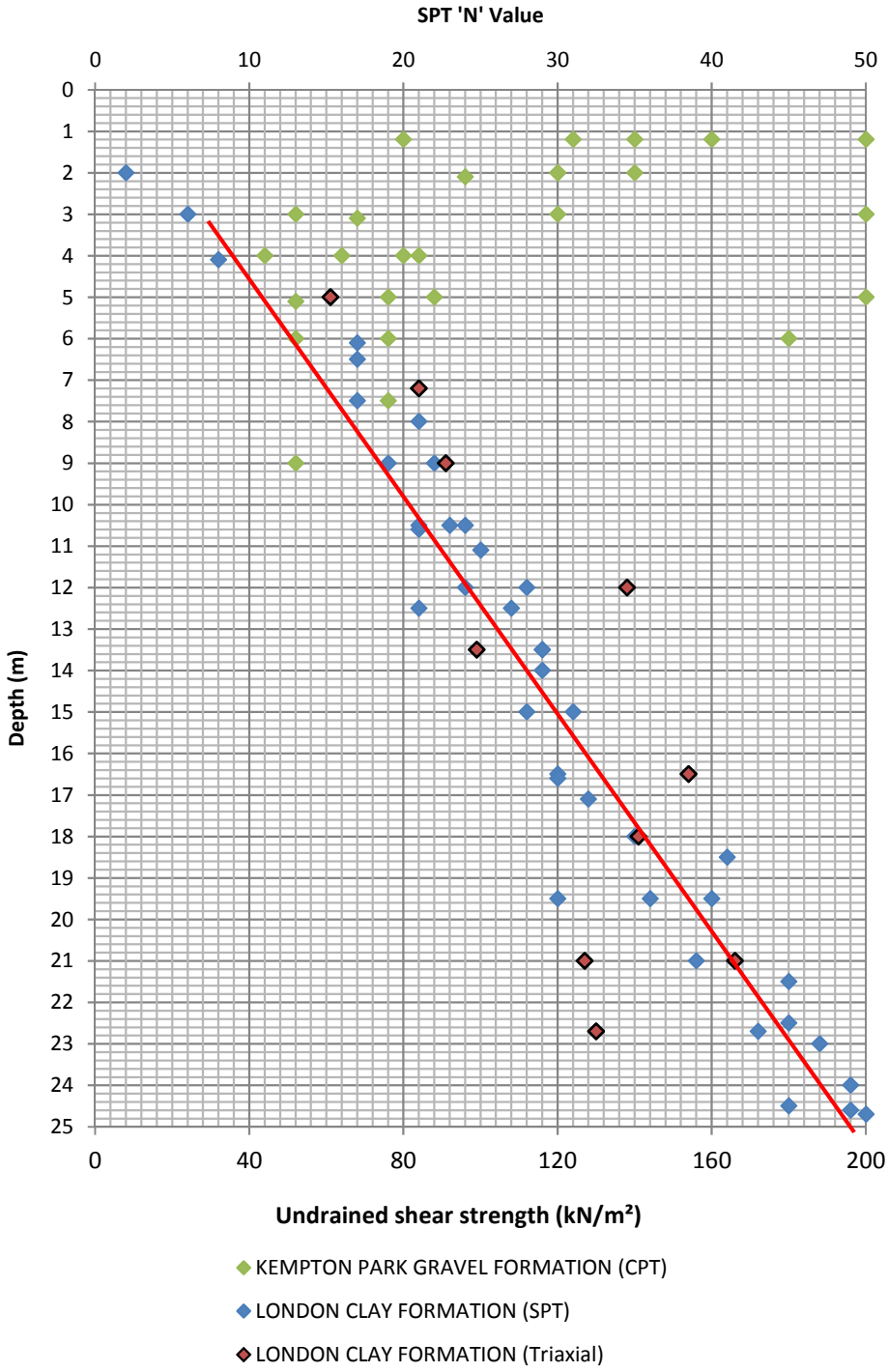
| Title | Scale | Drawing number |
|---|---|---|
| Section showing construction of gas monitoring standpipes installed in boreholes BHB, BHD, BHE and DTS114 | Not to scale | 06 |




Notes

1)SPT 'N' values calibrated against triaxial test data. Using this calibration SPT values need to be multiplied by a factor of 4 to derive an equivalent undrained shear strength

| Title | Scale | Drawing number |
|---|---|---|
| Plot summarising results of standard penetration test and triaxial results by location | As shown | 07a |




Approximate design line showing relationship of SPT value in london clay with depth

Notes

1)SPT 'N' values calibrated against triaxial test data. Using this calibration SPT values need to be multiplied by a factor of 4 to derive an equivalent undrained shear strength

| Title | Scale | Drawing number |
|---|---|---|
| Plot summarising results of standard penetration test and triaxial results by geology | As shown | 07b |

# Definition of geotechnical terms used in this report - foundations

***Strip foundations***.
A foundation providing a continuous longitudinal ground bearing.

***Trench fill concrete foundation***.
A trench filled with mass concrete providing continuous longitudinal ground bearing.

***Pad foundation***.
An isolated foundation to spread a concentrated load.

***Raft foundation***.
A foundation continuous in two directions, usually covering an area equal to or greater than the base area of the structure.

***Substructure***.
That part of any structure (including building, road, runway or earthwork) which is below natural or artificial ground level. In a bridge this includes piers and abutments (and wing walls), whether below ground level or not, which support the superstructure.

***Piled foundations and end bearing piles***. A pile driven or formed in the ground for transmitting the weight of a structure to the soil by the resistance developed at the pile point or base and the friction along its surface. If the pile supports the load mainly by the resistance developed at its point or base, it is referred to as an end-bearing pile; if mainly by friction along its surface, as a friction pile.

***Bored cast in place pile***.
A pile formed with or without a casing by excavating or boring a hole in the ground and subsequently filling it with plain or reinforced concrete.

***Driven pile***.
A pile driven into the ground by the blows of a hammer or a vibrator.

***Precast pile***.
A reinforced or prestressed concrete pile cast before driving.

***Driven cast in place pile***.
A pile installed by driving a permanent or temporary casing, and filling the hole so formed with plan or reinforced concrete.

***Displacement piles***.
Piled formed by displacement of the soil or ground through which they are driven.

***Skin friction***.
The frictional resistance of the surrounding soil on the surface of cofferdam or caisson walls, and pile shafts.

***Downdrag or negative skin friction***. A downwards frictional force applied to the shaft of a pile caused by the consolidation of compressible strata, e.g. under recently placed fill. Downdrag has the effect of adding load to the pile and reducing the factor of safety.

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## Definition of geotechnical terms used in this report – bearing values

***Ultimate bearing capacity.***
The value of the gross loading intensity for a particular foundation at which the resistance of the soil to displacement of the foundation is fully mobilised.

***Presumed bearing value.***
The net loading intensity considered appropriate to the particular type of ground for preliminary design purposes. The particular value is based on calculation from shear strength tests or other field tests incorporating a factor of safety against shear failure.

***Allowable bearing pressure.***
The maximum allowable net loading intensity at the base of the foundation, taking into account the ultimate bearing capacity, the amount and kind of settlement expected and our estimate of ability of the structure to accommodate this settlement.

***Factor of safety.***
The ratio of the ultimate bearing capacity to the intensity of the applied bearing pressure or the ratio of the ultimate load to the applied load.

## Definition of geotechnical terms used in this report – road pavements

The following definitions are based on Transport and Road Research Laboratory (TRRL) Report LR1132.

***Equilibrium CBR values.***
A prediction of the CBR value, which will be attained under the completed pavement.

***Thin pavement*.**
A thin pavement (which includes both bound and unbound pavement construction materials 1 in 300mm thick and a thick pavement is 1200mm thick (typical of motorway construction).

## Definition of geo-environmental terms used in this report

***Conceptual model***
Textual and/or schematic hypothesis of the nature and sources of contamination, potential migration pathways (including description of the ground and groundwater) and potential receptors, developed on the basis of the information obtained from the investigatory process.

***Contamination***
Presence of a substance which is in, on or under land, and which has the potential to cause harm or to cause pollution of controlled water.

***Controlled water***
Inland freshwater (any lake, pond or watercourse above the freshwater limit), water contained in underground strata and any coastal water between the limit of highest tide or the freshwater line to the three mile limit of territorial waters.

***Harm***
Adverse effect on the health of living organisms, or other interference with ecological systems of which they form part, and, in the case of humans, including property.

***Pathway***
Mechanism or route by which a contaminant comes into contact with, or otherwise affects, a receptor.

***Receptor***
Persons, living organisms, ecological systems, controlled waters, atmosphere, structures and utilities that could be adversely affected by the contaminant(s).

***Risk***
Probability of the occurrence of, and magnitude of the consequences of, an unwanted adverse effect on a receptor.

***Risk Assessment***
Process of establishing, to the extent possible, the existence, nature and significance of risk.

# Definition of environmental risk/hazard terms used in this report.

**Based on CIRIA report C552 '*Contaminated land risk assessment – A guide to good practice*'.**

**Potential hazard severity definition**

| Category | Definition |
|---|---|
| **Severe** | Acute risks to human health, catastrophic damage to buildings/property, major pollution of controlled waters |
| **Medium** | Chronic risk to human health, pollution of sensitive controlled waters, significant effects on sensitive ecosystems or species, significant damage to buildings or structures. |
| **Mild** | Pollution of non sensitive waters, minor damage to buildings or structures. |
| **Minor** | Requirement for protective equipment during site works to mitigate health effects, damage to non sensitive ecosystems or species. |

**Probability of risk definition**

| Category | Definition |
|---|---|
| **High likelihood** | Pollutant linkage may be present, and risk is almost certain to occur in long term, or there is evidence of harm to the receptor. |
| **Likely** | Pollutant linkage may be present, and it is probable that the risk will occur over the long term |
| **Low likelihood** | Pollutant linkage may be present, and there is a possibility of the risk occurring, although there is no certainty that it will do so. |
| **Unlikely** | Pollutant linkage may be present, but the circumstances under which harm would occur are improbable. |

**Level of risk for potential hazard definition**

| Probability of risk | Potential severity | | | |
|---|---|---|---|---|
| | Severe | Medium | Mild | Minor |
| **High Likelihood** | Very high | High | Moderate | Low/Moderate |
| **Likely** | High | Moderate | Low/Moderate | Low |
| **Low Likelihood** | Moderate | Low/Moderate | Low | Very low |
| **Unlikely** | Low/Moderate | Low | Very low | Very low |

Refer sheet 2 for definitions of 'very high' to 'low'

# Definition of environmental risk/hazard terms used in this report.

**Based on CIRIA report C552 '*Contaminated land risk assessment – A guide to good practice'.***

**Risk classifications and likely action required**:

***Very high risk***
High probability that severe harm could arise to a designated receptor from an identified hazard OR there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised is likely to result in substantial liability. Urgent investigation and remediation are likely to be required.

***High risk***
Harm is likely to arise to a designated receptor from an identified hazard. This risk, if realised, is likely to result in substantial liability. Urgent investigation is required and remedial works may be necessary in the short term and are likely over the long term.

***Moderate risk***
It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is likely that the harm would be relatively mild. Investigation is normally required to clarify risks and to determine potential liability. Some remedial works may be required in the long term.

***Low risk***
It is possible that harm could arise to a designated receptor from an identified hazard but it is likely that this harm, if realised, would at worst normally be mild.

***Very low risk***
It is a low possibility that harm could arise to a designated receptor. On the event of such harm being realised it is not likely to be severe.

## Gaseous contamination -
## Extract copy of table 3 of BS8485:2007 Solutions scores

| PROTECTION ELEMENT/SYSTEM | | SCORE | COMMENTS |
|---|---|---|---|
| **a) Venting/dilution (see Annex A of 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 of 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 layers 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.*<br>*Active ventilation can always be designed to meet good performance.*<br>*Mechanically assisted systems come in two main forms: extraction and positive pressurization* |
| Ventilated car park (basement or undercroft) | | 4 | *Assume car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F and IStructE guidance.* |
| **b) Barriers** | | | |
| **Floor Slabs** | | | *It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum.* |
| Block and beam floor slab | | 0 | |
| Reinforced concrete ground bearing floor slab | | 0.5 | |
| Reinforced concrete ground bearing foundation raft with limited service penetrations that are cast into slab | | 1.5 | *Breaches in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances.* |
| Reinforced concrete cast in situ suspended 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 and design of the installation, resistance to damage after installations, and the integrity of joints.* |
| Proprietary gas resistant membrane to reasonable levels of workmanship/in line with current 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 system 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 of 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 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 > 1 200g can be used to improve confidence in the barrier. Remember that their gas resistance is little more than the standard 1 200g (proportional to thickness) but their physical properties mean that they are more robust and resistant to site damage.

## List of documents used in assessment of chemical contamination

| No. | Title | Publication reference / publisher |
|---|---|---|
| 1 | Human health toxicological assessment of contaminants in soil | EA Science Report – SC050021/SR2 |
| 2 | Updated technical background to the CLEA model | EA Science Report – SC050021/SR3 |
| 3 | CLEA Software (Version 1.03 beta) Handbook | EA Science Report - SC050021/SR4 |
| 4 | Guidance on comparing Soil Contamination Data with a Critical Concentration | CIEH |
| 5 | Generic Assessment Criteria for Human Health Risk Assessment | LQM/CIEH |
| 6 | Assessment of Risks to Human Health from Land Contamination: An overview of the development of soil guideline values and related research | R&D Publication, Contaminated Land Report CLR 7 |
| 7 | Contaminants of Soil: Collation of Toxicological Data and Intake Values for Humans | R&D Publication, Contaminated Land Report CLR 9 |
| 8 | The Contaminated Land Exposure Assessment Model (CLEA): Technical Basis and Algorithms | R&D Publication, Contaminated Land Report CLR 10 |
| 9 | Model Procedures for the Management of Land Contamination | R&D Publication, Contaminated Land Report CLR 11 |
| 10 | Contaminants in Soil: Collection of Toxicological Data and Intake Values for Human Values | R&D Publications, Tox. 6 |
| 11 | Soil Guideline Values for Contamination (2002) | R&D Publications, SGV 10 |
| 12 | Soil Guideline Values (2009) | EA Science Reports – SC050021 |

CIEH Chartered institute of Environmental Health
LQM Land Quality Management
EA Environment Agency

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## Key to legends

### Composite materials, soils and lithology

| | | |
|---|---|---|
| Topsoil | Made Ground | Boulders |
| Chalk | Clay | Coal |
| Cobbles | Cobbles & Boulders | Concrete |
| Gravel | Limestone | Mudstone |
| Peat | Sand | Sand and Gravel |
| Sandstone | Silt | Silt / Clay |
| | | Siltstone |

*Note: Composite soil types are signified by combined symbols.*

## Key to 'test results' and 'sampling' columns

| Test result | |
|---|---|
| Depth | Records depth that the test was carried out (i.e.: at 2.10m or between 2.10m and 2.55m) |
| Result | PID - Photo Ionisation Detector result (ppm equivalent Isobutylene)<br><br>PP – Pocket penetrometer result ($kN/m^2$)<br>HVP – Hand held shear vane result ($kN/m^2$)<br><br>*PP result converted to an equivalent undrained shear strength by applying a factor of 50. Where at least 3 results obtained at same depth then an average value may be reported.* |

| Sampling | | |
|---|---|---|
| From (m)<br>To (m) | Records depth of sampling | |
| Type | D | Disturbed sample |
| | B | Bulk disturbed sample |
| | ES | Environmental sample comprising plastic and/or glass container |
| | W | Water sample |
| | CBR | Undisturbed sample in mould (California Bearing Ratio) |

## Water observations

Described at foot of log and shown in the 'water strike' column.

▼ = water level observed after specified delay in excavation

▽ = water strike

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| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick.<br>MADE GROUND (TYPE A) | | | | | | 0.30 | | D |
| TRIAL PIT TERMINATED AT 0.50m | | 0.50 | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.40m x 0.40m

**Date of excavation (range if applicable)**
08/10/2015

**Appendix**
C

**Method of excavation**
Hand tools

**Location plan on drawing number**
02

**HP01**

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| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 30mm in diameter. Gravel consists of sub-angular to angular quartzite and brick.<br>MADE GROUND (TYPE A) | | | | | | 0.40 | | D |
| TRIAL PIT TERMINATED AT 0.60m | | 0.60 | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.40m x 0.40m

**Date of excavation (range if applicable)**
08/10/2015

**Appendix**
C

**Method of excavation**
Hand tools

**Location plan on drawing number**
02

**HP02**

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| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 35mm in diameter. Gravel consists of sub-angular to angular quartzite, brick and glass. MADE GROUND (TYPE A) | | | | | | 0.20 | | ES |
| | | 0.30 | | | | | | |
| Medium dense to dense orange brown slightly sandy silty gravelly desiccated CLAY with many roots up to 20mm in diameter and rootlets. Gravel consists of sub-angular to sub-rounded sandstone and quartzite. KEMPTON PARK GRAVEL MEMBER | | | | | | | | |
| *...from 0.7m depth, gravels of flint present.* | | | | | | | | |
| | | 1.10 | | | | | | |
| Medium dense to dense orange brown clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-rounded flint and quartzite. KEMPTON PARK GRAVEL MEMBER | | | | | | 1.30 | | B |
| | | 1.40 | | | | | | |
| TRIAL PIT TERMINATED AT 1.40m | | | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion. Infiltration testing performed.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.60m x 2.30m

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
F

**Method of excavation**
Tracked mini digger

**Location plan on drawing number**
02

**TP101**

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| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick. MADE GROUND (TYPE A) | | | | | | 0.20 | | D |
| | | 0.50 | | | | | | |
| CLAY DRAINAGE PIPE. MADE GROUND | | 0.55 | | | | | | |
| TRIAL PIT TERMINATED AT 0.55m | | | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion. Trial pit terminated due to obstruction (clay pipe) traversing across trial pit.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.60m x 2.00m

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
C

**Method of excavation**
Tracked mini digger

**Location plan on drawing number**
02

**TP102**

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| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick. MADE GROUND (TYPE A) | | | | | | 0.20 | | ES |
| | | 0.40 | | | | | | |
| Medium dense to dense orange brown slightly sandy silty gravelly desiccated CLAY with many roots up to 20mm in diameter and rootlets. Gravel consists of sub-angular to sub-rounded sandstone and quartzite. KEMPTON PARK GRAVEL MEMBER | | | | | | 0.60 | | D |
| *...from 0.7m depth, gravels of sub-angular to angular flint present.* | | | | | | | | |
| | | 1.00 | | | | | | |
| Medium dense to dense orange brown clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-rounded flint and quartzite. KEMPTON PARK GRAVEL MEMBER | | | | | | 1.30 | | B |
| | | 1.45 | | | | | | |
| TRIAL PIT TERMINATED AT 1.45m | | | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion. Infiltration testing performed.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.60m x 2.45m

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
F

**Method of excavation**
Tracked mini digger

**Location plan on drawing number**
02

**TP102A**

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| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS TYPE/ DEPTH (m) | TEST RESULTS RESULT | SAMPLING FROM (m) | SAMPLING TO (m) | SAMPLING TYPE |
|---|---|---|---|---|---|---|---|---|
| Grass onto medium strength dark brown very sandy gravelly CLAY with occasional whole bricks (south side of trial pit), many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick. | | | | PP 0.20 | 38 | 0.20 | | ES |
| MADE GROUND (TYPE C) | | 0.30 | | | | | | |
| Firm medium strength grey brown mottled orange brown slightly gravelly very silty CLAY. Gravel consists of sub-angular to angular flint and whole bricks. MADE GROUND (TYPE C) | | | | PP 0.40 | 50 | | | |
| | | | | PP 0.60 | 63 | 0.60 | | D |
| | | | | PP 0.80 | 67 | | | |
| Medium dense to dense orange brown clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-rounded flint and quartzite. Whole brick in south of pit, potential former soak away chamber; no cover observed at surface. | | 0.90 | ▼ | | | 1.00 | | B |
| MADE GROUND (TYPE C) | | 1.20 | | | | | | |
| TRIAL PIT TERMINATED AT 1.20m | | | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
Inflow of water observed at 1m. Water level remained constant after 20 minutes.

**Dimensions (W x L)**
0.60m x 1.70m

**Date of excavation (range if applicable)**
08/10/2015

**Appendix**
C

**Method of excavation**
Tracked mini digger

**Location plan on drawing number**
02

**TP103**

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| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium strength dark brown very sandy gravelly CLAY with occasional whole bricks, many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick. MADE GROUND (TYPE C) | | | | PP 0.20 | 50 | 0.30 | | D |
| *...at 0.35m depth, pea gravel in north side of trial pit present.* | | 0.40 | | | | | | |
| Firm medium strength grey brown mottled orange brown slightly gravelly very silty CLAY with occasional whole and half bricks (south side of trial pit). Gravel consists of sub-angular to angular flint. Potential ACM encountered at 0.6m depth. MADE GROUND (TYPE C) | | | | PP 0.60 | 63 | 0.60 | | D |
| | | | | PP 0.80 | 79 | | | |
| TRIAL PIT TERMINATED AT 0.90m | | 0.90 | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion. Trial pit terminated due to service encountered in north side of trial pit and brick construction/potential ACM in south side of trial pit.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.60m x 1.90m

**Date of excavation (range if applicable)**
08/10/2015

**Appendix**
C

**Method of excavation**
Tracked mini digger

**Location plan on drawing number**
02

**TP103A**

soiltechnics
environmental and geotechnical consultants

| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick.<br>MADE GROUND (TYPE A) | | | | | | 0.20 | | ES |
| Medium dense to dense orange brown slightly sandy silty gravelly desiccated CLAY with many roots up to 20mm in diameter and rootlets. Gravel consists of sub-angular to sub-rounded sandstone and quartzite.<br>KEMPTON PARK GRAVEL MEMBER | | 0.35 | | | | | | |
| | | | | | | 0.80 | | D |
| *...from 0.9m depth, becoming very gravelly.* | | | | | | | | |
| TRIAL PIT TERMINATED AT 1.06m | | 1.06 | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion. Infiltration testing performed.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.60m x 1.80m

**Date of excavation (range if applicable)**
08/10/2015

**Appendix**
F

**Method of excavation**
Tracked mini digger

**Location plan on drawing number**
02

**TP104**

soiltechnics
environmental and geotechnical consultants

| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium dense very dark brown very clayey gravelly SAND with occasional whole bricks, many rootlets and occasional roots up to 45mm in diameter. Gravel consists of sub-angular to angular quartzite and brick. MADE GROUND (TYPE C) | | | | | | 0.20 | | ES |
| *...from 0.25m depth, crushed concrete present.* | | | | | | | | |
| | | 0.60 | | | | | | |
| Orange brown slightly gravelly sandy desiccated CLAY. Gravel consists of sub-angular to angular mudstone and occasional flint. KEMPTON PARK GRAVEL MEMBER | | | | | | 0.80 | | B |
| *...from 1.3m depth, becoming very gravelly.* | | | | | | | | |
| | | 1.40 | | | | | | |
| Medium dense to dense orange brown clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-rounded flint and quartzite. KEMPTON PARK GRAVEL MEMBER | | | | | | | | |
| TRIAL PIT TERMINATED AT 1.95m | | 1.95 | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion. Infiltration testing performed.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.60m x 2.60m

**Date of excavation (range if applicable)**
08/10/2015

**Appendix**
F

**Method of excavation**
Tracked mini digger

**Location plan on drawing number**
02

**TP105**

soiltechnics
environmental and geotechnical consultants

| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick.<br>MADE GROUND (TYPE A) | | | | | | | | |
| Stiff high strength grey brown mottled orange brown slightly gravelly very silty CLAY with occasional rootlets to 0.8m depth. Gravel consists of sub-angular to angular flint.<br>KEMPTON PARK GRAVEL MEMBER | | 0.35 | | | | 0.80 | | D |
| TRIAL PIT TERMINATED AT 1.00m | | 1.00 | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion. Infiltration testing performed.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.40m x 0.40m

**Date of excavation (range if applicable)**
09/10/2015

**Appendix**
F

**Method of excavation**
Hand tools

**Location plan on drawing number**
02

**TP107**

soiltechnics
environmental and geotechnical consultants

| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto dark brown slightly clayey gravelly SAND. Gravel consists of sub-angular to sub-rounded flint.<br>MADE GROUND (TYPE A) | | | | | | | | |
| | | 0.30 | | | | | | |
| Medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick.<br>MADE GROUND (TYPE A) | | | | | | 0.50 | | D |
| | | 0.70 | | | | | | |
| Medium dense to dense brown very clayey SAND and GRAVEL with occasional cobbles of sub-rounded to rounded flint. Sand is medium. Gravel consists of sub-angular to sub-rounded flint and rounded quartzite.<br>KEMPTON PARK GRAVEL MEMBER | | | | | | 1.00 | | B |
| | | 1.20 | | | | | | |
| TRIAL PIT TERMINATED AT 1.20m | | | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion. Infiltration testing performed.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.60m x 1.90m

**Date of excavation (range if applicable)**
09/10/2015

**Appendix**
F

**Method of excavation**
Tracked mini digger

**Location plan on drawing number**
02

**TP108**

soiltechnics
environmental and geotechnical consultants

| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick.<br>MADE GROUND (TYPE A) | | | | | | 0.30 | | ES |
| | | 0.40 | | | | | | |
| Stiff high strength grey brown mottled orange brown slightly gravelly very silty CLAY with occasional rootlets to 0.8m depth. Gravel consists of sub-angular to angular flint.<br>KEMPTON PARK GRAVEL MEMBER | | | | PP 0.50 | 88 | | | |
| | | | | PP 0.70 | 83 | | | |
| | | | | | | 0.80 | | B |
| | | | | PP 0.90 | 117 | | | |
| *...from 1m depth, becoming very stiff.* | | | | | | | | |
| | | | | PP 1.10 | 138 | | | |
| | | | | | | 1.20 | | B |
| Medium dense to dense orange brown clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-rounded flint and quartzite.<br>KEMPTON PARK GRAVEL MEMBER | | 1.30 | | | | | | |
| TRIAL PIT TERMINATED AT 1.60m | | 1.60 | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion. Infiltration testing performed.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.60m x 2.20m

**Date of excavation (range if applicable)**
09/10/2015

**Appendix**
F

**Method of excavation**
Tracked mini digger

**Location plan on drawing number**
02

**TP109**

soiltechnics
environmental and geotechnical consultants

| DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|
| | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| Grass onto medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick. MADE GROUND (TYPE A) | | | | | | 0.10 | | B |
| | | 0.40 | | | | | | |
| Medium dense dark brown very clayey gravelly SAND with occasional whole bricks, ACM and concrete boulders, many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick. MADE GROUND (TYPE C) | | | | | | 0.60 | | B |
| TRIAL PIT TERMINATED AT 0.80m | | 0.80 | | | | | | |

**Notes:** Trial pit sides remained upright and stable upon completion. Trial pit undertaken by others to obtain shallow soil sample.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Trial pit record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

**Dimensions (W x L)**
0.60m x 2.00m

**Date of excavation (range if applicable)**
08/10/2015

**Appendix**
C

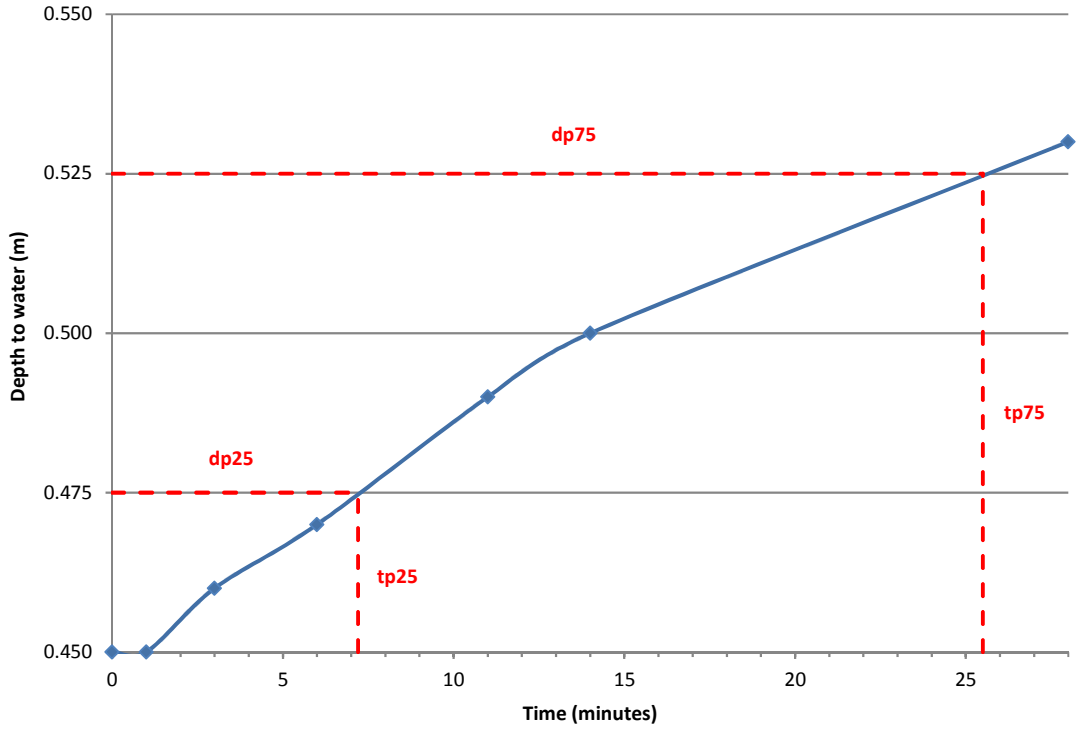
**Method of excavation**
Tracked mini digger

**Location plan on drawing number**
02

**TP201**

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.45 | | |
| 1 | 0.45 | | |
| 3 | 0.46 | | |
| 6 | 0.47 | | |
| 11 | 0.49 | | |
| 14 | 0.5 | | |
| 28 | 0.53 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.06m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.46m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***18.3 (minutes)***
= ***1098 (seconds)***

***f* = 3.74E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.55

Co-ordinates
-

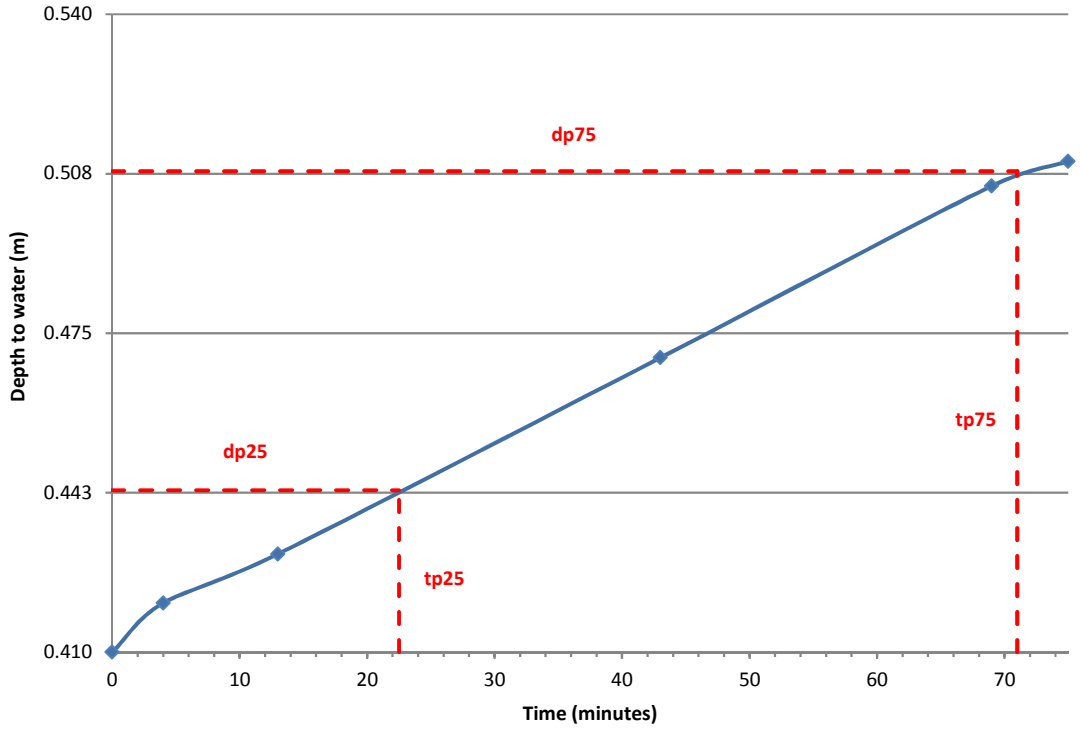
Trial pit number
TP301

Cycle number
1

Date of excavation
25/11/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.41 | | |
| 4 | 0.42 | | |
| 13 | 0.43 | | |
| 43 | 0.47 | | |
| 69 | 0.505 | | |
| 75 | 0.51 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.078m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.538m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***48.5 (minutes)***
= ***2910 (seconds)***

**$f$ = 1.74E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.54

Co-ordinates
-

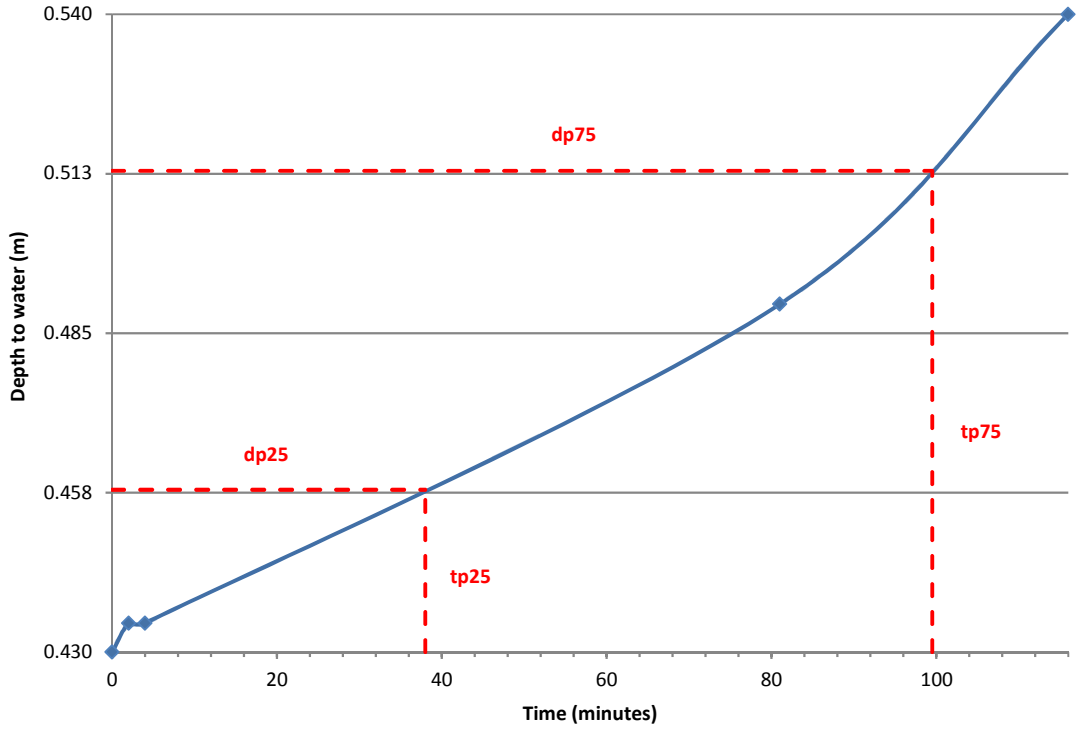
Trial pit number
TP301

Cycle number
2

Date of excavation
25/11/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.43 | | |
| 2 | 0.435 | | |
| 4 | 0.435 | | |
| 81 | 0.49 | | |
| 116 | 0.54 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.066m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.486m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***61.5 (minutes)***
= ***3690 (seconds)***

**$f$ = 1.20E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.54

Co-ordinates
-

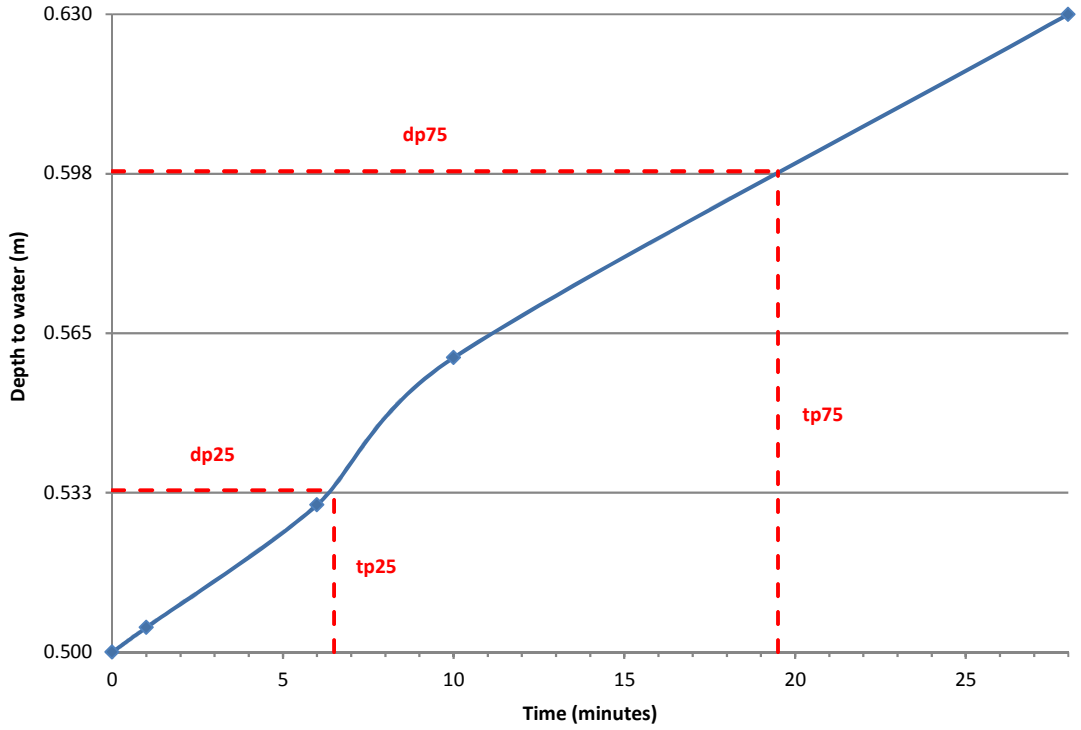
Trial pit number
TP301

Cycle number
3

Date of excavation
25/11/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.5 | | |
| 1 | 0.505 | | |
| 6 | 0.53 | | |
| 10 | 0.56 | | |
| 28 | 0.63 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.078m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.538m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***13 (minutes)***
= ***780 (seconds)***

**$f$ = 6.50E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.63

Co-ordinates
-

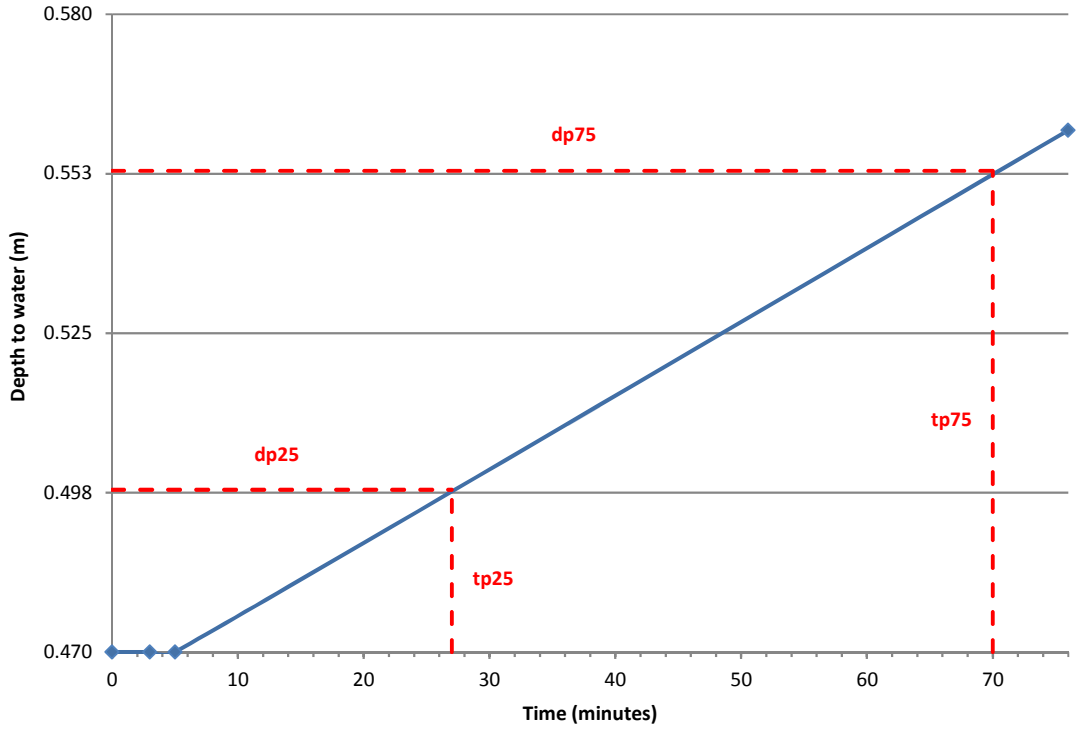
Trial pit number
TP302

Cycle number
1

Date of excavation
25/11/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.47 | | |
| 3 | 0.47 | | |
| 5 | 0.47 | | |
| 76 | 0.56 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.066m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.486m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***43 (minutes)***
= ***2580 (seconds)***

**$f$ = 1.72E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.58

Co-ordinates
-

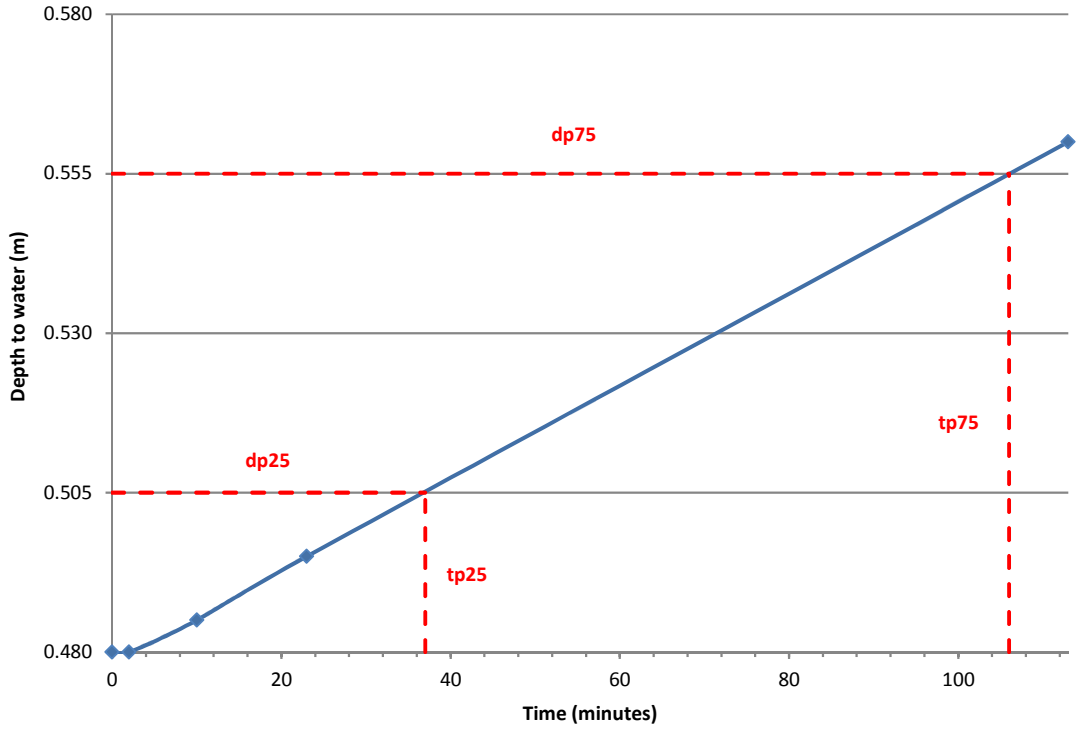
Trial pit number
TP302

Cycle number
2

Date of excavation
25/11/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.48 | | |
| 2 | 0.48 | | |
| 10 | 0.485 | | |
| 23 | 0.495 | | |
| 113 | 0.56 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.06m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.46m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***69 (minutes)***
= ***4140 (seconds)***

**$f$ = 9.93E-06 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

| Trial pit dimensions (width x length) | Ground level | Location plan on drawing number |
|---|---|---|
| 0.6m x 2m | N/A | 02 |

| Depth of trial pit at start of test (m) | Co-ordinates | Trial pit number | Cycle number | Date of excavation |
|---|---|---|---|---|
| 0.58 | - | TP302 | 3 | 25/11/2015 |

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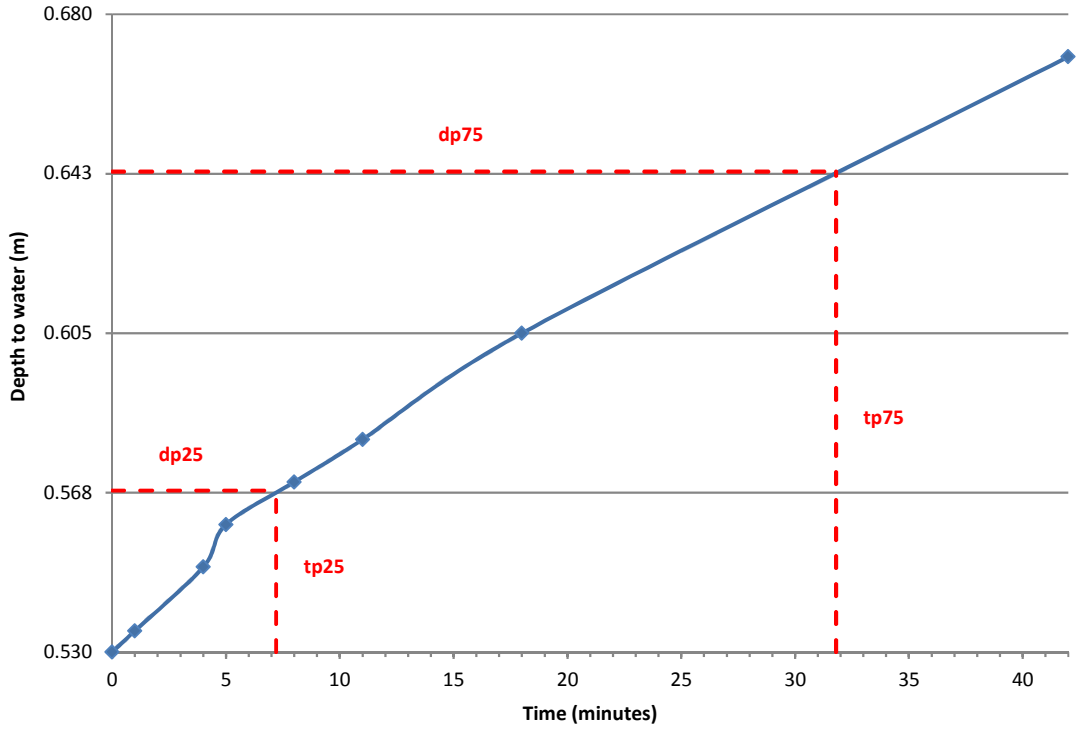
## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.53 | | |
| 1 | 0.535 | | |
| 4 | 0.55 | | |
| 5 | 0.56 | | |
| 8 | 0.57 | | |
| 11 | 0.58 | | |
| 18 | 0.605 | | |
| 42 | 0.67 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.09m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.59m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***24.6 (minutes)***
= ***1476 (seconds)***

**$f$ = 3.83E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.68

Co-ordinates
-

Trial pit number
TP303

Cycle number
1

Date of excavation
25/11/2015

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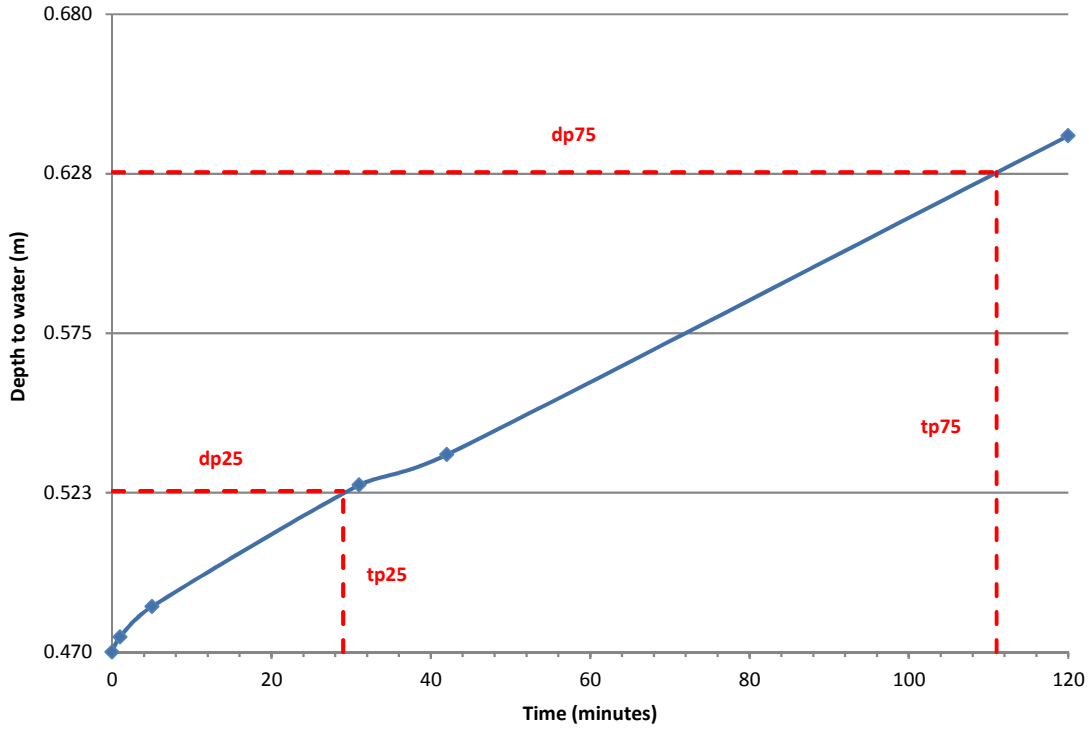
## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.47 | | |
| 1 | 0.475 | | |
| 5 | 0.485 | | |
| 31 | 0.525 | | |
| 42 | 0.535 | | |
| 120 | 0.64 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.126m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.746m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***82 (minutes)***
= ***4920 (seconds)***

***f* = 1.47E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.68

Co-ordinates
-

Trial pit number
TP303

Cycle number
2

Date of excavation
25/11/2015

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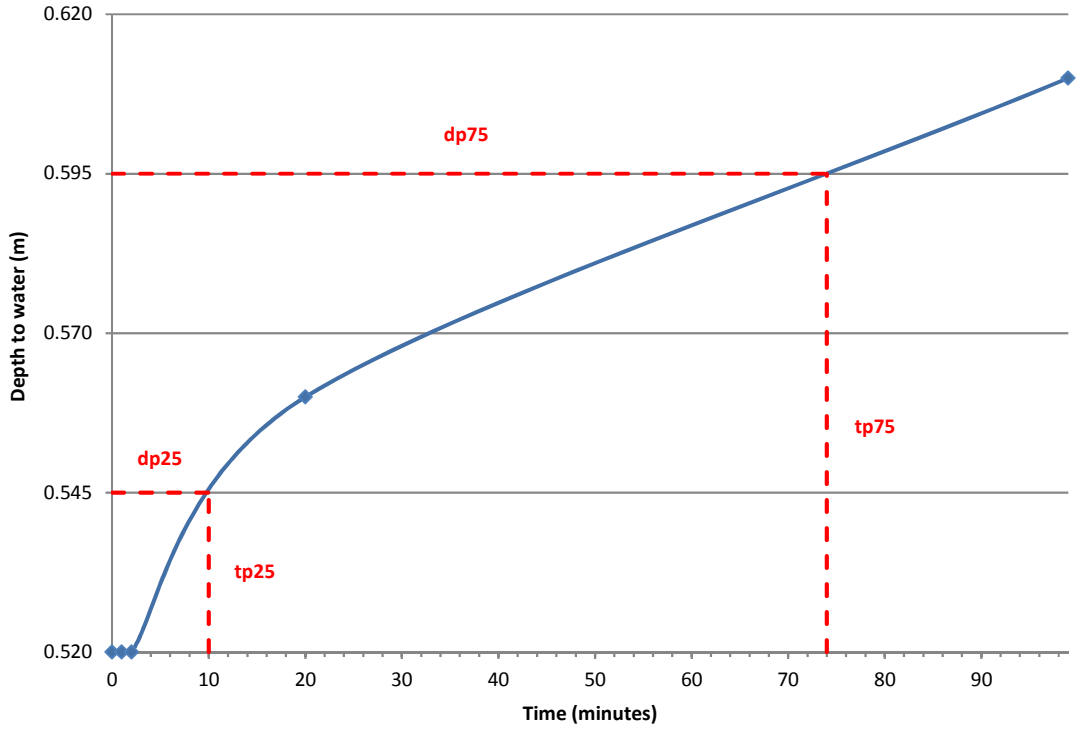
## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.52 | | |
| 1 | 0.52 | | |
| 2 | 0.52 | | |
| 20 | 0.56 | | |
| 99 | 0.61 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.06m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.46m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***64 (minutes)***
= ***3840 (seconds)***

**$f$ = 1.07E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.62

Co-ordinates
-

Trial pit number
TP303

Cycle number
3

Date of excavation
25/11/2015

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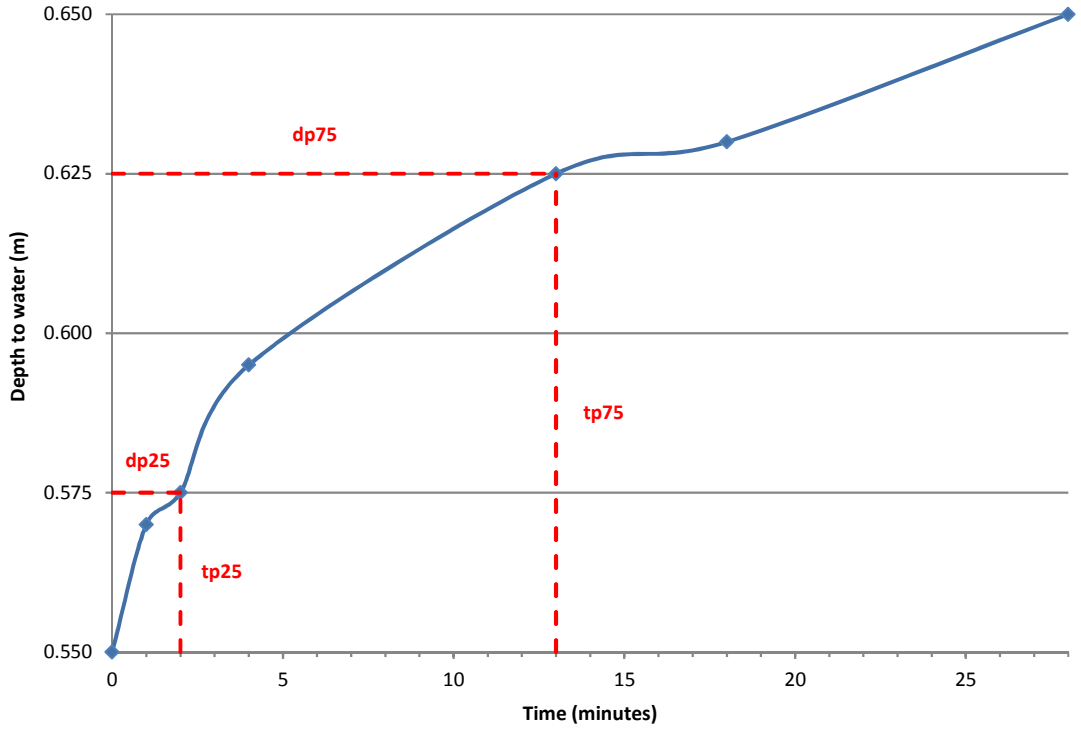
## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.55 | | |
| 1 | 0.57 | | |
| 2 | 0.575 | | |
| 4 | 0.595 | | |
| 13 | 0.625 | | |
| 18 | 0.63 | | |
| 28 | 0.65 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.06m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.46m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***11 (minutes)***
= ***660 (seconds)***

**$f$ = 6.23E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.65

Co-ordinates
-

Trial pit number
TP305

Cycle number
1

Date of excavation
25/11/2015

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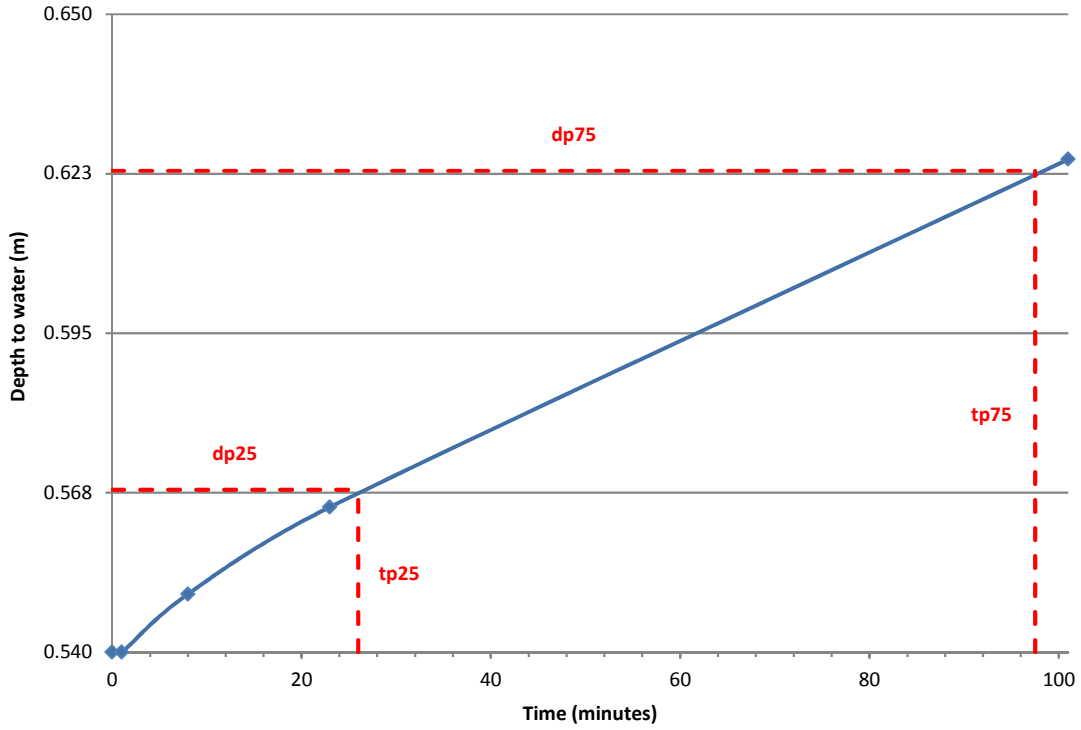
## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.54 | | |
| 1 | 0.54 | | |
| 8 | 0.55 | | |
| 23 | 0.565 | | |
| 101 | 0.625 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.066m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.486m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***71.5 (minutes)***
= ***4290 (seconds)***

***f* = 1.04E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.65

Co-ordinates
-

Trial pit number
TP305

Cycle number
2

Date of excavation
25/11/2015

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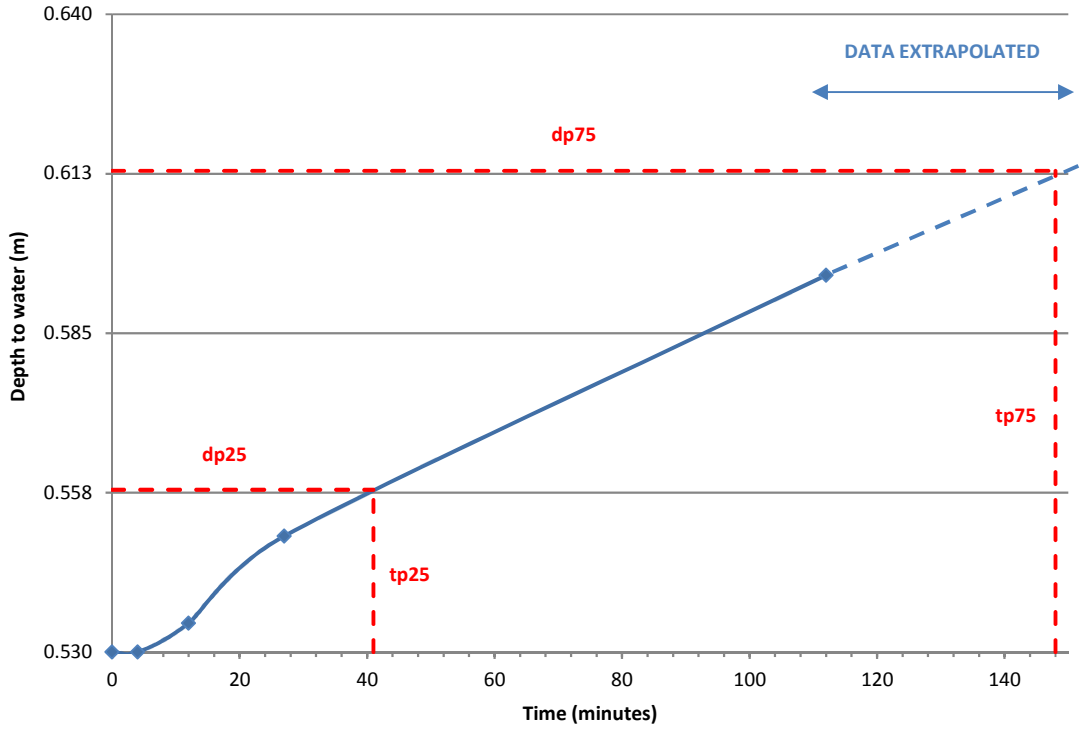
## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.53 | | |
| 4 | 0.53 | | |
| 12 | 0.535 | | |
| 27 | 0.55 | | |
| 112 | 0.595 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.066m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.486m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***107 (minutes)***
= ***6420 (seconds)***

**$f$ = 6.92E-06 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.64

Co-ordinates
-

Trial pit number
TP305

Cycle number
3

Date of excavation
25/11/2015

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## Key to legends

### Composite materials, soils and lithology

| | | |
|---|---|---|
| Topsoil | Made Ground | Boulders |
| Chalk | Clay | Coal |
| Cobbles | Cobbles & Boulders | Concrete |
| Gravel | Limestone | Mudstone |
| Peat | Sand | Sand and Gravel |
| Sandstone | Silt | Silt / Clay |
| | | Siltstone |

*Note: Composite soil types are signified by combined symbols.*

## Key to 'test results' and 'sampling' columns

| Test result | |
|---|---|
| Depth | Records depth that the test was carried out *(i.e.: at 2.10m or between 2.10m and 2.55m)* |
| Result | PID - Photo Ionisation Detector result (ppm equivalent Isobutylene)<br>PP – Pocket penetrometer result ($kN/m^2$)<br>HVP – Hand held shear vane result ($kN/m^2$)<br>*PP result converted to an equivalent undrained shear strength by applying a factor of 50. Where at least 3 results obtained at same depth then an average value may be reported.* |
| | *SPT – Standard Penetration Test result (uncorrected)*[1,2,3]<br>*SPT(c) – Standard Penetration Test result (solid cone) (uncorrected)*[1,2,3] |

| Sampling | | |
|---|---|---|
| From (m)<br>To (m) | Records depth of sampling | |
| Type | D | Disturbed sample |
| | B | Bulk disturbed sample |
| | ES | Environmental sample comprising plastic and/or glass container |
| | W | Water sample |
| | U (32) | Undisturbed sample 100mm diameter sampler with number of blows of driving equipment required to obtain sample |

*Note [1]: Seating blows recorded in brackets.*
*Note [2]: Casing depth records depth of casing when SPT or SPT(c) was carried out.*
*Note [3]: Water depth records depth of water when SPT or SPT(c) was carried out.*

## Water observations

Described at foot of log and shown in the 'water strike' column.

▼ = water level observed after specified delay in drilling

▽ = water strike

## Standpipe details

Gravel filter

Arisings

Bentonite

Slotted pipe

Unslotted pipe

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | Dark brown very clayey gravelly SAND with many rootlets. Gravel consists of quartzite. | | | | | | | | 0.20 | | D |
| | MADE GROUND (TYPE A) | | 0.40 | | | | | | 0.40 | 0.90 | B |
| | Dark brown slightly clayey slightly gravelly silty fine to medium SAND with frequent rootlets. Gravel consists of clinker, quartz, brick, chalk and flint. | | | | | | | | 0.40 | | D |
| | MADE GROUND (TYPE A) | | 0.90 | | SPT (c) 1.20-1.65 | (8) 31 | | DRY | 1.20 | 1.50 | B |
| | Dense orange brown clayey medium SAND and GRAVEL. Gravel consists of sub-angular flint and sub-rounded quartz. | | 1.50 | | | | | | | | |
| | KEMPTON PARK GRAVEL MEMBER | | | | SPT (c) 2.00-2.45 | (6) 30 | 2.00 | 1.8 | 2.00 | 2.50 | B |
| | Dense becoming medium dense orange brown very gravelly medium to coarse SAND. Gravel consists of flint and quartz. | | | | | | | | | | |
| | KEMPTON PARK GRAVEL MEMBER | | | | SPT (c) 3.00-3.45 | (23) 30 | 3.00 | 2.8 | 3.00 | 3.50 | B |
| | | | | | SPT (c) 4.00-4.45 | (5) 21 | 4.00 | 3.5 | 4.00 | 4.50 | B |
| | | | | | SPT (c) 5.00-5.45 | (6) 22 | 5.00 | 4 | 5.00 | 5.50 | B |
| | | | | | SPT (c) 6.00-6.45 | (3) 13 | 6.00 | 4 | 6.00 | 6.30 | B |
| | Stiff [high strength] dark grey brown silty sandy CLAY. | | 6.40 | | | | | | | | |
| | LONDON CLAY FORMATION | | | | | | | | 7.00 | | D |
| | Very stiff [high strength] dark grey brown slightly silty CLAY. | | 7.00 | | | | | | | | |
| | LONDON CLAY FORMATION | | | | SPT 7.50-7.95 | (5) 17 | 7.50 | DAMP | 7.50 | | D |
| | | | | | | | | | 8.50 | | D |
| | | | | | | | | | 9.00 | 9.45 | U |
| | | | | | | | | | 9.45 | | D |
| | CONTINUED ON NEXT SHEET | | | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.5m and 3.5m depth. Inspection pit excavated from 0.0m to 1.2m depth. Brackets indicate inferred strength.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
09/10/2015 - 13/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHA**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | | | | | | | | | 10.00 | | D |
| | ...from 10.5m depth, shell and fossil fragments present. | | | | SPT 10.50-10.95 | (5) 23 | 7.00 | DRY | 10.50 | | D |
| | | | | | | | | | 11.50 | | D |
| | | | | | | | | | 12.00 | 12.45 | U |
| | | | | | | | | | 12.45 | | D |
| | | | | | | | | | 13.00 | | D |
| | | | | | SPT 13.50-13.95 | (7) 29 | 7.00 | DRY | 13.50 | | D |
| | | | | | | | | | 14.50 | | D |
| | | | | | SPT 15.00-15.45 | (8) 31 | 7.00 | DRY | 15.00 | | D |
| | | | | | | | | | 16.00 | | D |
| | | | | | | | | | 16.45 | 16.95 | D |
| | | | | | | | | | 16.50 | | U |
| | | | | | | | | | 17.50 | | D |
| | | | | | SPT 18.00-18.45 | (10) 35 | 7.00 | DRY | 18.00 | | D |
| | | | | | | | | | 19.00 | | D |
| | | | | | SPT 19.50-19.95 | (11) 40 | 7.00 | DRY | 19.50 | | D |
| | CONTINUED ON NEXT SHEET | | | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.5m and 3.5m depth. Inspection pit excavated from 0.0m to 1.2m depth. Brackets indicate inferred strength.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
09/10/2015 - 13/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHA**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | | | | | | | | | 20.50 | | D |
| | | | | | | | | | 21.00 | 21.45 | U |
| | | | | | | | | | 21.45 | | D |
| | | | | | | | | | 22.20 | | D |
| | | | | | SPT 22.70-23.15 | (13) 43 | 7.00 | DRY | 22.70 | | D |
| | | | | | | | | | 23.70 | | D |
| | | | | | | | | | 24.50 | | D |
| | | | | | SPT 24.70-25.15 | (13) 50 | 7.00 | DRY | | | |
| | BOREHOLE TERMINATED AT 25.00m | | 25.00 | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.5m and 3.5m depth. Inspection pit excavated from 0.0m to 1.2m depth. Brackets indicate inferred strength.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
09/10/2015 - 13/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHA**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | Dark brown very clayey gravelly SAND with many rootlets. Gravel consists of quartzite. MADE GROUND (TYPE A) | | 0.25 | | | | | | 0.20 | | D |
| | | | | | | | | | 0.40 | 0.80 | B |
| | Dark brown slightly clayey slightly gravelly silty fine to medium SAND with frequent rootlets. Gravel consists of clinker, quartz, brick, chalk, flint and sandstone. MADE GROUND (TYPE A) | | 1.20 | | SPT (c) 1.20-1.62 | (7) 50 blows for 265mm penetration | | DRY | 1.10 | 1.60 | D |
| | *...from 0.4m depth, becoming brown.* | | | | | | | | 1.20 | | B |
| | Very dense to medium dense orange brown medium to coarse SAND and GRAVEL. Gravel consists of sub-angular flint and quartz. KEMPTON PARK GRAVEL MEMBER | | | | SPT (c) 2.10-2.55 | (6) 24 | 2.10 | 1.6 | 2.10 | 2.50 | B |
| | | | | | SPT (c) 3.00-3.45 | (14) 13 | 3.00 | 2.8 | 3.00 | 3.50 | B |
| | Medium dense grey gravelly medium SAND. Gravel consists of sub-angular to angular flint and sub-rounded to rounded quartzite. KEMPTON PARK GRAVEL MEMBER | | 3.20 | | | | | | | | |
| | *...drillers observed thin clay bands from 3.2m depth.* | | | | SPT (c) 4.00-4.45 | (6) 11 | 4.00 | 3 | 4.00 | 4.50 | B |
| | | | | | SPT (c) 5.00-5.45 | (7) 19 | 5.00 | 3 | 5.00 | 5.50 | B |
| | Medium dense to dense orange brown medium to coarse SAND and GRAVEL. Gravel consists of sub-angular flint and quartz. KEMPTON PARK GRAVEL MEMBER | | 5.80 | | SPT (c) 6.00-6.45 | (13) 45 | 6.00 | 3 | 6.00 | 6.50 | B |
| | | | | | SPT (c) 7.50-7.95 | (5) 19 | 7.50 | 3 | 7.50 | 8.00 | B |
| | Medium dense becoming dense orange brown very gravelly medium to coarse SAND. Gravel consists of flint and quartz. KEMPTON PARK GRAVEL MEMBER | | 9.00 | | SPT (c) 9.00-9.45 | (4) 13 | 9.00 | 3 | 9.00 | 9.50 | B |
| | CONTINUED ON NEXT SHEET | | | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.5m and 4.5m depth. Standpipe installed to 4m depth. Inspection pit excavated from 0.0m to 1.2m depth. Brackets indicate inferred strength.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
07/10/2015 - 08/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHB**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | Very stiff [very high strength] dark grey brown slightly sandy CLAY. | | 10.20 | | | | | | 10.30 | | D |
| | LONDON CLAY FORMATION | | 10.60 | | SPT 10.60-11.05 | (4) 21 | 10.60 | 3 | 10.60 | | D |
| | Very stiff [very high strength] dark grey brown CLAY. LONDON CLAY FORMATION | | | | | | | | 11.50 | | D |
| | | | | | | | | | 12.00 | 12.45 | U |
| | | | | | SPT 12.50-12.95 | (5) 21 | 10.60 | 3 | 12.45 | | D |
| | | | | | | | | | 12.50 | | D |
| | BOREHOLE TERMINATED AT 13.00m | | 13.00 | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.5m and 4.5m depth. Standpipe installed to 4m depth. Inspection pit excavated from 0.0m to 1.2m depth. Brackets indicate inferred strength.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
07/10/2015 - 08/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHB**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | Dark brown slightly clayey slightly gravelly silty fine to medium SAND with frequent rootlets. Gravel consists of clinker, quartz, brick, chalk, flint and plastic. MADE GROUND (TYPE A) | | 0.40 | | | | | | 0.30<br>0.40 | 0.70 | D<br>B |
| | Dark orange brown clayey silty fine to medium SAND and GRAVEL. Gravel consists of siltstone, brick, quartz and clinker. MADE GROUND (TYPE B) | | 0.80 | | SPT (c) 1.20-1.65 | (6) 35 | | DRY | 1.10<br>1.20 | 1.80 | D<br>B |
| | Dense and dense orange brown slightly clayey medium to coarse SAND and GRAVEL. Gravel consists of sub-angular to angular flint and sub-rounded to rounded quartz. KEMPTON PARK GRAVEL MEMBER | | | | SPT (c) 2.00-2.45 | (6) 35 | 2.00 | 1.8 | 2.00 | 2.50 | B |
| | Medium dense to dense dark grey very gravelly medium to coarse SAND. Gravel consists of sub-angular to sub-rounded flint and sub-rounded to rounded quartzite. KEMPTON PARK GRAVEL MEMBER | | 3.00 | | SPT (c) 3.00-3.45 | (12) 50 | 3.00 | 2.8 | 3.00 | 3.50 | B |
| | | | | | SPT (c) 4.00-4.45 | (6) 20 | 4.00 | 3.8 | 4.00 | 4.50 | B |
| | | | | | SPT (c) 5.00-5.45 | (5) 50 | 5.00 | 4 | 5.00 | 5.50 | B |
| | | | | | SPT (c) 6.00-6.45 | (6) 19 | 6.00 | 4 | 6.00 | 6.50 | B |
| | Very stiff [high strength] dark grey slightly silty CLAY. LONDON CLAY FORMATION | | 6.50 | | | | | | 6.60 | | D |
| | | | | | | | | | 7.20 | 7.65 | U |
| | | | | | | | | | 7.65 | | D |
| | | | | | | | | | 8.30 | | D |
| | *...from 9m depth, shell and fossil fragments present.* | | | | SPT 9.00-9.45 | (5) 19 | 7.00 | DRY | 9.00 | | D |
| | CONTINUED ON NEXT SHEET | | | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.5m and 4.0m depth. Inspection pit excavated from 0.0m to 1.2m depth. Brackets indicate inferred strength.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
14/10/2015 - 15/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHC**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | | | | | | | | | 10.00 | | D |
| | | | | | SPT 10.50-10.95 | (5) 21 | 7.00 | DRY | 10.50 | | D |
| | | | | | | | | | 11.50 | | D |
| | | | | | SPT 12.00-12.45 | (6) 24 | 7.00 | DRY | 12.00 | | D |
| | | | | | | | | | 13.00 | | D |
| | | | | | | | | | 13.45 | 13.95 | D |
| | | | | | | | | | 13.50 | | U |
| | | | | | | | | | 14.50 | | D |
| | | | | | SPT 15.00-15.45 | (7) 28 | 7.00 | DRY | 15.00 | | D |
| | | | | | | | | | 16.00 | | D |
| | | | | | SPT 16.50-16.95 | (9) 30 | 7.00 | DRY | 16.50 | | D |
| | | | | | | | | | 17.50 | | D |
| | | | | | | | | | 18.00 | 18.45 | U |
| | | | | | | | | | 18.45 | | D |
| | | | | | | | | | 19.00 | | D |
| | | | | | SPT 19.50-19.95 | (9) 30 | 7.00 | DRY | 19.50 | | D |
| | CONTINUED ON NEXT SHEET | | | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.5m and 4.0m depth. Inspection pit excavated from 0.0m to 1.2m depth. Brackets indicate inferred strength.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
14/10/2015 - 15/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHC**

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environmental and geotechnical consultants

| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | | | | | | | | | 20.50 | | D |
| | | | | | SPT 21.00-21.45 | (13) 39 | 7.00 | DRY | 21.00 | | D |
| | | | | | | | | | 22.00 | | D |
| | | | | | | | | | 22.70 | 23.15 | U |
| | | | | | | | | | 23.45 | | D |
| | | | | | | | | | 24.20 | | D |
| | | | | | SPT 24.50-24.95 | (13) 45 | 7.00 | DRY | 24.50 | | D |
| | BOREHOLE TERMINATED AT 25.00m | | 25.00 | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.5m and 4.0m depth. Inspection pit excavated from 0.0m to 1.2m depth. Brackets indicate inferred strength.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
14/10/2015 - 15/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHC**

soiltechnics
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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | Topsoil (drillers description). MADE GROUND | | 0.40 | | | | | | 0.60 | | D |
| | Very stiff orange brown slightly gravelly very sandy CLAY. Gravel consists of sub-angular to angular flint and sub-rounded to rounded quartzite. KEMPTON PARK GRAVEL MEMBER | | 1.10 | | SPT (c) 1.20-1.65 | (5) 20 | | DRY | 1.20<br>1.30 | 1.65 | D<br>D |
| | Medium dense to very loose orange brown SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-rounded to rounded quartzite and flint. KEMPTON PARK GRAVEL MEMBER | | 1.60 | | | | | | 1.80 | | D |
| | Stiff silty gravelly CLAY. LONDON CLAY FORMATION | | | | SPT 2.00-2.45 | (1) 2 | 1.80 | DRY | 2.00 | 2.45 | D |
| | | | | | | | | | 2.70 | | D |
| | | | | | SPT 3.00-3.45 | (1) 6 | 2.50 | DRY | 3.00 | 3.45 | D |
| | | | | | | | | | 3.70 | | D |
| | | | | | SPT 4.10-4.55 | (2) 8 | 3.00 | DRY | 4.10 | 4.55 | D |
| | | | | | | | | | 4.60 | | D |
| | | | | | | | | | 5.00 | 5.45 | U |
| | | | | | | | | | 5.50 | | D |
| | | | | | SPT 6.50-6.95 | (4) 17 | 3.00 | DRY | 6.50 | 6.95 | D |
| | | | | | | | | | 7.20 | | D |
| | | | | | SPT 8.00-8.45 | (6) 21 | 3.00 | DRY | 8.00 | 8.45 | D |
| | | | | | | | | | 8.80 | | D |
| | | | | | | | | | 9.60 | 10.05 | U |
| | CONTINUED ON NEXT SHEET | | | | | | | | | | |

**Notes:** Approximately 100L water added to aid drilling between 1.2m and 1.4m depth. Standpipe installed to 3m depth. Inspection pit excavated from 0.0m to 1.2m depth.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
21/10/2015 - 22/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHD**

soiltechnics
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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | | | | | | | | | 10.10 | | D |
| | | | | | SPT 11.10-11.55 | (7) 25 | 3.00 | DRY | 11.10 | 11.55 | D |
| | | | | | | | | | 11.90 | | D |
| | ...from 12.5m depth, occasional selenite crystals present. | | | | SPT 12.50-12.95 | (7) 27 | 3.00 | DRY | 12.50 | 12.95 | D |
| | | | | | | | | | 13.30 | | D |
| | | | | | SPT 14.00-14.45 | (7) 29 | 3.00 | DRY | 14.00 | 14.45 | D |
| | | | | | | | | | 15.00 | | D |
| | | | | | | | | | 15.60 | 16.05 | U |
| | | | | | | | | | 16.10 | | D |
| | | | | | SPT 17.10-17.55 | (8) 32 | 3.00 | DRY | 17.10 | 17.55 | D |
| | ...from 17.8m depth, becoming very stiff. | | | | | | | | 17.80 | | D |
| | | | | | SPT 18.50-18.95 | (9) 41 | 3.00 | DRY | 18.50 | 18.95 | D |
| | | | | | | | | | 19.40 | | D |
| | CONTINUED ON NEXT SHEET | | | | | | | | | | |

**Notes:** Approximately 100L water added to aid drilling between 1.2m and 1.4m depth. Standpipe installed to 3m depth. Inspection pit excavated from 0.0m to 1.2m depth.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
21/10/2015 - 22/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHD**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | | | | | | | | | 20.00 | 20.45 | U |
| | | | | | | | | | 20.50 | | D |
| | | | | | SPT 21.50-21.95 | (10) 45 | 3.00 | DRY | 21.50 | 21.95 | D |
| | | | | | | | | | 22.40 | | D |
| | | | | | SPT 23.00-23.45 | (11) 47 | 3.00 | DRY | 23.00 | 23.45 | D |
| | | | | | | | | | 24.00 | | D |
| | | | | | SPT 24.60-25.05 | (12) 49 | 3.00 | DRY | 24.60 | 25.05 | D |
| | BOREHOLE TERMINATED AT 25.05m | | 25.05 | | | | | | | | |

**Notes:** Approximately 100L water added to aid drilling between 1.2m and 1.4m depth. Standpipe installed to 3m depth. Inspection pit excavated from 0.0m to 1.2m depth.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
21/10/2015 - 22/10/2015

**Appendix**
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**Location plan on drawing number**
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**BHD**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS TYPE/ DEPTH (m) | TEST RESULTS RESULT | TEST RESULTS CASING DEPTH (m) | TEST RESULTS WATER LEVEL (m) | SAMPLING FROM (m) | SAMPLING TO (m) | SAMPLING TYPE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Black BITUMINOUS BOUND MATERIAL. MADE GROUND | | 0.10 | | | | | | | | |
| | Brick FILL. MADE GROUND (TYPE B) | | 0.25 | | | | | | 0.50 | | ES |
| | Soft brown gravelly very sandy CLAY. Gravel consists of sub-angular to angular flint. KEMPTON PARK GRAVEL MEMBER | | 0.80 | | | | | | | | |
| | Dense orange brown very clayey GRAVEL. Gravel consists of sub-angular to angular flint and quartzite. KEMPTON PARK GRAVEL MEMBER | | 1.20 | | SPT (c) 1.20-1.65 | (11) 40 | | DRY | 1.10<br>1.20<br>1.30 | 1.70 | D<br>D<br>B |
| | Dense orange brown clayey SAND and GRAVEL. Sand is coarse. Gravel consists of sub-rounded to rounded quartzite and sub-angular to angular flint. KEMPTON PARK GRAVEL MEMBER | | | | SPT (c) 2.00-2.45 | (10) 30 | 2.00 | 1.1 | 2.00<br>2.10<br>2.70 | | D<br>D<br>D |
| | Medium dense dark grey very sandy GRAVEL. Gravel consists of sub-angular to sub-rounded quartzite and sub-angular to angular flint. KEMPTON PARK GRAVEL MEMBER | | 3.00 | | SPT (c) 3.10-3.55 | (5) 17 | 3.00 | 1.9 | 3.10<br>3.30 | | D<br>D |
| | | | | | SPT (c) 4.00-4.45 | (4) 16 | 4.00 | 3.1 | 4.00<br>4.30 | | D<br>D |
| | | | | | SPT (c) 5.10-5.55 | (3) 13 | 5.00 | 5 | 5.10<br>5.20 | | D<br>D |
| | Stiff dark brown and grey silty CLAY. LONDON CLAY FORMATION | | 5.60 | | | | | | 5.80 | | D |
| | | | | | SPT 6.10-6.55 | (3) 17 | 5.80 | 6.1 | 6.10 | | D |
| | | | | | | | | | 7.00 | | D |
| | | | | | | | | | 7.50 | 7.95 | U |
| | | | | | | | | | 8.00 | | D |
| | | | | | SPT 9.00-9.45 | (6) 22 | 5.80 | DRY | 9.00 | | D |
| | *...from 9.7m depth, becoming grey.* | | | | | | | | 9.70 | | D |
| | CONTINUED ON NEXT SHEET | | | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.2m and 4.0m depth. Standpipe installed to 5m depth. Inspection pit excavated from 0.0m to 1.2m depth.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
22/10/2015 - 23/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHE**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | | | | | SPT 10.50-10.95 | (6) 24 | 5.80 | DRY | 10.50 | | D |
| | | | | | | | | | 11.40 | | D |
| | | | | | SPT 12.00-12.45 | (6) 28 | 5.80 | DRY | 12.00 | | D |
| | ...from 12.8m depth, occasional selenite crystals present. | | | | | | | | 12.80 | | D |
| | | | | | SPT 13.50-13.95 | (7) 29 | 5.80 | DRY | 13.50 | | D |
| | | | | | | | | | 14.40 | | D |
| | | | | | | | | | 15.00 | 15.45 | U |
| | | | | | | | | | 15.50 | | D |
| | ...from 16.6m depth, becoming very stiff. | | | | SPT 16.60-17.05 | (7) 30 | 5.80 | DRY | 16.60 | | D |
| | | | | | | | | | 17.30 | | D |
| | | | | | | | | | 18.10 | 18.55 | U |
| | | | | | | | | | 18.50 | | D |
| | | | | | SPT 19.50-19.95 | (8) 36 | 5.80 | DRY | 19.50 | | D |
| | CONTINUED ON NEXT SHEET | | | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.2m and 4.0m depth. Standpipe installed to 5m depth. Inspection pit excavated from 0.0m to 1.2m depth.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
22/10/2015 - 23/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHE**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | CASING DEPTH (m) | WATER LEVEL (m) | FROM (m) | TO (m) | TYPE |
| | | | | | | | | | 20.60 | | D |
| | | | | | | | | | 21.50 | | D |
| | | | | | SPT 22.50-22.95 | (9) 45 | 5.80 | DRY | 22.50 | | D |
| | | | | | | | | | 23.20 | | D |
| | | | | | SPT 24.00-24.45 | (10) 49 | 5.80 | DRY | 24.00 | | D |
| | | | | | | | | | 25.00 | 25.45 | D |
| | | | | | | | | | 25.00 | | U |
| | BOREHOLE TERMINATED AT 25.45m | | 25.45 | | | | | | | | |

**Notes:** Approximately 250L water added to aid drilling between 1.2m and 4.0m depth. Standpipe installed to 5m depth. Inspection pit excavated from 0.0m to 1.2m depth.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Borehole record

**Method of excavation**
Shell and auger

**Groundwater observations**
Unable to determine groundwater depth due to addition of water to aid drilling.

**Date of excavation (range if applicable)**
22/10/2015 - 23/10/2015

**Appendix**
D

**Location plan on drawing number**
02

**BHE**

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## Key to legends

### Composite materials, soils and lithology

| | | |
|---|---|---|
| Topsoil | Made Ground | Boulders |
| Chalk | Clay | Coal |
| Cobbles | Cobbles & Boulders | Concrete |
| Gravel | Limestone | Mudstone |
| Peat | Sand | Sand and Gravel |
| Sandstone | Silt | Silt / Clay |
| | | Siltstone |

*Note: Composite soil types are signified by combined symbols.*

## Key to 'test results' and 'sampling' columns

| Test result | |
|---|---|
| Depth | Records depth that the test was carried out *(i.e.: at 2.10m or between 2.10m and 2.55m)* |
| Result | PID - Photo Ionisation Detector result (ppm equivalent Isobutylene)<br>PP – Pocket penetrometer result ($kN/m^2$)<br>HVP – Hand held shear vane result ($kN/m^2$)<br>*PP result converted to an equivalent undrained shear strength by applying a factor of 50. Where at least 3 results obtained at same depth then an average value may be reported.* |
| | *SPT – Standard Penetration Test result (uncorrected)*<br>*SPT(c) – Standard Penetration Test result (solid cone) (uncorrected)* |

| Sampling | | |
|---|---|---|
| From (m)<br>To (m) | Records depth of sampling | |
| Type | D | Disturbed sample |
| | B | Bulk disturbed sample |
| | ES | Environmental sample comprising plastic and/or glass container |
| | W | Water sample |
| | U (32) | Undisturbed sample 100mm diameter sampler with number of blows of driving equipment required to obtain sample |

## Water observations

Described at foot of log and shown in the 'water strike' column.

▼ = water level observed after specified delay in drilling

▽ = water strike

## Standpipe details

Gravel filter

Arisings

Bentonite

Slotted pipe

Unslotted pipe

## Density

Density recorded in brackets inferred from density testing and soil descriptions from across the site (i.e.: [Medium dense]).

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Dark grey BITUMINOUS BOUND MATERIAL. MADE GROUND | | 0.05 | | | | | | |
| | Dark grey sandy GRAVEL. Gravel consists of flint, concrete and bituminous bound material. MADE GROUND (TYPE B) | | 0.20 | | | | 0.25 | | ES |
| | Orange brown sandy GRAVEL. Gravel consists of brick and concrete. MADE GROUND (TYPE B) | | | | | | 0.50 | | ES |
| | Stiff high strength orange brown slightly gravelly CLAY. Gravel consists of flint. KEMPTON PARK GRAVEL MEMBER | | 0.70 | | PP 0.80<br>PP 0.90 | 100<br>100 | | | |
| | High strength orange brown slightly clayey silty GRAVEL. Gravel consists of flint. KEMPTON PARK GRAVEL MEMBER | | 1.10 | | PP 1.10 | 100 | 1.20 | | D |
| | BOREHOLE TERMINATED AT 3.00m | | 3.00 | | | | | | |

**Notes:** Borehole terminated at 3.0m depth due to competency of ground. Borehole remained upright and stable upon completion.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
Inflow of water observed at 1.8m. Water level remained constant after 15 minutes.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS101**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Dark grey BITUMINOUS BOUND MATERIAL. MADE GROUND | | 0.05 | | | | | | |
| | Dark grey sandy GRAVEL. Gravel consists of flint and bituminous bound material. MADE GROUND (TYPE B) | | 0.20 | | | | 0.25 | | ES |
| | Red brown slightly clayey sandy GRAVEL. Gravel consists of brick and concrete. MADE GROUND (TYPE B) | | | | | | 0.50 | | ES |
| | Firm medium strength orange brown slightly gravelly sandy CLAY. Gravel consists of flint. KEMPTON PARK GRAVEL MEMBER | | 0.80 | | PP 0.90 | 50 | 0.90 | | D |
| | | | | | PP 1.10 | 50 | | | |
| | Orange brown clayey sandy GRAVEL. Gravel consists of rounded and angular medium flint. KEMPTON PARK GRAVEL MEMBER | | 1.20 | | | | 1.50 | | D |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole remained upright and stable upon completion.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
No groundwater encountered.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS102**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Dark grey BITUMINOUS BOUND MATERIAL. MADE GROUND | | 0.05 | | | | 0.15 | | ES |
| | Dark grey sandy GRAVEL. Gravel consists of flint, bituminous bound material and concrete. MADE GROUND (TYPE B) | | 0.20 | | | | 0.30 | | ES |
| | Medium dense red brown GRAVEL. Gravel consists of brick. MADE GROUND (TYPE B) | | 0.55 | | PP 0.60 | 50 | | | |
| | Firm medium strength orange brown mottled grey slightly sandy slightly gravelly silty CLAY. Gravel consists of flint. KEMPTON PARK GRAVEL MEMBER | | 0.80 | | PP 0.80 | 38 | | | |
| | Soft to firm low to medium strength orange brown mottled grey slightly sandy very gravelly silty CLAY. Gravel consists of flint. KEMPTON PARK GRAVEL MEMBER | | | | PP 1.10 | 44 | 1.20 | | D |
| | | | | ▼ | PP 1.30 | 50 | | | |
| | | | | | PP 1.50 | 50 | | | |
| | | | | | PP 1.70 | 50 | | | |
| | | | | | PP 1.90 | 50 | | | |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole remained upright and stable upon completion. For Dynamic Cone Penetration testing, refer to DCP01.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
Inflow of water observed at 1.4m. Water level remained constant after 15 minutes.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS103**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Dark grey BITUMINOUS BOUND MATERIAL. MADE GROUND | | 0.05 | | | | 0.10 | | ES |
| | Dark grey slightly clayey slightly sandy GRAVEL. Gravel consists of bituminous bound material and flint. MADE GROUND (TYPE B) | | 0.25 | | PP 0.30 | 50 | 0.35 | | ES |
| | Firm medium strength brown sandy gravelly CLAY. Gravel consists of flint, concrete and ash. MADE GROUND (TYPE B) | | 0.50 | | PP 0.50 | 50 | | | |
| | Soft medium to low strength orange brown slightly gravelly silty sandy CLAY. Gravel consists of flint. KEMPTON PARK GRAVEL MEMBER | | | | PP 0.70 | 25 | | | |
| | Soft low strength orange brown very gravelly silty sandy CLAY. Gravel consists of flint. KEMPTON PARK GRAVEL MEMBER | | 0.90 | | PP 0.90 | 25 | | | |
| | Orange brown clayey SAND and GRAVEL. Gravel consists of rounded and angular fine to coarse flint. KEMPTON PARK GRAVEL MEMBER | | 1.20 | | | | 1.50 | | D |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole remained upright and stable upon completion.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
No groundwater encountered.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS104**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Dark grey BITUMINOUS BOUND MATERIAL. MADE GROUND | | 0.05 | | | | | | |
| | Dark grey sandy GRAVEL. Gravel consists of bituminous bound material and flint. MADE GROUND (TYPE B) | | 0.20 | | | | 0.25 | | ES |
| | Orange yellow brown slightly gravelly silty SAND. Gravel consists of flint. MADE GROUND (TYPE B) | | 0.35 | | PP 0.40 | 50 | 0.50 | | ES |
| | Firm medium strength brown slightly gravelly sandy CLAY. Gravel consists of flint, brick and ash. MADE GROUND (TYPE C) | | 0.70 | | PP 0.60<br>PP 0.80 | 50<br>25 | | | |
| | Soft low strength orange brown sandy gravelly CLAY. Gravel consists of rounded and angular flint. KEMPTON PARK GRAVEL MEMBER | | 1.10 | | PP 0.90 | 25 | | | |
| | Orange brown slightly clayey SAND and GRAVEL. Gravel consists of rounded and angular fine to medium flint. KEMPTON PARK GRAVEL MEMBER | | | | | | 1.30 | | D |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole remained upright and stable upon completion.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
Inflow of water observed at 1.8m. Water level remained constant after 15 minutes.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS105**

soiltechnics
environmental and geotechnical consultants

| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS TYPE/ DEPTH (m) | TEST RESULTS RESULT | SAMPLING FROM (m) | SAMPLING TO (m) | SAMPLING TYPE |
|---|---|---|---|---|---|---|---|---|---|
| | Dark grey BITUMINOUS BOUND MATERIAL. MADE GROUND | | 0.05 | | | | 0.20 | | ES |
| | Dark grey sandy GRAVEL. Gravel consists of bituminous bound material and flint. MADE GROUND (TYPE B) | | 0.15 | | PP 0.30 | 50 | | | |
| | Orange yellow brown slightly gravelly silty SAND. Gravel consists of flint and concrete. MADE GROUND (TYPE B) | | 0.20 | | PP 0.50 | 50 | 0.60 | | ES |
| | Firm medium strength brown slightly gravelly sandy CLAY. Gravel consists of flint, brick and ash. MADE GROUND (TYPE C) | | 0.65 | | PP 0.70 | 75 | | | |
| | Firm medium strength orange brown sandy gravelly CLAY. Gravel consists of rounded and angular flint. KEMPTON PARK GRAVEL MEMBER | | | | PP 0.90 | 50 | | | |
| | | | | | PP 1.10 | 50 | | | |
| | | | | | PP 1.30 | 50 | | | |
| | Orange brown clayey sandy GRAVEL. Gravel consists of rounded and angular flint. KEMPTON PARK GRAVEL MEMBER | | 1.55 | ▼ | | | 1.50 | | D |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** 40% recovery between 1m and 2m depth. Borehole remained upright and stable upon completion.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
Inflow of water observed at 1.6m. Water level remained constant after 15 minutes.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS106**

soiltechnics
environmental and geotechnical consultants

| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Black BITUMINOUS BOUND MATERIAL. | | | | | | | | |
| | MADE GROUND | | 0.06 | | | | | | |
| | Black and brown slightly sandy GRAVEL. Gravel consists of bituminous coated material, igneous-type rock and brick. | | | | | | | | |
| | MADE GROUND (TYPE B) | | 0.30 | | PP 0.40 | 46 | 0.40 | | D |
| | Stiff medium strength dark grey brown slightly sandy gravelly CLAY. Gravel consists of brick, ceramic and ash. | | 0.50 | | PP 0.50 | 50 | | | |
| | MADE GROUND (TYPE C) | | | | PP 0.60 | 58 | 0.60 | | D |
| | Firm medium strength brown slightly gravelly very silty CLAY. Gravel consists of sub-angular to sub-rounded flint. | | 0.80 | | PP 0.70 | 75 | | | |
| | KEMPTON PARK GRAVEL MEMBER | | | | | | | | |
| | Firm [medium strength] grey brown mottled orange brown slightly gravelly very silty CLAY. Gravel consists of sub-angular to angular flint. | | | | | | 1.00 | | D |
| | KEMPTON PARK GRAVEL MEMBER | | 1.10 | | | | | | |
| | Orange brown very clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-angular to angular flint and quartzite. | | | | | | | | |
| | KEMPTON PARK GRAVEL MEMBER | | | | | | | | |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole collapsed to 1.57m. Brackets indicate inferred strength.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
Inflow of water observed at 1.75m depth, filling borehole to 1.5m in 30 minutes.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS107**

soiltechnics
environmental and geotechnical consultants

| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Black BITUMINOUS BOUND MATERIAL. MADE GROUND | | 0.03 | | | | | | |
| | Black and brown slightly sandy GRAVEL. Gravel consists of bituminous coated material, igneous-type rock and brick. MADE GROUND (TYPE B) | | | | | | 0.30 | | D |
| | Firm medium strength brown slightly gravelly very silty CLAY. Gravel consists of sub-angular to sub-rounded flint. MADE GROUND (TYPE C) | | 0.45 | | PP 0.50<br>PP 0.60 | 50<br>63 | 0.50 | | D |
| | Firm medium strength grey brown mottled orange brown slightly gravelly very silty CLAY. Gravel consists of sub-angular to angular flint. KEMPTON PARK GRAVEL MEMBER | | 0.70 | | PP 0.80<br>PP 0.90 | 67<br>75 | 0.80 | | D |
| | Orange brown very clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-angular to angular flint and quartzite. KEMPTON PARK GRAVEL MEMBER | | 1.00 | | | | | | |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole collapsed to 1.5m.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
Inflow of water observed at 1.7m depth, filling borehole to 1.55m in 30 minutes.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS108**

soiltechnics
environmental and geotechnical consultants

| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Black BITUMINOUS BOUND MATERIAL. MADE GROUND | | 0.05 | | | | | | |
| | Black and brown slightly sandy GRAVEL. Gravel consists of bituminous coated material, igneous-type rock and brick. MADE GROUND (TYPE B) | | | | | | | | |
| | Stiff medium strength dark grey brown slightly sandy gravelly CLAY. Gravel consists of brick, ceramic and ash. MADE GROUND (TYPE C) | | 0.50 | | PP 0.50<br>PP 0.60 | 75<br>63 | 0.50 | | D |
| | Firm medium strength grey brown mottled orange brown slightly gravelly very silty CLAY. Gravel consists of sub-angular to angular flint. KEMPTON PARK GRAVEL MEMBER | | 0.70 | | PP 0.70<br>PP 0.90 | 63<br>75 | 1.00 | | D |
| | Orange brown very clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-angular to angular flint and quartzite. KEMPTON PARK GRAVEL MEMBER | | 1.10 | | | | 1.50 | 2.00 | D |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole collapsed to 1.65m.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
Inflow of water observed at 1.7m depth, filling borehole to 1.6m in 30 minutes.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS109**

soiltechnics
environmental and geotechnical consultants

| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS TYPE/ DEPTH (m) | TEST RESULTS RESULT | SAMPLING FROM (m) | SAMPLING TO (m) | SAMPLING TYPE |
|---|---|---|---|---|---|---|---|---|---|
| | Black BITUMINOUS BOUND MATERIAL. | | 0.05 | | | | | | |
| | MADE GROUND | | | | | | | | |
| | Black and brown slightly sandy GRAVEL. Gravel consists of bituminous coated material, igneous-type rock and brick. | | | | | | 0.30 | | D |
| | MADE GROUND (TYPE B) | | 0.35 | | PP 0.40 | 83 | | | |
| | Stiff high strength dark grey brown slightly sandy gravelly CLAY. Gravel consists of brick, ceramic and ash. | | | | | | 0.50 | | ES |
| | MADE GROUND (TYPE C) | | | | PP 0.60 | 75 | | | |
| | Firm medium strength grey brown mottled orange brown slightly gravelly very silty CLAY. Gravel consists of sub-angular to angular flint. | | 0.70 | | PP 0.80 | 67 | | | |
| | KEMPTON PARK GRAVEL MEMBER | | | | PP 0.90 | 75 | | | |
| | *...from 0.8m depth, becoming very gravelly.* | | 0.95 | | | | | | |
| | Orange brown very clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-angular to angular flint and quartzite. | | | | | | 1.20 | 1.50 | D |
| | LONDON CLAY FORMATION | | | | | | | | |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole collapsed to 1.9m.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
Inflow of water observed at 1.75m. Water level remained constant after 20 minutes.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS110**

soiltechnics
environmental and geotechnical consultants

| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Black BITUMINOUS BOUND MATERIAL. | | | | | | | | |
| | MADE GROUND | | 0.06 | | | | | | |
| | Medium dense black and brown slightly sandy GRAVEL. Gravel consists of bituminous coated material, igneous-type rock and brick. MADE GROUND (TYPE B) | | | | | | 0.40 | | ES |
| | Stiff medium strength dark grey brown slightly sandy gravelly CLAY. Gravel consists of brick, ceramic and ash. | | 0.50 | | PP 0.55 | 75 | | | |
| | MADE GROUND (TYPE C) | | 0.60 | | PP 0.70 | 58 | | | |
| | Firm medium strength grey brown mottled orange brown slightly gravelly very silty CLAY. Gravel consists of sub-angular to angular flint. KEMPTON PARK GRAVEL MEMBER | | | | PP 0.90 | 63 | 0.80 | | D |
| | Medium dense to very dense orange brown very clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-angular to angular flint and quartzite. KEMPTON PARK GRAVEL MEMBER | | 1.00 | | | | 1.50 | 2.00 | B |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole collapsed to 1.93m. For Dynamic Cone Penetration testing, refer to DCP02.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
Yes

**Groundwater observations**
Inflow of water observed at 1.7m depth, filling borehole to 1.68m in 15 minutes.

**Date of excavation (range if applicable)**
07/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS111**

soiltechnics
environmental and geotechnical consultants

| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS TYPE/ DEPTH (m) | TEST RESULTS RESULT | SAMPLING FROM (m) | SAMPLING TO (m) | SAMPLING TYPE |
|---|---|---|---|---|---|---|---|---|---|
| | Grass onto loose to medium dense dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite and brick. MADE GROUND (TYPE A) | | | | | | 0.30 | | ES |
| | Firm medium to high strength grey brown mottled orange brown slightly gravelly very silty CLAY. Gravel consists of sub-angular to angular flint. KEMPTON PARK GRAVEL MEMBER | | 0.50 | | PP 0.65 | 75 | 0.70 | | D |
| | | | | | PP 0.85 | 83 | | | |
| | Very loose to very dense orange brown very clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-angular to angular flint and quartzite. KEMPTON PARK GRAVEL MEMBER | | 0.95 | ▼ | | | 1.50 | | D |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole remained upright and stable upon completion. For Dynamic Cone Penetration testing, refer to DCP03. Infiltration testing performed.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
No

**Groundwater observations**
Inflow of water observed at 1.79m. Water level remained constant after 15 minutes.

**Date of excavation (range if applicable)**
08/10/2015

**Appendix**
F

**Location plan on drawing number**
02

**DTS112**

soiltechnics
environmental and geotechnical consultants

| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Grass onto dark brown very clayey gravelly SAND with many rootlets and occasional roots up to 40mm in diameter. Gravel consists of sub-angular to angular quartzite, brick, clinker and ash. MADE GROUND (TYPE A) | | | | | | 0.30 | | ES |
| | Orange brown slightly sandy silty gravelly desiccated CLAY with many roots up to 20mm in diameter and rootlets. Gravel consists of sub-angular to sub-rounded sandstone and quartzite. KEMPTON PARK GRAVEL MEMBER | | 0.50 | | | | 0.60 | | ES |
| | Orange brown very clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-angular to angular flint and quartzite. KEMPTON PARK GRAVEL MEMBER | | 0.80 | | | | 1.50 | 2.00 | B |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole remained upright and stable upon completion.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
No

**Groundwater observations**
Inflow of water observed at 1.8m. Water level remained constant after 10 minutes.

**Date of excavation (range if applicable)**
08/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS113**

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environmental and geotechnical consultants

| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS TYPE/ DEPTH (m) | TEST RESULTS RESULT | SAMPLING FROM (m) | SAMPLING TO (m) | SAMPLING TYPE |
|---|---|---|---|---|---|---|---|---|---|
| | Grass onto dark brown slightly gravelly silty very clayey fine to meidum SAND. Gravel consists of sub-angular to angular flint and brick. MADE GROUND (TYPE A) | | 0.20 | | | | 0.30 | | ES |
| | Brown slightly silty very gravelly SAND. Gravel consists of sub-rounded to rounded quartzite and angular flint and occasional ash. MADE GROUND (TYPE A) | | 0.40 | | PP 0.40 | 46 | | | |
| | | | | | PP 0.50 | 58 | 0.50 | | D |
| | Firm to stiff medium to high strength orange brown mottled dark brown slightly gravelly very silty CLAY. Gravel consists of sub-angular to angular flint. KEMPTON PARK GRAVEL MEMBER | | 0.65 | | PP 0.60 | 88 | | | |
| | Very loose to dense grey brown very clayey SAND and GRAVEL with occasional gravel-sized pockets of dark brown very gravelly CLAY. Sand is medium to coarse. Gravel consists of sub-angular to angular flint. KEMPTON PARK GRAVEL MEMBER | | | | | | 1.00 | 2.00 | B |
| | Medium dense to dense orange gravelly medium to coarse SAND. Gravel consists of sub-angular to angular flint. KEMPTON PARK GRAVEL MEMBER | | 2.00 | | | | 2.00 | 2.90 | B |
| | Medium dense orange SAND and GRAVEL. Sand is coarse. Gravel consists of angular flint and sub-angular to sub-rounded quartzite. KEMPTON PARK GRAVEL MEMBER | | 2.90 | | | | 3.00 | 4.00 | B |
| | BOREHOLE TERMINATED AT 4.00m | | 4.00 | | | | | | |

**Notes:** Borehole collapsed to 2.9m. Standpipe installed to 2.9m. For Dynamic Cone Penetration testing, refer to DCP04.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
No

**Groundwater observations**
Inflow of water observed at 2.5m. Water level remained constant after 10 minutes.

**Date of excavation (range if applicable)**
09/10/2015

**Appendix**
E

**Location plan on drawing number**
02

**DTS114**

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| WELL | DESCRIPTION | LEGEND | DEPTH (m) | WATER STRIKE | TEST RESULTS | | SAMPLING | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | TYPE/ DEPTH (m) | RESULT | FROM (m) | TO (m) | TYPE |
| | Grass onto dark brown slightly gravelly silty very clayey fine to meidum SAND. Gravel consists of sub-angular to angular flint and brick. MADE GROUND (TYPE A) | | 0.15 | | | | 0.10 | | ES |
| | Brown slightly silty very gravelly SAND. Gravel consists of sub-rounded to rounded quartzite, angular flint and brick fragments. MADE GROUND (TYPE A) | | | | | | 0.50 | | ES |
| | Orange brown slightly sandy silty gravelly desiccated CLAY with many roots up to 20mm in diameter and rootlets. Gravel consists of sub-angular to sub-rounded sandstone and quartzite. KEMPTON PARK GRAVEL MEMBER | | 0.70 | | | | 1.00 | | D |
| | Orange brown clayey SAND and GRAVEL. Sand is medium to coarse. Gravel consists of sub-rounded flint and quartzite. KEMPTON PARK GRAVEL MEMBER | | 1.10 | | | | 1.50 | | B |
| | BOREHOLE TERMINATED AT 2.00m | | 2.00 | | | | | | |

**Notes:** Borehole remained upright and stable upon completion. Infiltration testing performed.

**Ground level (mAOD)**

**Co-ordinates**

**Title**
Driven tube sampler borehole record

**Surface breaking**
No

**Groundwater observations**
No groundwater encountered.

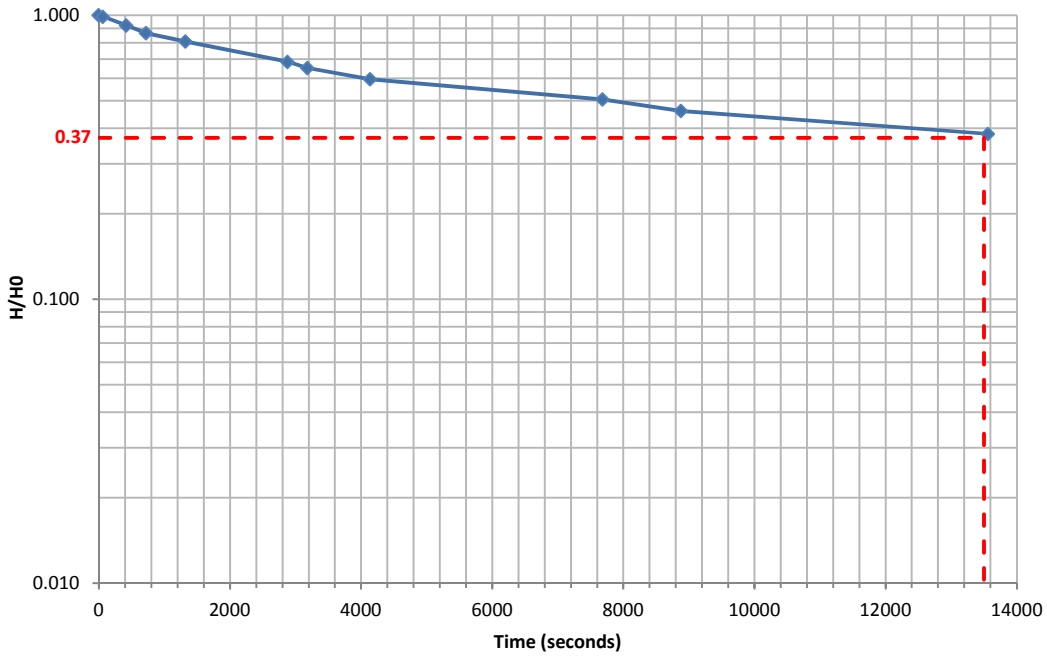
**Date of excavation (range if applicable)**
09/10/2015

**Appendix**
F

**Location plan on drawing number**
02

**DTS115**

The basic time lag (T) is obtained from the plot of the head ratio H/Ho (log scale) against elapsed time t (seconds). The basic time lag corresponds to a value of H/Ho = 0.37 where Ho denotes the head at the start of the test and H is time measured head at the elapsed time t. The plot and identification of T is shown below.




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.9 | | |
| 1 | 0.91 | | |
| 7 | 0.97 | | |
| 12 | 1.02 | | |
| 22 | 1.07 | | |
| 48 | 1.18 | | |
| 53 | 1.21 | | |
| 69 | 1.26 | | |
| 128 | 1.34 | | |
| 148 | 1.38 | | |
| 226 | 1.45 | | |

## Calculations:

Adopting the basic time lag method, k = permeability = $\frac{\pi r2}{FT}$

Where F = intake factor (adopting fig 6D of BS5930)

$$F = \frac{2\pi L}{In\left[\frac{L}{D} + \sqrt{1 + \left(\frac{L}{D}\right)^2}\right]}$$ **= 2.068**

Then

**k = 2.81E-07 m/s**

**Borehole dimensions**

L = 0.98m G = 1.79m

A = 0.007854m²

Groundwater observations

Inflow of water observed at 1.79m. Water level remained constant after 15 minutes.

Borehole diameter

0.1m

Ground level

N/A

Depth of borehole at start of test (m)

1.88

Co-ordinates

-

Title

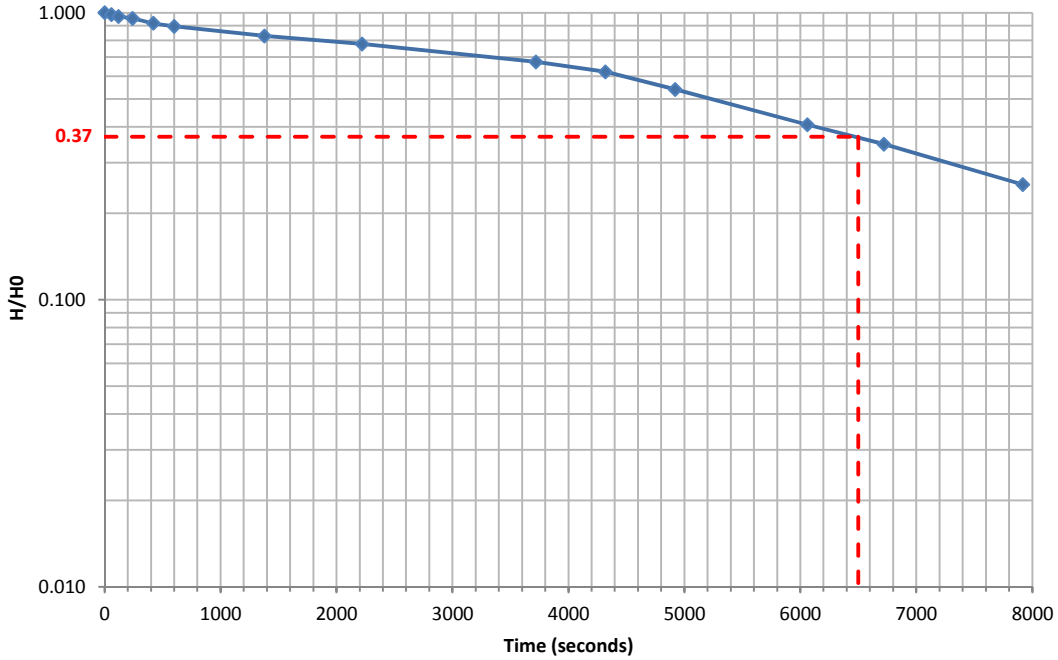
Variable Head Test carried out in accordance with BS5930: 1999 (Section 25.4) and CIRIA special publication 25 'Site Investigation Manual'

Location plan on drawing number

02

| Borehole number | Cycle number | Date of excavation |
|---|---|---|
| DTS112 | 1 | 09/10/2015 |

The basic time lag (T) is obtained from the plot of the head ratio H/Ho (log scale) against elapsed time t (seconds). The basic time lag corresponds to a value of H/Ho = 0.37 where Ho denotes the head at the start of the test and H is time measured head at the elapsed time t. The plot and identification of T is shown below.




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.28 | | |
| 1 | 0.3 | | |
| 2 | 0.32 | | |
| 4 | 0.34 | | |
| 7 | 0.39 | | |
| 10 | 0.42 | | |
| 23 | 0.51 | | |
| 37 | 0.58 | | |
| 62 | 0.72 | | |
| 72 | 0.79 | | |
| 82 | 0.9 | | |
| 101 | 1.08 | | |
| 112 | 1.16 | | |
| 132 | 1.29 | | |

## Calculations:

Adopting the basic time lag method, k = permeability = $\frac{\pi r2}{FT}$

Where F = intake factor (adopting fig 6D of BS5930)

$$F = \frac{2\pi L}{In\left[\frac{L}{D} + \sqrt{1 + \left(\frac{L}{D}\right)^2}\right]}$$ **= 2.900**

Then

**k = 4.17E-07 m/s**

**Borehole dimensions**

L = 1.6m G = 1.63m

A = 0.007854m²

Groundwater observations

Inflow of water observed at 1.79m. Water level remained constant after 15 minutes.

Borehole diameter

0.1m

Ground level

N/A

Depth of borehole at start of test (m)

1.88

Co-ordinates

-

Title

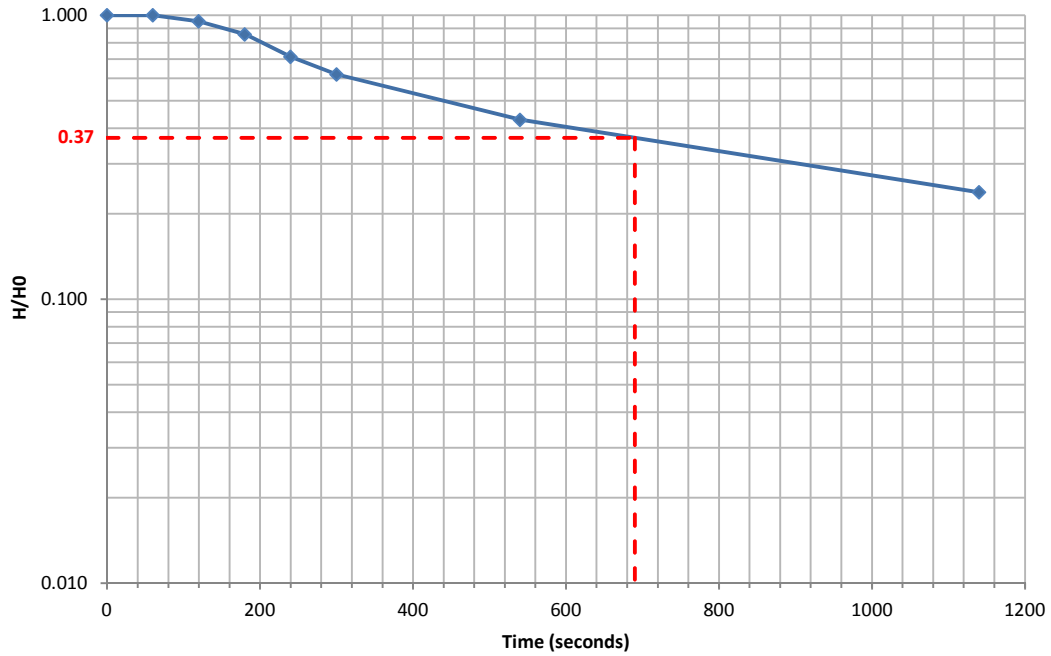
Variable Head Test carried out in accordance with BS5930: 1999 (Section 25.4) and CIRIA special publication 25 'Site Investigation Manual'

Location plan on drawing number

02

| Borehole number | Cycle number | Date of excavation |
|---|---|---|
| DTS112 | 1 | 09/10/2015 |

The basic time lag (T) is obtained from the plot of the head ratio H/Ho (log scale) against elapsed time t (seconds). The basic time lag corresponds to a value of H/Ho = 0.37 where Ho denotes the head at the start of the test and H is time measured head at the elapsed time t. The plot and identification of T is shown below.




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.08 | | |
| 1 | 1.08 | | |
| 2 | 1.09 | | |
| 3 | 1.11 | | |
| 4 | 1.14 | | |
| 5 | 1.16 | | |
| 9 | 1.2 | | |
| 19 | 1.24 | | |
| 29 | 1.31 | | |
| 39 | 1.35 | | |
| 54 | 1.4 | | |
| 74 | 1.44 | | |
| 79 | 1.48 | | |
| 91 | 1.51 | | |

## Calculations:

Adopting the basic time lag method, k = permeability = $\frac{\pi r2}{FT}$

Where F = intake factor (adopting fig 6D of BS5930)

$$F = \frac{2\pi L}{In\left[\frac{L}{D} + \sqrt{1 + \left(\frac{L}{D}\right)^2}\right]}$$ **= 1.810**

Then

**k = 6.29E-06 m/s**

**Borehole dimensions**

L = 0.8m G = 1.29m

A = 0.007854m²

Groundwater observations

Inflow of water observed at 1.79m. Water level remained constant after 15 minutes.

Borehole diameter

0.1m

Ground level

N/A

Depth of borehole at start of test (m)

1.88

Co-ordinates

-

Title

Variable Head Test carried out in accordance with BS5930: 1999 (Section 25.4) and CIRIA special publication 25 'Site Investigation Manual'

Location plan on drawing number

02

Borehole number

DTS112

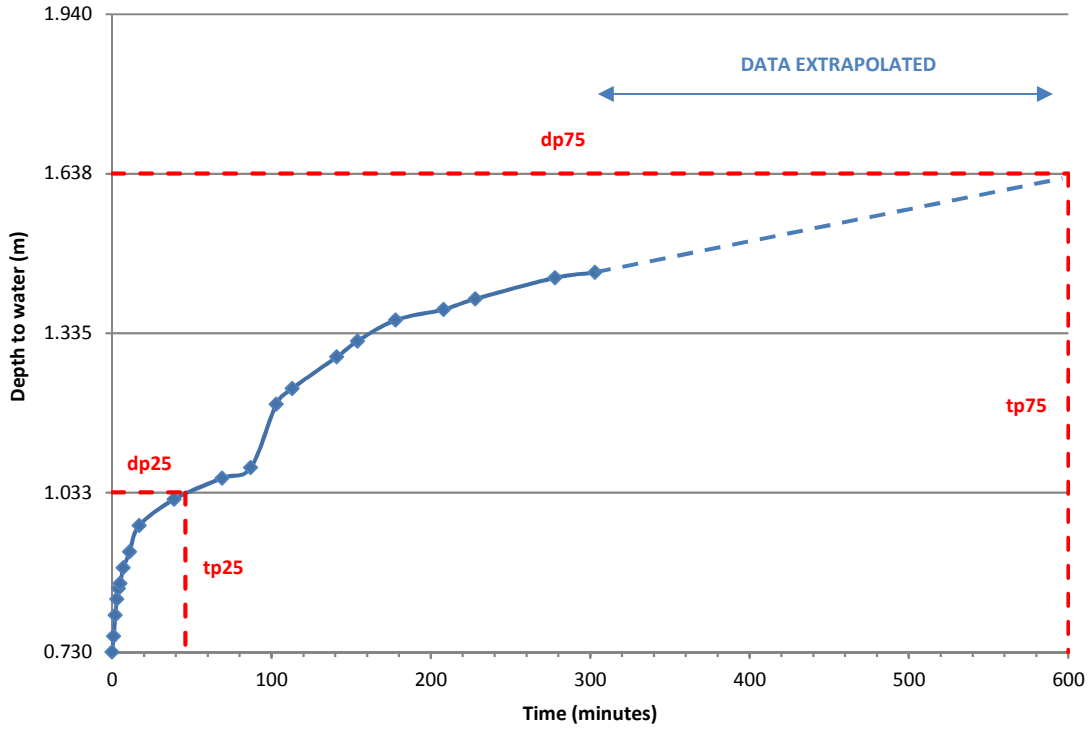
Cycle number

1

Date of excavation

09/10/2015

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.73 | 178 | 1.36 |
| 1 | 0.76 | 208 | 1.38 |
| 2 | 0.8 | 228 | 1.4 |
| 3 | 0.83 | 278 | 1.44 |
| 4 | 0.85 | 303 | 1.45 |
| 5 | 0.86 | | |
| 7 | 0.89 | | |
| 11 | 0.92 | | |
| 17 | 0.97 | | |
| 39 | 1.02 | | |
| 69 | 1.06 | | |
| 87 | 1.08 | | |
| 103 | 1.2 | | |
| 113 | 1.23 | | |
| 141 | 1.29 | | |
| 154 | 1.32 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the borehole between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.00475m³***

$a_{p50}$ = *the internal surface area of the borehole up to 50% effective depth and including the base area*
= ***0.19792m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***554 (minutes)***
= ***33240 (seconds)***

**$f$ = 7.22E-07 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Borehole diameter
0.1m

Ground level
N/A

Location plan on drawing number
02

Depth of borehole at start of test (m)
1.94

Co-ordinates
-

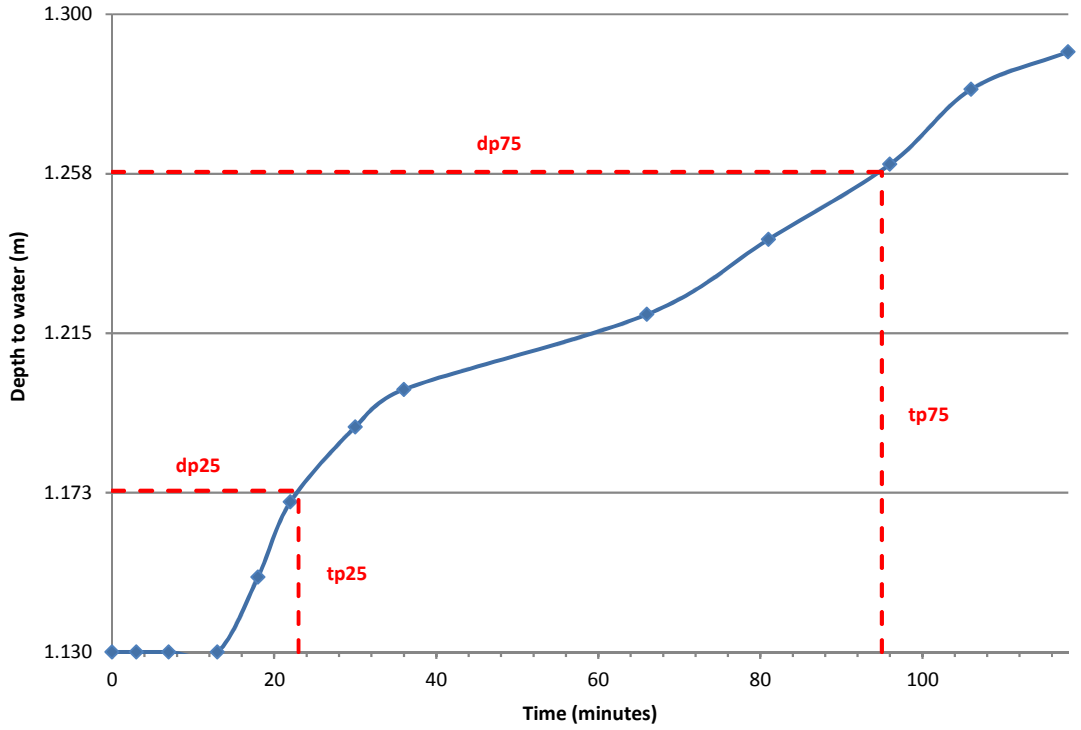
Borehole number
DTS115

Cycle number
1

Date of excavation
09/10/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.13 | | |
| 3 | 1.13 | | |
| 7 | 1.13 | | |
| 13 | 1.13 | | |
| 18 | 1.15 | | |
| 22 | 1.17 | | |
| 30 | 1.19 | | |
| 36 | 1.2 | | |
| 66 | 1.22 | | |
| 81 | 1.24 | | |
| 96 | 1.26 | | |
| 106 | 1.28 | | |
| 118 | 1.29 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.1173m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.873m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***72 (minutes)***
= ***4320 (seconds)***

***f* = 1.45E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2.3m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.3

Co-ordinates
-

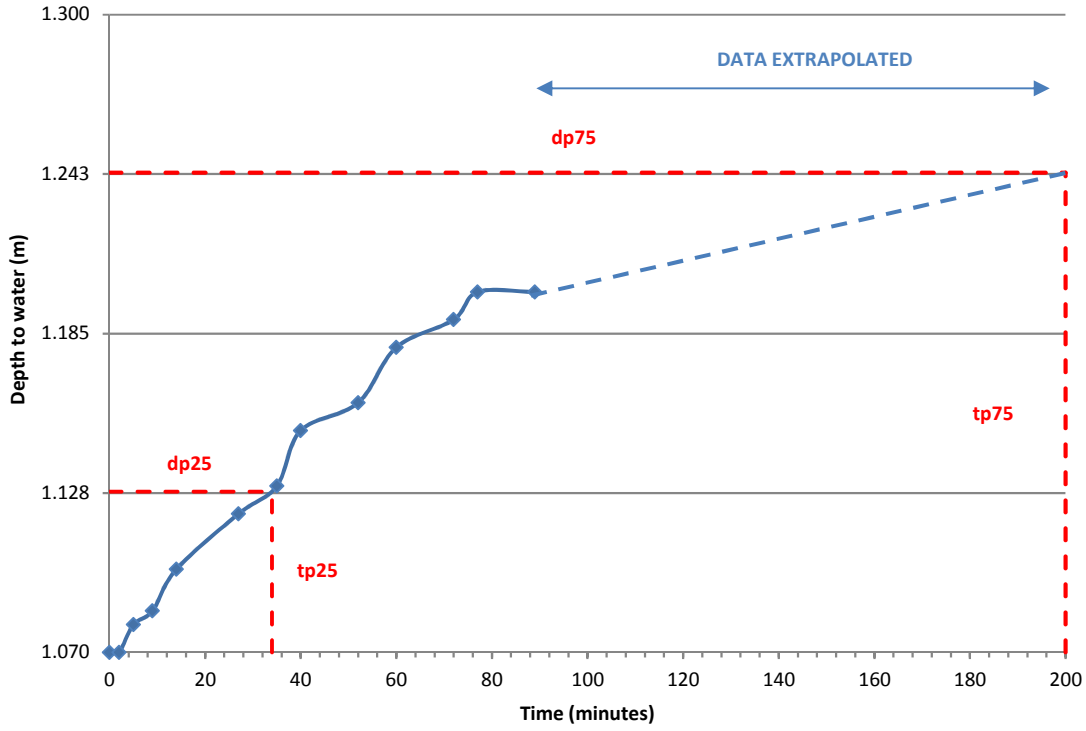
Trial pit number
TP101

Cycle number
1

Date of excavation
07/10/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.07 | | |
| 2 | 1.07 | | |
| 5 | 1.08 | | |
| 9 | 1.085 | | |
| 14 | 1.1 | | |
| 27 | 1.12 | | |
| 35 | 1.13 | | |
| 40 | 1.15 | | |
| 52 | 1.16 | | |
| 60 | 1.18 | | |
| 72 | 1.19 | | |
| 77 | 1.2 | | |
| 89 | 1.2 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.1587m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***2.047m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***166 (minutes)***
= ***9960 (seconds)***

***f* = 7.78E-06 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2.3m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.3

Co-ordinates
-

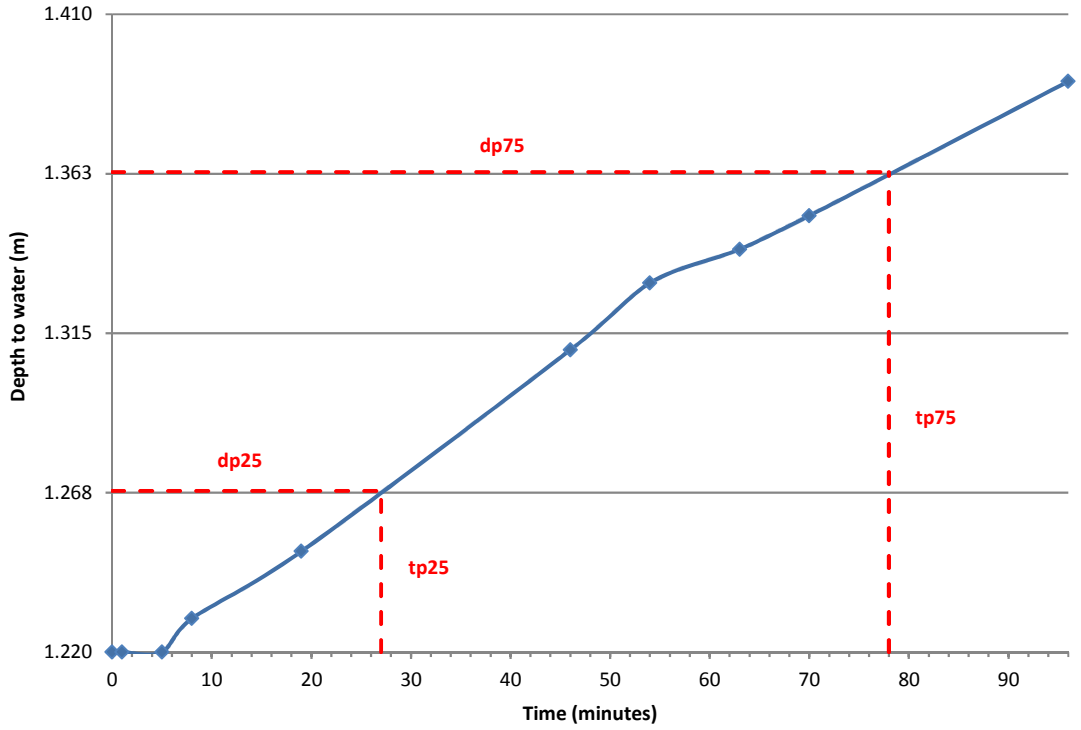
Trial pit number
TP101

Cycle number
2

Date of excavation
07/10/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.22 | | |
| 1 | 1.22 | | |
| 5 | 1.22 | | |
| 8 | 1.23 | | |
| 19 | 1.25 | | |
| 46 | 1.31 | | |
| 54 | 1.33 | | |
| 63 | 1.34 | | |
| 70 | 1.35 | | |
| 96 | 1.39 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.1311m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.931m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***51 (minutes)***
= ***3060 (seconds)***

***f* = 2.22E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2.3m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.41 (re-excavated following day)

Co-ordinates
-

Trial pit number
TP101

Cycle number
3

Date of excavation
08/10/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:

## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.1 | | |
| 1 | 1.1 | | |
| 3 | 1.1 | | |
| 7 | 1.09 | | |
| 11 | 1.09 | | |
| 15 | 1.09 | | |
| 21 | 1.08 | | |
| 30 | 1.08 | | |
| 45 | 1.08 | | |
| 105 | 1.08 | | |
| 203 | 1.08 | | |

## Calculations:

Insufficient infiltration over 203 minutes of monitoring due to rising water level due to collapse of trial pit sides.

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2.45m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.45

Co-ordinates
-

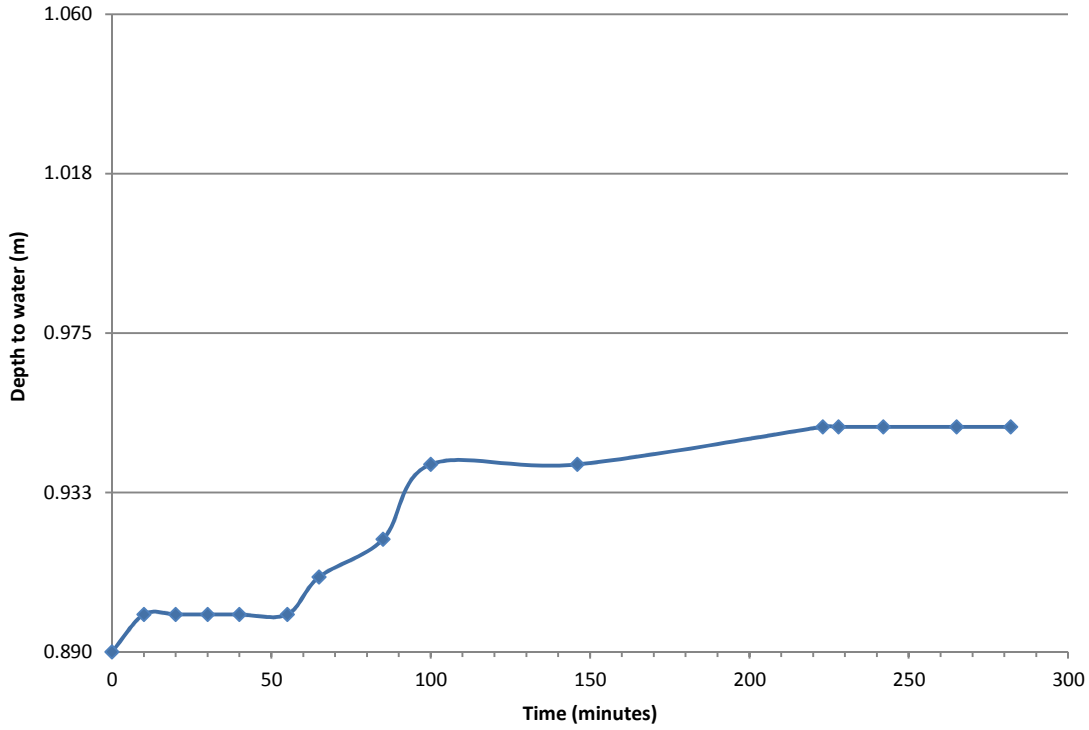
Trial pit number
TP102A

Cycle number
1

Date of excavation
07/10/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.89 | | |
| 10 | 0.9 | | |
| 20 | 0.9 | | |
| 30 | 0.9 | | |
| 40 | 0.9 | | |
| 55 | 0.9 | | |
| 65 | 0.91 | | |
| 85 | 0.92 | | |
| 100 | 0.94 | | |
| 146 | 0.94 | | |
| 223 | 0.95 | | |
| 228 | 0.95 | | |
| 242 | 0.95 | | |
| 265 | 0.95 | | |
| 282 | 0.95 | | |

## Calculations:

Insufficient infiltration over 282 minutes of monitoring therefore unable to calculate soil infiltration rate.

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 1.8m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.06

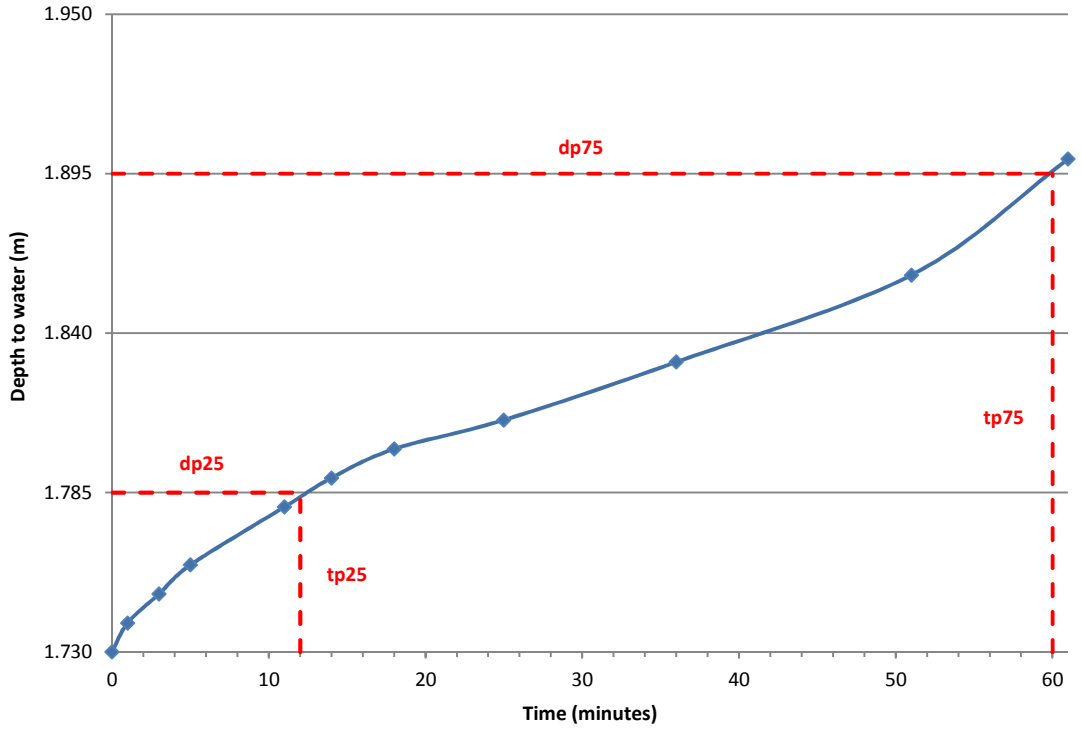
Co-ordinates
-

Trial pit number
TP104

Cycle number
1

Date of excavation
08/10/2015

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.73 | | |
| 1 | 1.74 | | |
| 3 | 1.75 | | |
| 5 | 1.76 | | |
| 11 | 1.78 | | |
| 14 | 1.79 | | |
| 18 | 1.8 | | |
| 25 | 1.81 | | |
| 36 | 1.83 | | |
| 51 | 1.86 | | |
| 61 | 1.9 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
**= 0.1716m³**

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
**= 2.264m²**

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
**= 48 (minutes)**
**= 2880 (seconds)**

**$f$ = 2.63E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2.6m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.95

Co-ordinates
-

Trial pit number
TP105

Cycle number
1

Date of excavation
08/10/2015

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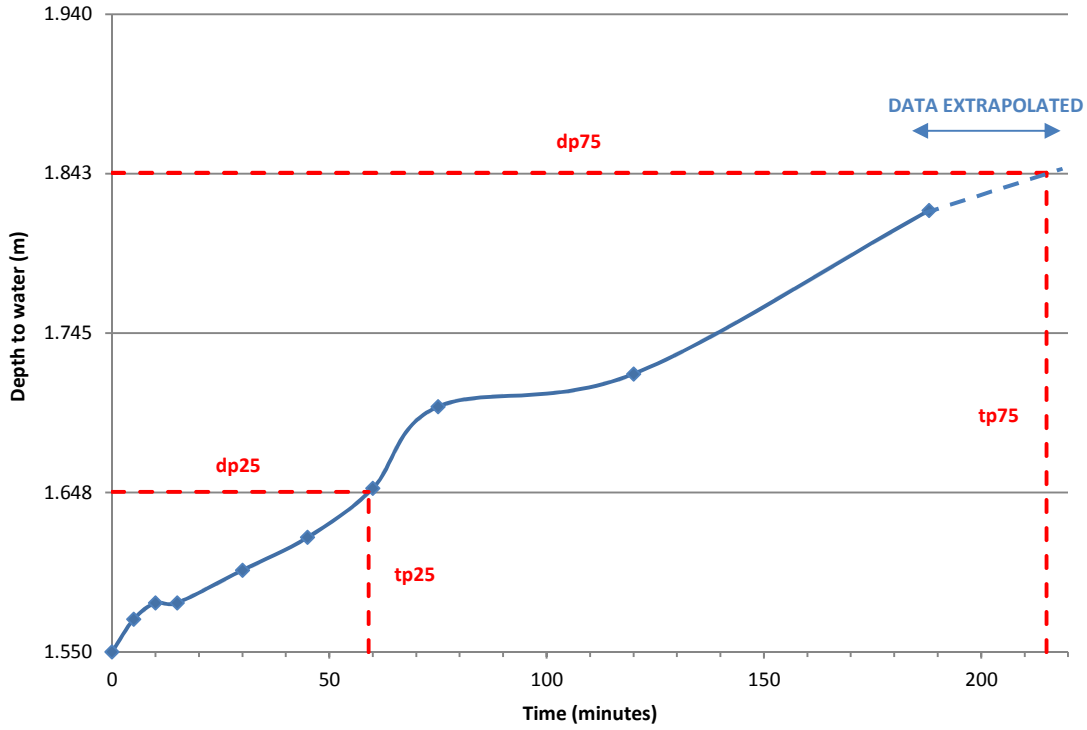
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.55 | | |
| 5 | 1.57 | | |
| 10 | 1.58 | | |
| 15 | 1.58 | | |
| 30 | 1.6 | | |
| 45 | 1.62 | | |
| 60 | 1.65 | | |
| 75 | 1.7 | | |
| 120 | 1.72 | | |
| 188 | 1.82 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.3042m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***2.808m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***156 (minutes)***
= ***9360 (seconds)***

***f* = 1.16E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2.6m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.94

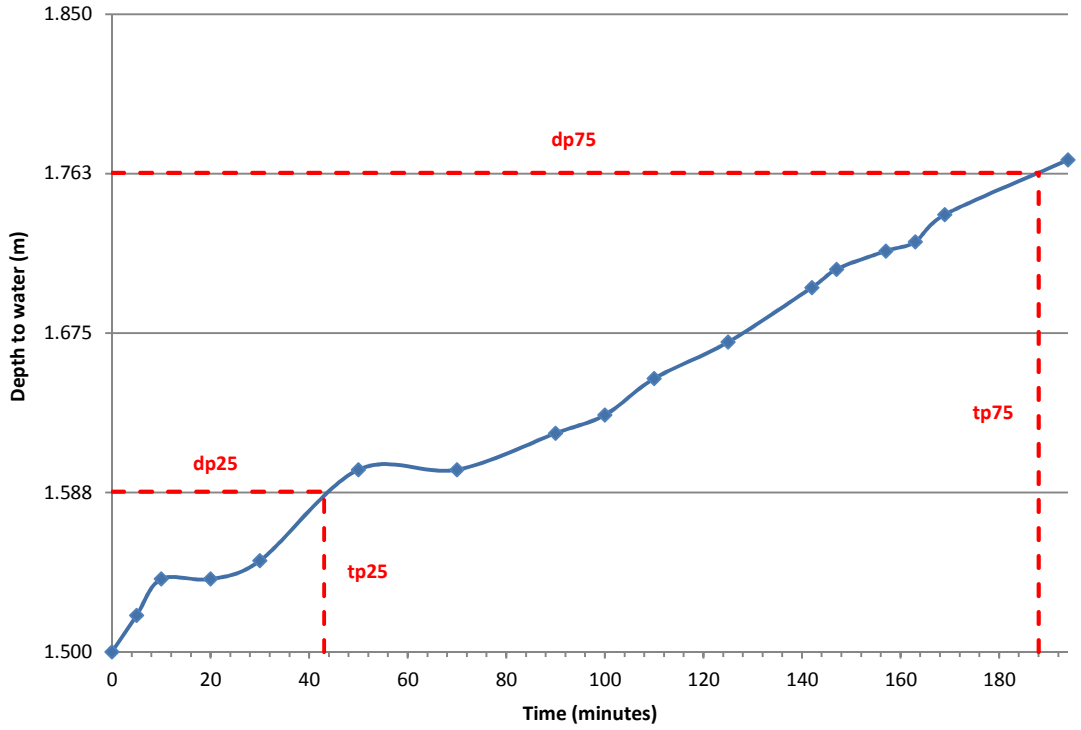
Co-ordinates
-

Trial pit number
TP105

Cycle number
2

Date of excavation
08/10/2015

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.5 | 194 | 1.77 |
| 5 | 1.52 | | |
| 10 | 1.54 | | |
| 20 | 1.54 | | |
| 30 | 1.55 | | |
| 50 | 1.6 | | |
| 70 | 1.6 | | |
| 90 | 1.62 | | |
| 100 | 1.63 | | |
| 110 | 1.65 | | |
| 125 | 1.67 | | |
| 142 | 1.7 | | |
| 147 | 1.71 | | |
| 157 | 1.72 | | |
| 163 | 1.725 | | |
| 169 | 1.74 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.273m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***2.68m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***145 (minutes)***
= ***8700 (seconds)***

***f* = 1.17E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2.6m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.85

Co-ordinates
-

Trial pit number
TP105

Cycle number
3

Date of excavation
08/10/2015

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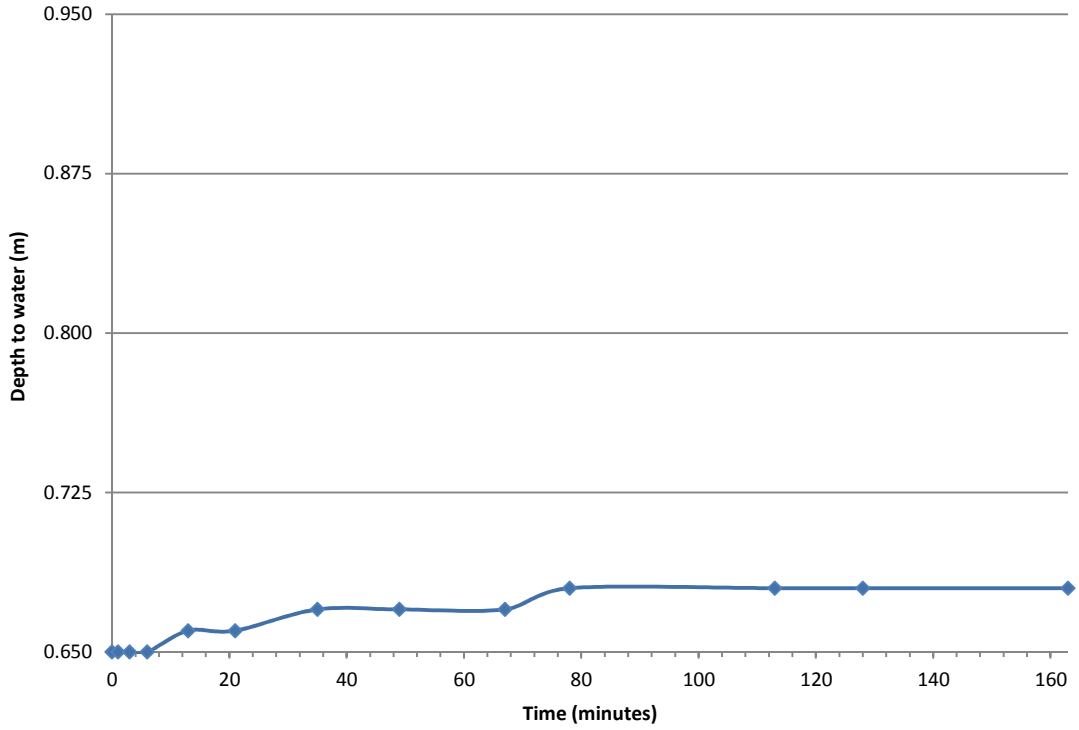
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.65 | | |
| 1 | 0.65 | | |
| 3 | 0.65 | | |
| 6 | 0.65 | | |
| 13 | 0.66 | | |
| 21 | 0.66 | | |
| 35 | 0.67 | | |
| 49 | 0.67 | | |
| 67 | 0.67 | | |
| 78 | 0.68 | | |
| 113 | 0.68 | | |
| 128 | 0.68 | | |
| 163 | 0.68 | | |

## Calculations:

Insufficient infiltration over 163 minutes of monitoring therefore unable to calculate soil infiltration rate.

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.4m x 0.4m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
0.95

Co-ordinates
-

Trial pit number
TP107

Cycle number
1

Date of excavation
09/10/2015

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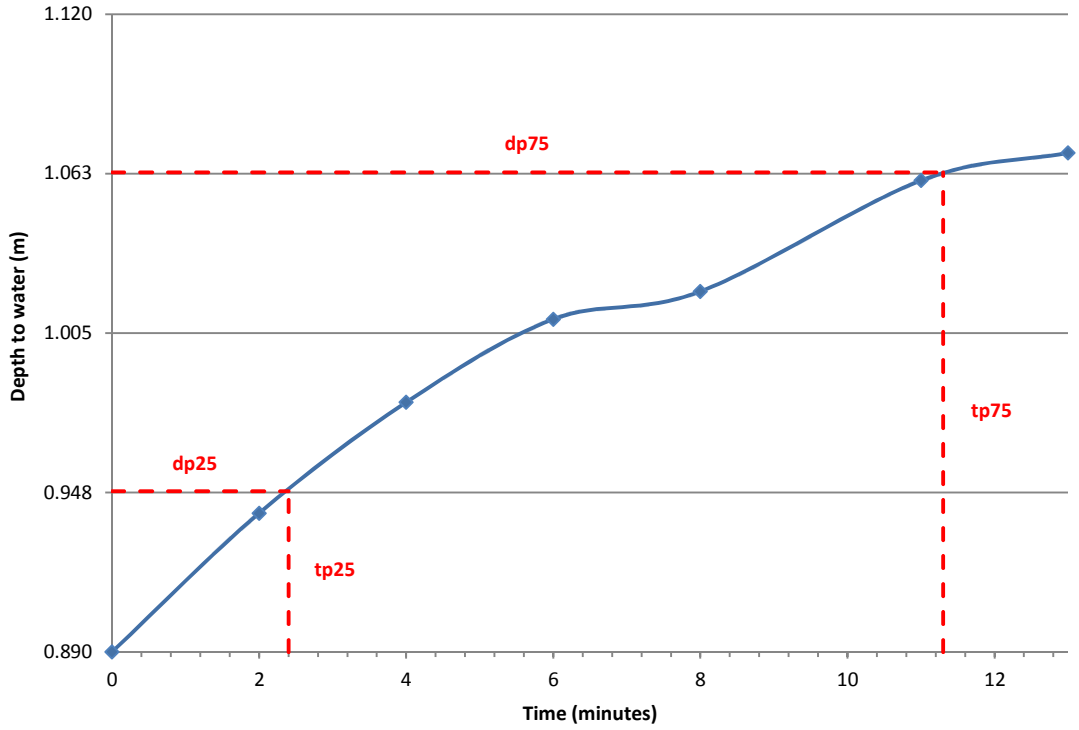
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.89 | | |
| 2 | 0.94 | | |
| 4 | 0.98 | | |
| 6 | 1.01 | | |
| 8 | 1.02 | | |
| 11 | 1.06 | | |
| 13 | 1.07 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.1311m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.715m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***8.9 (minutes)***
= ***534 (seconds)***

***f* = 1.43E-04 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 1.9m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.12

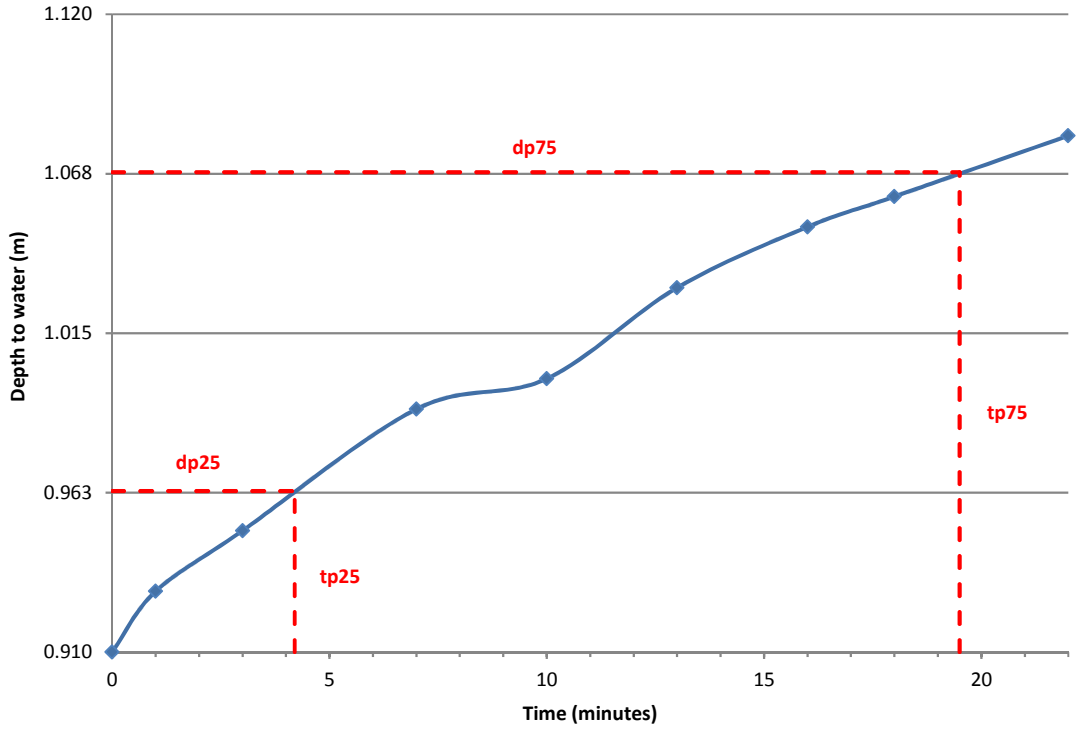
Co-ordinates
-

Trial pit number
TP108

Cycle number
1

Date of excavation
09/10/2015

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.91 | | |
| 1 | 0.93 | | |
| 3 | 0.95 | | |
| 7 | 0.99 | | |
| 10 | 1 | | |
| 13 | 1.03 | | |
| 16 | 1.05 | | |
| 18 | 1.06 | | |
| 22 | 1.08 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.1197m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.665m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***15.3 (minutes)***
= ***918 (seconds)***

***f* = 7.83E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 1.9m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.12

Co-ordinates
-

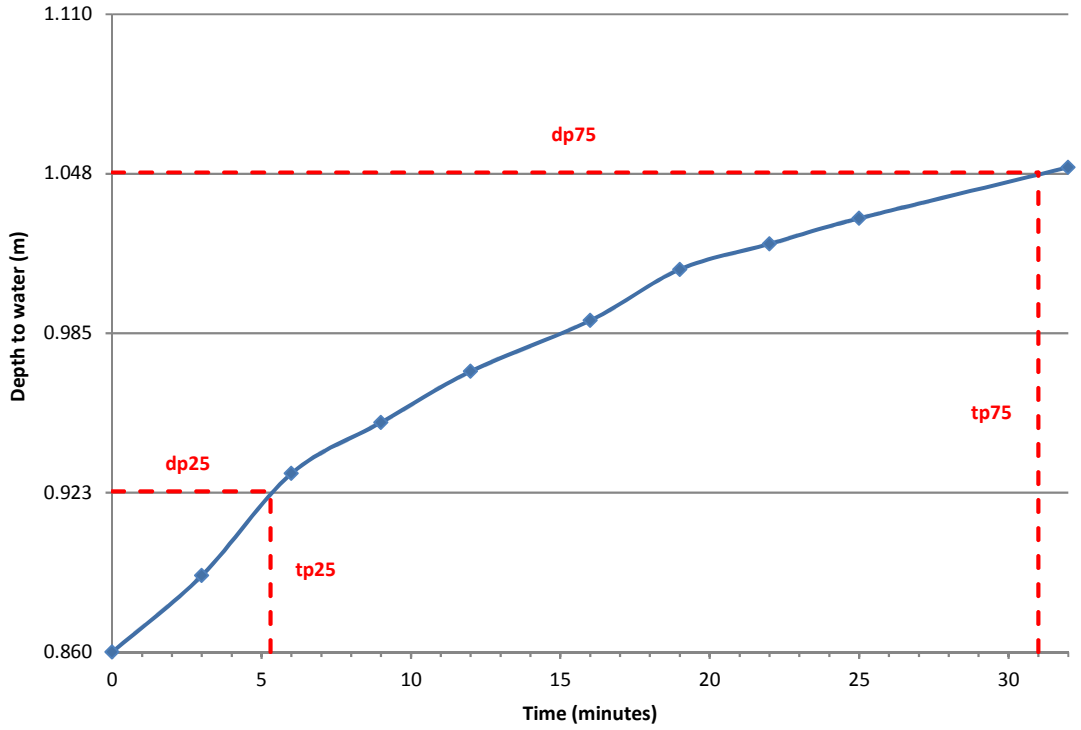
Trial pit number
TP108

Cycle number
2

Date of excavation
09/10/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 0.86 | | |
| 3 | 0.89 | | |
| 6 | 0.93 | | |
| 9 | 0.95 | | |
| 12 | 0.97 | | |
| 16 | 0.99 | | |
| 19 | 1.01 | | |
| 22 | 1.02 | | |
| 25 | 1.03 | | |
| 32 | 1.05 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
**= 0.1425m³**

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
**= 1.765m²**

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
**= 25.7 (minutes)**
**= 1542 (seconds)**

**$f$ = 5.24E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 1.9m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.11

Co-ordinates
-

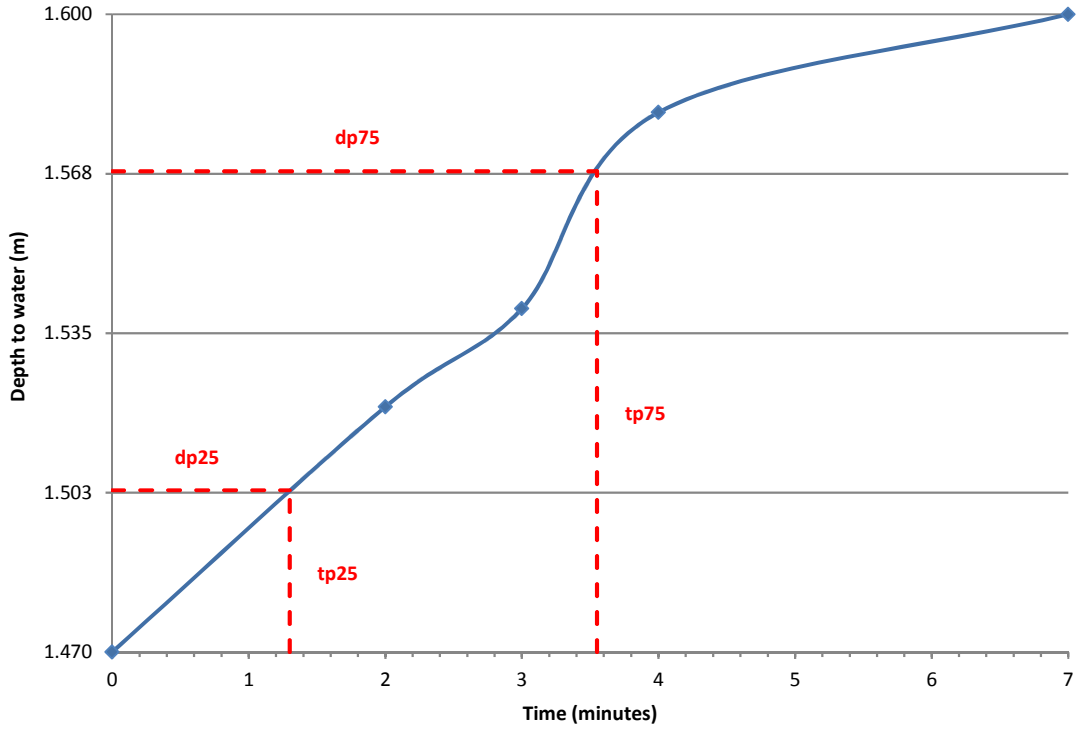
Trial pit number
TP108

Cycle number
3

Date of excavation
09/10/2015

soiltechnics
environmental and geotechnical consultants

## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.47 | | |
| 2 | 1.52 | | |
| 3 | 1.54 | | |
| 4 | 1.58 | | |
| 7 | 1.6 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
= ***0.0858m³***

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
= ***1.684m²***

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
= ***2.25 (minutes)***
= ***135 (seconds)***

**$f$ = 3.77E-04 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2.2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.6

Co-ordinates
-

Trial pit number
TP109

Cycle number
1

Date of excavation
09/10/2015

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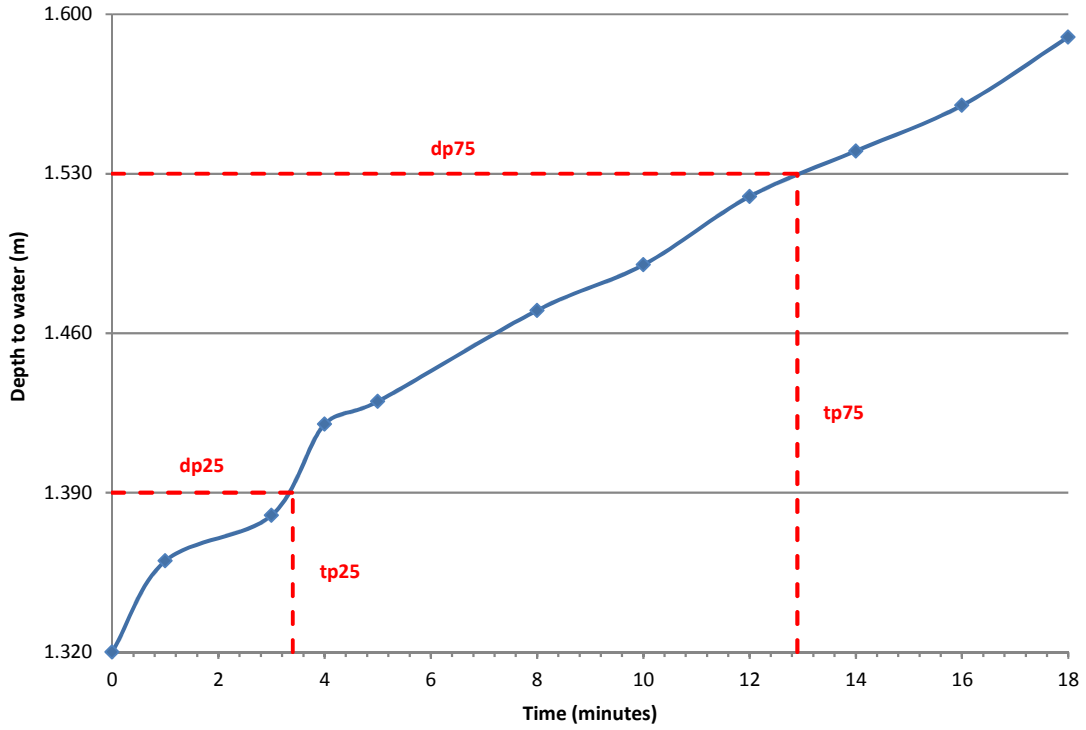
## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.32 | | |
| 1 | 1.36 | | |
| 3 | 1.38 | | |
| 4 | 1.42 | | |
| 5 | 1.43 | | |
| 8 | 1.47 | | |
| 10 | 1.49 | | |
| 12 | 1.52 | | |
| 14 | 1.54 | | |
| 16 | 1.56 | | |
| 18 | 1.59 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
**= 0.1848m³**

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
**= 2.104m²**

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
**= 9.5 (minutes)**
**= 570 (seconds)**

**$f$ = 1.54E-04 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2.2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.6

Co-ordinates
-

Trial pit number
TP109

Cycle number
2

Date of excavation
09/10/2015

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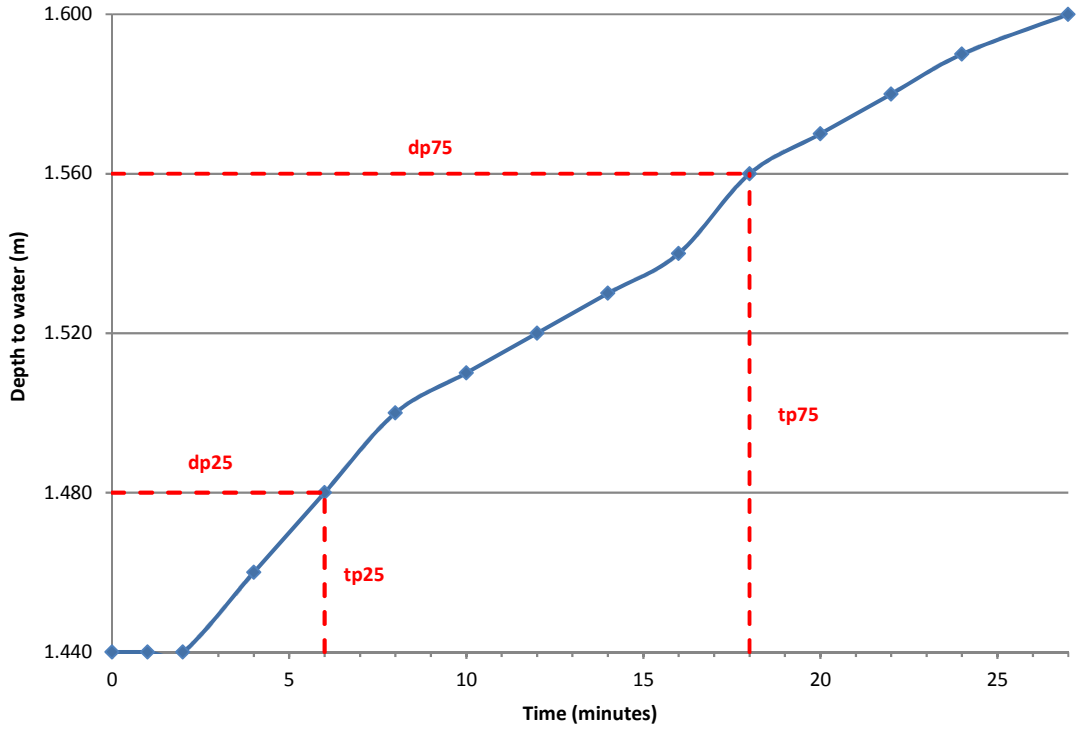
## Plot showing time against depth to water:




## Test observations:

| TIME (mins) | DEPTH TO WATER (m) | TIME (mins) | DEPTH TO WATER (m) |
|---|---|---|---|
| 0 | 1.44 | | |
| 1 | 1.44 | | |
| 2 | 1.44 | | |
| 4 | 1.46 | | |
| 6 | 1.48 | | |
| 8 | 1.5 | | |
| 10 | 1.51 | | |
| 12 | 1.52 | | |
| 14 | 1.53 | | |
| 16 | 1.54 | | |
| 18 | 1.56 | | |
| 20 | 1.57 | | |
| 22 | 1.58 | | |
| 24 | 1.59 | | |
| 27 | 1.6 | | |

## Calculations:

Soil infiltration rate (SIR), $f = \frac{V_{p75-25}}{a_{p50} \times t_{p75-25}}$

$V_{p75-25}$ = *effective storage volume of water in the trial pit between 75% ($d_{p75}$) and 25% ($d_{p25}$) effective depth*
**= 0.1056m³**

$a_{p50}$ = *the internal surface area of the trial pit up to 50% effective depth and including the base*
**= 1.768m²**

$t_{p75} - t_{p25}$ = *the time for the water level to fall from 75% to 25% effective depth*
**= 12 (minutes)**
**= 720 (seconds)**

**$f$ = 8.30E-05 m/s**

Groundwater observations
No groundwater encountered.

Title
Soil infiltration test (following principles of the Building Research Establishment Digest 365 2007)

Trial pit dimensions (width x length)
0.6m x 2.2m

Ground level
N/A

Location plan on drawing number
02

Depth of trial pit at start of test (m)
1.6

Co-ordinates
-

Trial pit number
TP109

Cycle number
3

Date of excavation
09/10/2015

ESG
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

0001

TEST REPORT

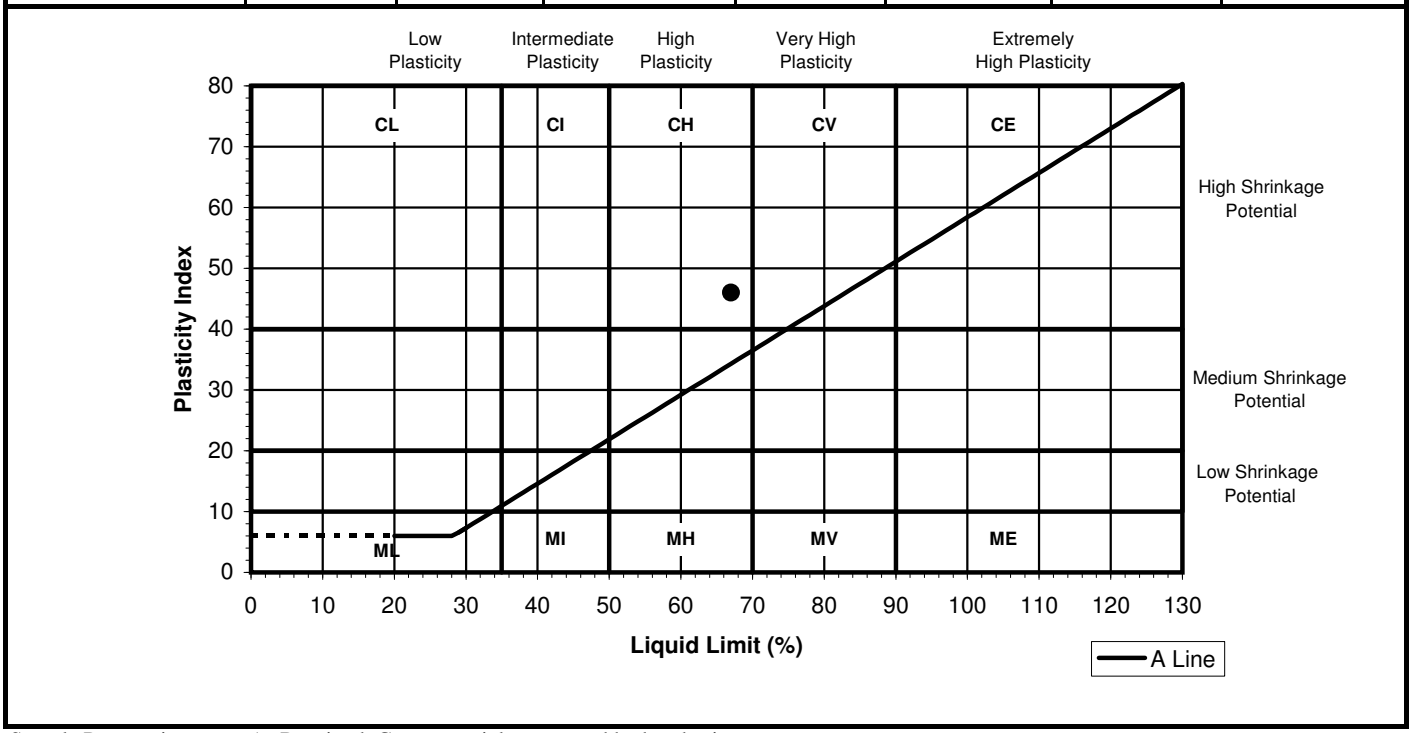
# Determination of Moisture Content and Atterberg Limits

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/01 |
| Client Address: | Cedar Barn, | Batch Number: | DAM0056598 |
| | White Lodge | | |
| | Walgrave | Client Reference: | STM3361D |
| Postcode: | NN6 9PY | Sampled by: | Client |
| Contact: | Andy Keeler | Date Sampled: | 12.10.15 |
| | | Date Received: | 12.10.15 |
| Site: | STM3361D Richmond College London | Tested From: | 14.10.15-15.10.15 |
| | | Sample Type: | Disturbed |

**Test Results:**

Description: Brown Sandy CLAY

| Laboratory Reference | Location | Depth (m) | As Received Moisture Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | % Passing 425µm |
|---|---|---|---|---|---|---|---|
| 45259847 | TP107 | 0.80 | N/A | 67 | 21 | 46 | 100 |




Sample Preparation: As Received, Coarse particles removed by hand prior to test
Estimated % passing 425µm BS Test Sieve

Certified that the laboratory testing was carried out in accordance with BS 1377-2: 1990: Method 3.2, 4.4 and 5

Page: 1 of 1
Date: 23.10.15

**Signed** D. Berrill

[ ] M. Carr - Section Manager
[✓] D. Berrill - Laboratory Manager

For and on behalf of Environmental Scientifics Group

ESG
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

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TEST REPORT

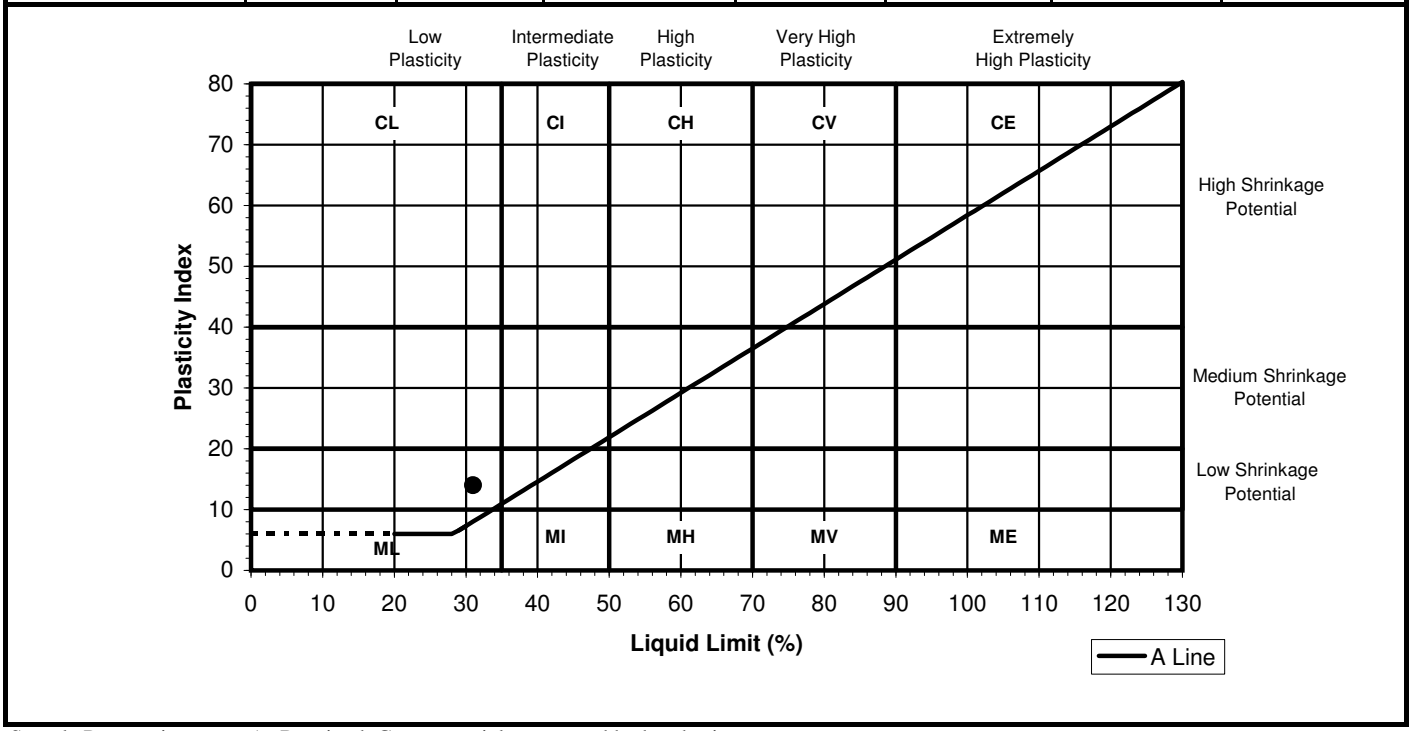
# Determination of Moisture Content and Atterberg Limits

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/02 |
| Client Address: | Cedar Barn, | Batch Number: | DAM0056598 |
| | White Lodge | | |
| | Walgrave | Client Reference: | STM3361D |
| Postcode: | NN6 9PY | Sampled by: | Client |
| Contact: | Andy Keeler | Date Sampled: | 12.10.15 |
| | | Date Received: | 12.10.15 |
| Site: | STM3361D Richmond College London | Tested From: | 14.10.15-15.10.15 |
| | | Sample Type: | Disturbed |

**Test Results:**

Description: Brown Sandy Silty CLAY

| Laboratory Reference | Location | Depth (m) | As Received Moisture Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | % Passing 425µm |
|---|---|---|---|---|---|---|---|
| 45259848 | DTS115 | 1.00 | N/A | 31 | 17 | 14 | 94 |




Sample Preparation: As Received, Coarse particles removed by hand prior to test
Estimated % passing 425µm BS Test Sieve

Certified that the laboratory testing was carried out in accordance with BS 1377-2: 1990: Method 3.2, 4.4 and 5

Page: 1 of 1
Date: 23.10.15

**Signed**

[ ] M. Carr - Section Manager
[✓] D. Berrill - Laboratory Manager

For and on behalf of Environmental Scientifics Group

ESG
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

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TEST REPORT

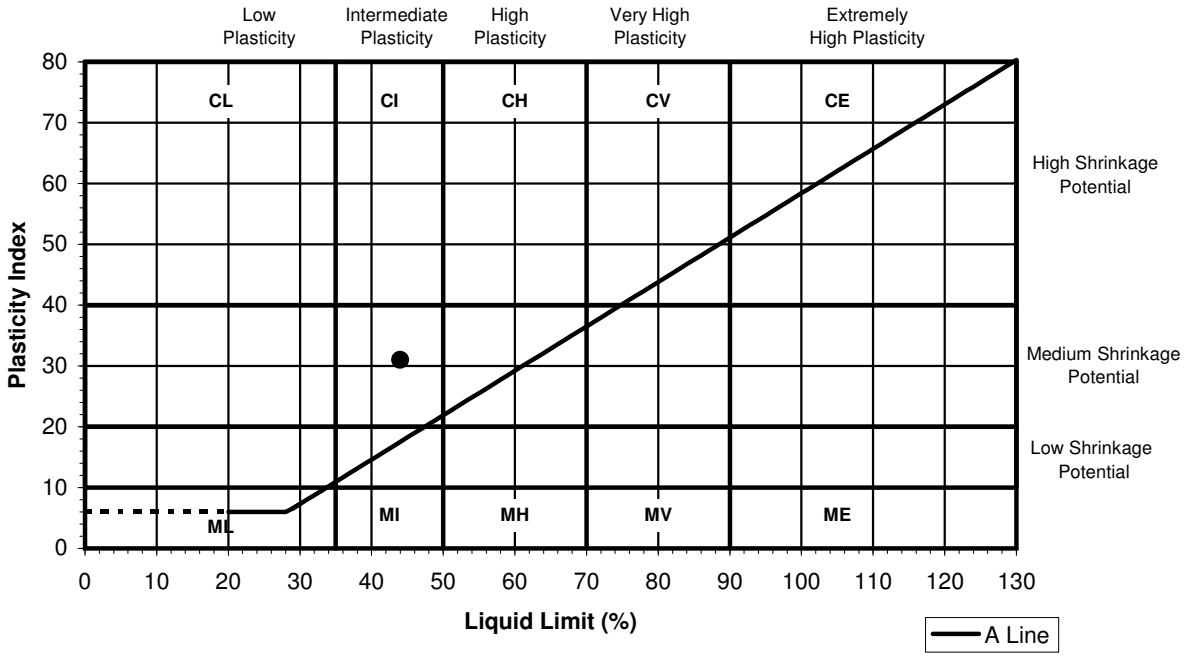
# Determination of Moisture Content and Atterberg Limits

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/03 |
| Client Address: | Cedar Barn, | Batch Number: | DAM0056598 |
| | White Lodge | | |
| | Walgrave | Client Reference: | STM3361D |
| Postcode: | NN6 9PY | Sampled by: | Client |
| Contact: | Andy Keeler | Date Sampled: | 12.10.15 |
| | | Date Received: | 12.10.15 |
| Site: | STM3361D Richmond College London | Tested From: | 14.10.15-15.10.15 |
| | | Sample Type: | Disturbed |

**Test Results:**

Description: Brown Sandy CLAY

| Laboratory Reference | Location | Depth (m) | As Received Moisture Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | % Passing 425µm |
|---|---|---|---|---|---|---|---|
| 45259849 | DTS102 | 0.90 | N/A | 44 | 13 | 31 | 93 |




Sample Preparation: As Received, Coarse particles removed by hand prior to test
Estimated % passing 425µm BS Test Sieve

Certified that the laboratory testing was carried out in accordance with BS 1377-2: 1990: Method 3.2, 4.4 and 5

Page: 1 of 1
Date: 23.10.15

**Signed**

[ ] M. Carr - Section Manager
[✓] D. Berrill - Laboratory Manager

For and on behalf of Environmental Scientifics Group

ESG
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

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TEST REPORT

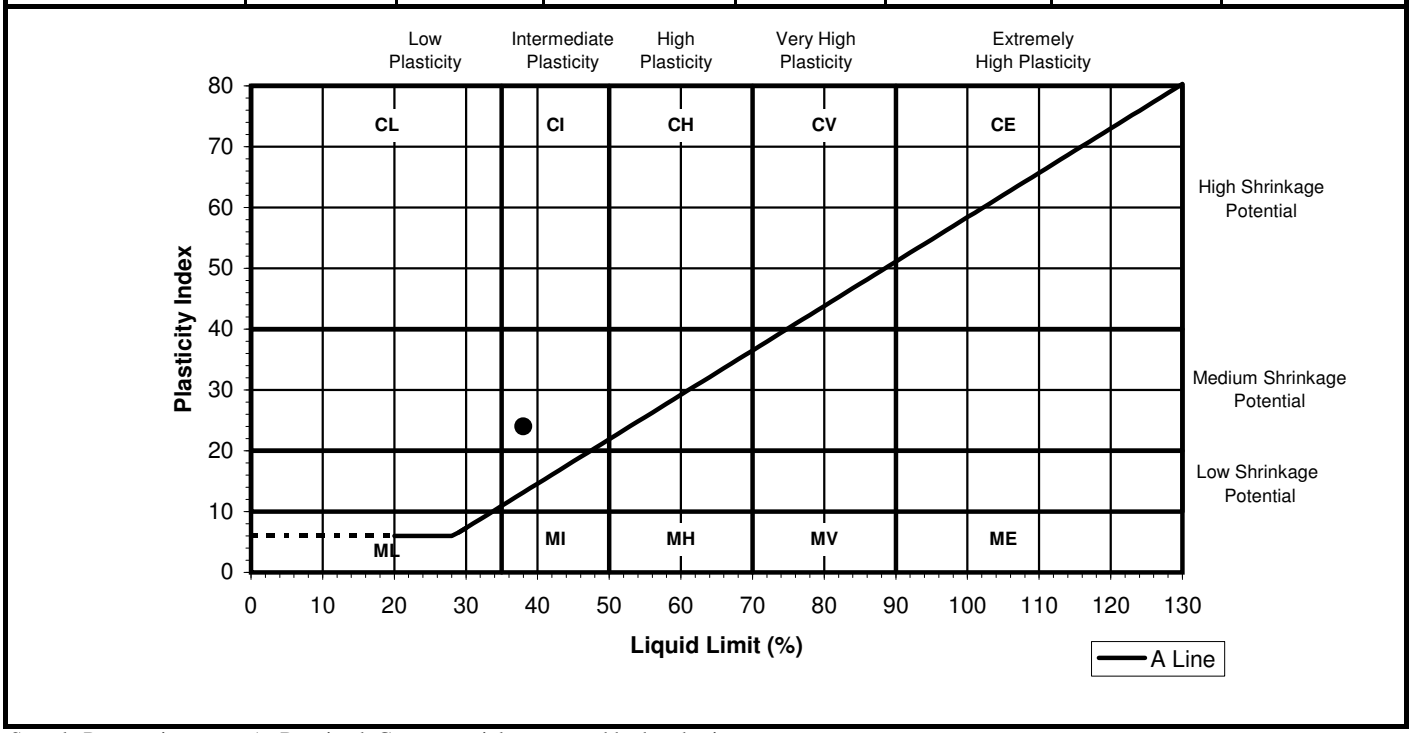
# Determination of Moisture Content and Atterberg Limits

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/04 |
| Client Address: | Cedar Barn, | Batch Number: | DAM0056598 |
| | White Lodge | | |
| | Walgrave | Client Reference: | STM3361D |
| Postcode: | NN6 9PY | Sampled by: | Client |
| Contact: | Andy Keeler | Date Sampled: | 12.10.15 |
| | | Date Received: | 12.10.15 |
| Site: | STM3361D Richmond College London | Tested From: | 14.10.15-15.10.15 |
| | | Sample Type: | Disturbed |

**Test Results:**

Description: Brown Sandy CLAY

| Laboratory Reference | Location | Depth (m) | As Received Moisture Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | % Passing 425µm |
|---|---|---|---|---|---|---|---|
| 45259850 | DTS109 | 1.00 | N/A | 38 | 14 | 24 | 84 |




Sample Preparation: As Received, Coarse particles removed by hand prior to test
Estimated % passing 425µm BS Test Sieve

Certified that the laboratory testing was carried out in accordance with BS 1377-2: 1990: Method 3.2, 4.4 and 5

Page: 1 of 1
Date: 23.10.15

**Signed**

[ ] M. Carr - Section Manager
[✓] D. Berrill - Laboratory Manager

For and on behalf of Environmental Scientifics Group

ESG
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

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TEST REPORT

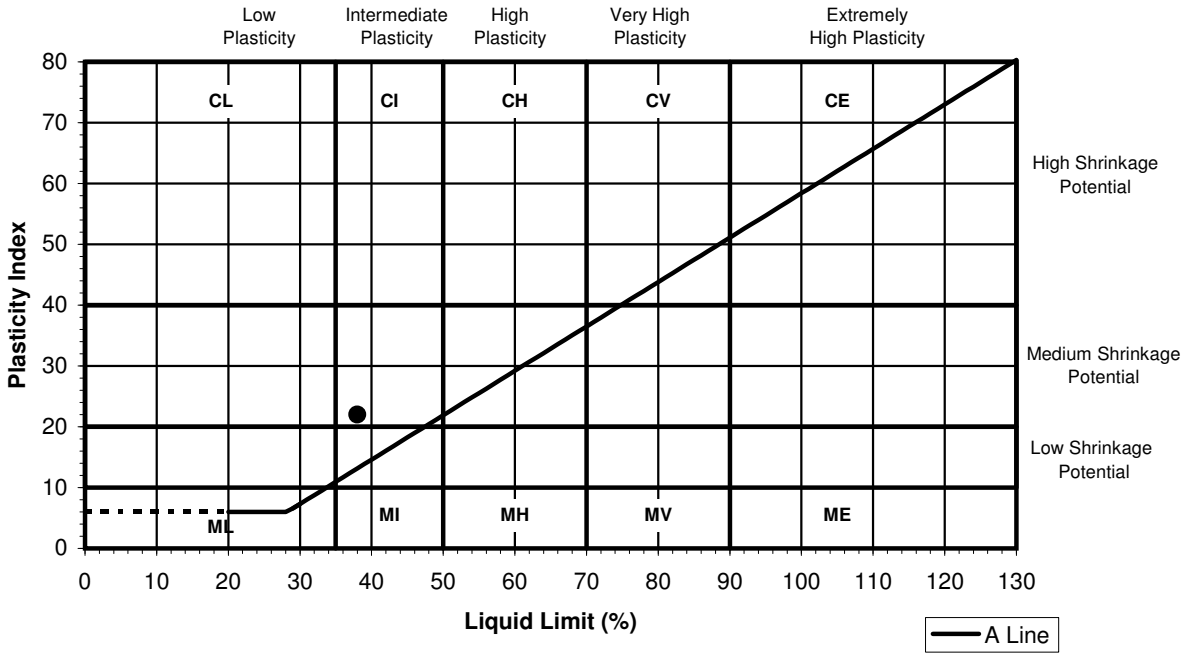
# Determination of Moisture Content and Atterberg Limits

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/05 |
| Client Address: | Cedar Barn, | Batch Number: | DAM0056598 |
| | White Lodge | | |
| | Walgrave | Client Reference: | STM3361D |
| Postcode: | NN6 9PY | Sampled by: | Client |
| Contact: | Andy Keeler | Date Sampled: | 12.10.15 |
| | | Date Received: | 12.10.15 |
| Site: | STM3361D Richmond College London | Tested From: | 14.10.15-15.10.15 |
| | | Sample Type: | Disturbed |

**Test Results:**

Description: Brown Sandy Silty CLAY

| Laboratory Reference | Location | Depth (m) | As Received Moisture Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | % Passing 425µm |
|---|---|---|---|---|---|---|---|
| 45259851 | TP104 | 0.80 | N/A | 38 | 16 | 22 | 100 |




Sample Preparation: As Received, Coarse particles removed by hand prior to test
Estimated % passing 425µm BS Test Sieve

Certified that the laboratory testing was carried out in accordance with BS 1377-2: 1990: Method 3.2, 4.4 and 5

Page: 1 of 1
Date: 23.10.15

**Signed**

[ ] M. Carr - Section Manager
[✓] D. Berrill - Laboratory Manager

For and on behalf of Environmental Scientifics Group

ESG
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

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TEST REPORT

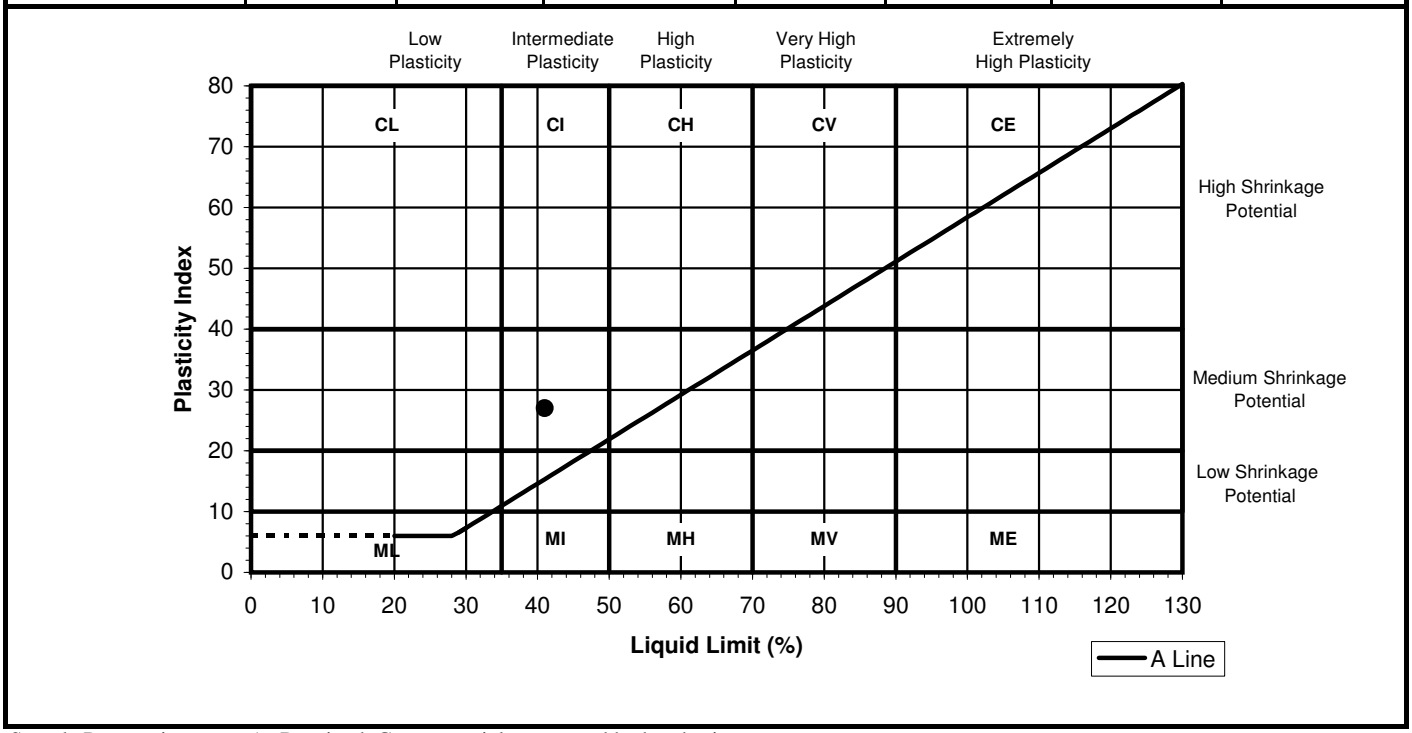
# Determination of Moisture Content and Atterberg Limits

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/06 |
| Client Address: | Cedar Barn, | Batch Number: | DAM0056598 |
| | White Lodge | | |
| | Walgrave | Client Reference: | STM3361D |
| Postcode: | NN6 9PY | Sampled by: | Client |
| Contact: | Andy Keeler | Date Sampled: | 12.10.15 |
| | | Date Received: | 12.10.15 |
| Site: | STM3361D Richmond College London | Tested From: | 14.10.15-15.10.15 |
| | | Sample Type: | Disturbed |

**Test Results:**

Description: Brown Sandy Silty CLAY

| Laboratory Reference | Location | Depth (m) | As Received Moisture Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | % Passing 425µm |
|---|---|---|---|---|---|---|---|
| 45259852 | TP105 | 0.80 | N/A | 41 | 14 | 27 | 100 |




Sample Preparation: As Received, Coarse particles removed by hand prior to test
Estimated % passing 425µm BS Test Sieve

Certified that the laboratory testing was carried out in accordance with BS 1377-2: 1990: Method 3.2, 4.4 and 5

Page: 1 of 1
Date: 23.10.15

**Signed**

[ ] M. Carr - Section Manager
[✓] D. Berrill - Laboratory Manager

For and on behalf of Environmental Scientifics Group

ESG
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

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TEST REPORT

# Determination of Particle Size Distribution

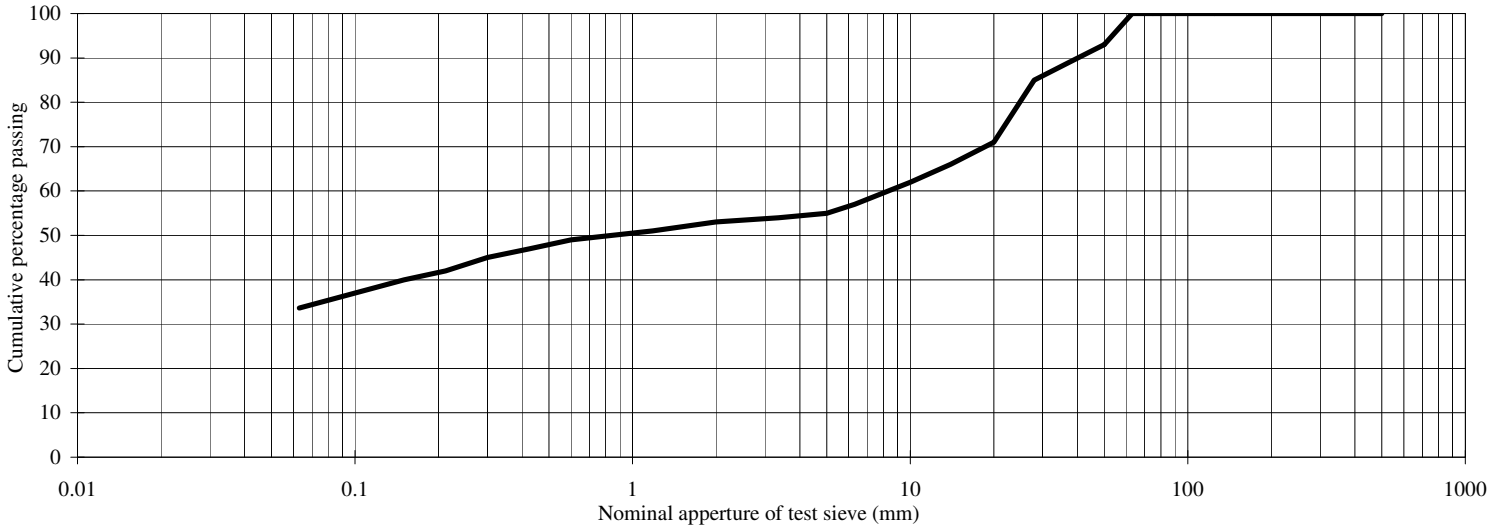
| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/07 |
| Client Address: | Cedar Barn, White Lodge Walgrave | Batch Number: | DAM0056598 |
| | | Lab Ref: | 45259846 |
| Postcode: | NN6 9PY | Client Ref: | 1 |
| Contact: | Andy Keeler | Location: | TP108 |
| | | Depth (m): | 1.00 |
| Site: | STM3361D Richmond College London | | |
| | | Date Sampled: | 12.10.15 |
| Sampled by: | Client | Date Received: | 12.10.15 |
| Sampled from: | Site | Date Tested: | 21.10.15 |
| Supplier: | Client | Sample Type: | Bulk |
| Source: | Site | Sample Mass (kg): | 12.8 |

Description: Brown CLAY with Gravel

Specification: Not Required

Comments:

| SIEVE ANALYSIS | | |
|---|---|---|
| BS Sieve (mm) | Passing (%) | Material Specification |
| 500 | 100 | |
| 300 | 100 | |
| 125 | 100 | |
| 100 | 100 | |
| 90 | 100 | |
| 75 | 100 | |
| 63 | 100 | |
| 50 | 93 | |
| 37.5 | 89 | |
| 28 | 85 | |
| 20 | 71 | |
| 14 | 66 | |
| 10 | 62 | |
| 6.3 | 57 | |
| 5 | 55 | |
| 3.35 | 54 | |
| 2 | 53 | |
| 1.18 | 51 | |
| 0.600 | 49 | |
| 0.425 | 47 | |
| 0.300 | 45 | |
| 0.212 | 42 | |
| 0.150 | 40 | |
| 0.063 | 33.6 | |




Certified that the Particle Size Distribution was determined in accordance with BS 1377 - 2 : 1990, Method 9.2. Washing & Dry Sieving
Method of Preparation: BS 1377 - 1 & 2 : 1990

Page: 1 of 1
Date: 23.10.15

**Signed:** _____

[ ] M. Carr - Section Manager
[✓] D. Berrill - Laboratory Manager

For and on behalf of Environmental Scientifics Group

ESG
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

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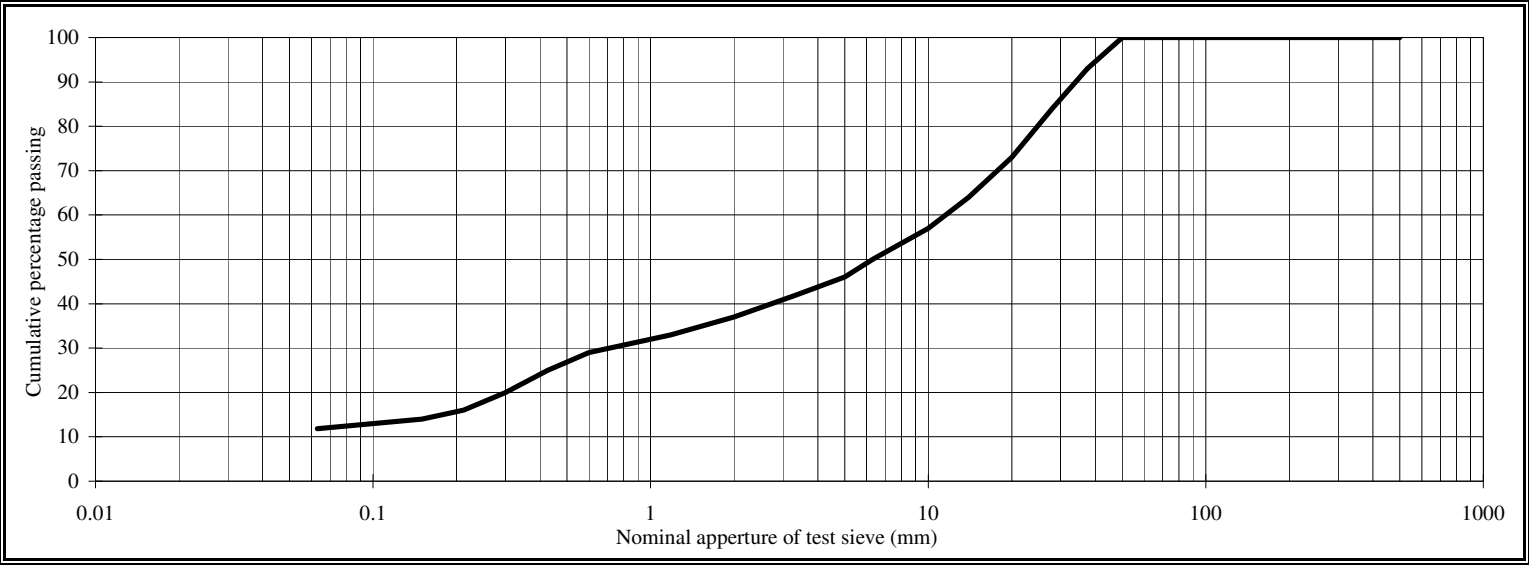
TEST REPORT

# Determination of Particle Size Distribution

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/08 |
| Client Address: | Cedar Barn, White Lodge Walgrave | Batch Number: | DAM0056598 |
| | | Lab Ref: | 45259853 |
| Postcode: | NN6 9PY | Client Ref: | 8 |
| Contact: | Andy Keeler | Location: | TP102A |
| | | Depth (m): | 1.50 |
| Site: | STM3361D Richmond College London | | |
| | | Date Sampled: | 12.10.15 |
| Sampled by: | Client | Date Received: | 12.10.15 |
| Sampled from: | Site | Date Tested: | 21.10.15 |
| Supplier: | Client | Sample Type: | Bulk |
| Source: | Site | Sample Mass (kg): | 9.9 |
| Description: | Brown Sandy Gravel | | |
| Specification: | Not Required | | |
| Comments: | | | |

| SIEVE ANALYSIS | | |
|---|---|---|
| BS Sieve (mm) | Passing (%) | Material Specification |
| 500 | 100 | |
| 300 | 100 | |
| 125 | 100 | |
| 100 | 100 | |
| 90 | 100 | |
| 75 | 100 | |
| 63 | 100 | |
| 50 | 100 | |
| 37.5 | 93 | |
| 28 | 84 | |
| 20 | 73 | |
| 14 | 64 | |
| 10 | 57 | |
| 6.3 | 50 | |
| 5 | 46 | |
| 3.35 | 42 | |
| 2 | 37 | |
| 1.18 | 33 | |
| 0.600 | 29 | |
| 0.425 | 25 | |
| 0.300 | 20 | |
| 0.212 | 16 | |
| 0.150 | 14 | |
| 0.063 | 11.8 | |




Certified that the Particle Size Distribution was determined in accordance with BS 1377 - 2 : 1990, Method 9.2. Washing & Dry Sieving
Method of Preparation: BS 1377 - 1 & 2 : 1990

Page: 1 of 1
Date: 23.10.15

**Signed:** _____

[ ] M. Carr - Section Manager
[✓] D. Berrill - Laboratory Manager

For and on behalf of Environmental Scientifics Group

ESG
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

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TEST REPORT

# Determination of Undrained Shear Strength in Triaxial Compression

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/09 |
| | Cedar Barn, | Batch Number: | DAM0056847 |
| | White Lodge | Date Sampled: | Not Advised |
| | Walgrave | Date Received: | 22.10.15 |
| | NN6 9PY | Date Tested: | 02.11.15 |
| Contact: | Andy Keeler | Sampled By: | Client |
| Site: | Richmond College, London | Sampling Certificate: | Not Received |
| | | Sample Type: | U100 |

| Sample Details: | Laboratory Reference: | 45261171 | 45261172 | 45261173 |
|---|---|---|---|---|
| | Client Ref: | STM3361D | STM3361D | STM3361D |
| | Location: | BHA | BHA | BHA |
| | Depth (m): | 9.00 | 16.50-16.95 | 21.00-21.45 |
| | Initial Height (mm) | 210 | 210 | 210 |
| | Initial Diameter (mm) | 103 | 103 | 103 |
| | Bulk Density (Mg/m³) | 1.97 | 1.98 | 2.02 |
| | Moisture Content (%) | 29 | 25 | 25 |
| | Dry Density (Mg/m³) | 1.53 | 1.58 | 1.61 |
| Test Conditions: | Cell Pressure (kPa) | 180 | 330 | 420 |
| | Rate of Strain (%/min.) | 1.19 | 1.19 | 1.19 |
| Failure Conditions: | Load at Failure (kN) | 1.655 | 2.925 | 3.423 |
| | Strain at Failure (mm) | 6.40 | 14.00 | 28.40 |
| | Max Deviator Stress (kPa) | 182 | 309 | 332 |
| | Membrane Correction (kPa) | 0.32 | 0.62 | 1.10 |
| | Strain (%) | 3.0 | 6.7 | 13.5 |
| | Shear Strength (kPa) | 91 | 154 | 166 |

Failure Diagram:

| | | | |
|---|---|---|---|
| Mode of Failure: | Shear/Barrel | Shear/Barrel | Shear/Barrel |
| Depth of test specimen from base within original sample (mm) | 13 | 14 | 6 |
| Membrane Latex Rubber Thickness (mm) | 0.40 | 0.40 | 0.40 |

Sample Description:

| | |
|---|---|
| 45261171 | Grey CLAY |
| 45261172 | Grey CLAY |
| 45261173 | Grey CLAY |

Comments: Sample Preparation: Undisturbed
Orientation: Maintaining sample direction.

Certified that the test was carried out in accordance with BS 1377-7 :1990, Method 8
Certified that the Moisture Content was determined in accordance with BS 1377-2:1990, Method 3.2

Page 1 of 1
Date: 04.11.15

**Signed:** M. Carr

[✓] M. Carr - Section Manager
[ ] D. Berrill - Laboratory Manager

For and on behalf of Environmental Scientifics Group

ESG
2 Newton Close
Drayton Fields Industrial Estate
Daventry
Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

0001

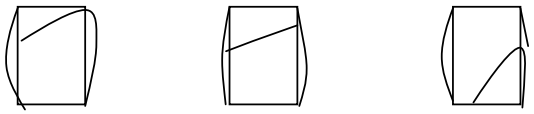
TEST REPORT

# Determination of Undrained Shear Strength in Triaxial Compression

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/10 |
| | Cedar Barn, | Batch Number: | DAM0056847 |
| | White Lodge | Date Sampled: | Not Advised |
| | Walgrave | Date Received: | 22.10.15 |
| | NN6 9PY | Date Tested: | 02.11.15 |
| Contact: | Andy Keeler | Sampled By: | Client |
| Site: | Richmond College, London | Sampling Certificate: | Not Received |
| | | Sample Type: | U100 |

| Sample Details: | Laboratory Reference: | 45261174 | 45261175 | 45261176 |
|---|---|---|---|---|
| | Client Ref: | STM3361D | STM3361D | STM3361D |
| | Location: | BHC | BHC | BHC |
| | Depth (m): | 7.20-7.65 | 13.50-13.95 | 18.00-18.45 |
| | Initial Height (mm) | 210 | 210 | 210.1 |
| | Initial Diameter (mm) | 103 | 103 | 103 |
| | Bulk Density (Mg/m³) | 1.96 | 1.98 | 2.00 |
| | Moisture Content (%) | 30 | 26 | 27 |
| | Dry Density (Mg/m³) | 1.51 | 1.57 | 1.58 |
| Test Conditions: | Cell Pressure (kPa) | 145 | 270 | 360 |
| | Rate of Strain (%/min.) | 1.19 | 1.19 | 1.19 |
| Failure Conditions: | Load at Failure (kN) | 1.515 | 1.836 | 2.615 |
| | Strain at Failure (mm) | 9.60 | 6.60 | 7.00 |
| | Max Deviator Stress (kPa) | 167 | 198 | 282 |
| | Membrane Correction (kPa) | 0.45 | 0.33 | 0.34 |
| | Strain (%) | 4.6 | 3.1 | 3.3 |
| | Shear Strength (kPa) | 84 | 99 | 141 |

Failure Diagram:



| | | | |
|---|---|---|---|
| Mode of Failure: | Shear/Barrel | Shear/Barrel | Shear/Barrel |
| Depth of test specimen from base within original sample (mm) | 22 | 20 | 10 |
| Membrane Latex Rubber Thickness (mm) | 0.40 | 0.40 | 0.40 |

Sample Description:

45261174 Brown CLAY
45261175 Brown CLAY
45261176 Brown CLAY

Comments: Sample Preparation: Undisturbed
Orientation: Maintaining sample direction.

Certified that the test was carried out in accordance with BS 1377-7 :1990, Method 8
Certified that the Moisture Content was determined in accordance with BS 1377-2:1990, Method 3.2

Page 1 of 1
Date: 04.11.15

**Signed:** M. Carr

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Daventry
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Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

0001

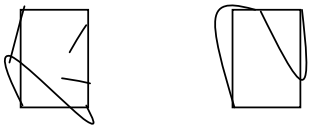
TEST REPORT

# Determination of Undrained Shear Strength in Triaxial Compression

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/11 |
| | Cedar Barn, | Batch Number: | DAM0056847 |
| | White Lodge | Date Sampled: | Not Advised |
| | Walgrave | Date Received: | 22.10.15 |
| | NN6 9PY | Date Tested: | 02.11.15 |
| Contact: | Andy Keeler | Sampled By: | Client |
| Site: | Richmond College, London | Sampling Certificate: | Not Received |
| | | Sample Type: | U100 |

| Sample Details: | Laboratory Reference: | 45261177 | 45261178 |
|---|---|---|---|
| | Client Ref: | STM3361D | STM3361D |
| | Location: | BHC | BHD |
| | Depth (m): | 22.70-23.15 | 12.00-12.45 |
| | Initial Height (mm) | 194.8 | 209.6 |
| | Initial Diameter (mm) | 103 | 103 |
| | Bulk Density (Mg/m³) | 1.92 | 2.03 |
| | Moisture Content (%) | 26 | 26 |
| | Dry Density (Mg/m³) | 1.52 | 1.61 |
| Test Conditions: | Cell Pressure (kPa) | 455 | 240 |
| | Rate of Strain (%/min.) | 1.28 | 1.19 |
| Failure Conditions: | Load at Failure (kN) | 2.460 | 2.575 |
| | Strain at Failure (mm) | 5.40 | 13.20 |
| | Max Deviator Stress (kPa) | 259 | 276 |
| | Membrane Correction (kPa) | 0.29 | 0.59 |
| | Strain (%) | 2.8 | 6.3 |
| | Shear Strength (kPa) | 130 | 138 |

Failure Diagram:



| | | |
|---|---|---|
| Mode of Failure: | Shear/Barrel | Shear/Barrel |
| Depth of test specimen from base within original sample (mm) | 43 | 8.9 |
| Membrane Latex Rubber Thickness (mm) | 0.40 | 0.40 |

Sample Description:
45261177 Brown CLAY with Silt
45261178 Brown CLAY

Comments: Sample Preparation: Undisturbed
Orientation: Maintaining sample direction.

Certified that the test was carried out in accordance with BS 1377-7 :1990, Method 8
Certified that the Moisture Content was determined in accordance with BS 1377-2:1990, Method 3.2

Page 1 of 1
Date: 04.11.15

**Signed:** M. Carr

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Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

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TEST REPORT

# Determination of Undrained Shear Strength in Triaxial Compression

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/12 |
| | Cedar Barn, | Batch Number: | DAM0057060 |
| | White Lodge | Date Sampled: | Not Advised |
| | Walgrave | Date Received: | 03.11.15 |
| | NN6 9PY | Date Tested: | 05.11.15 |
| Contact: | Andy Keeler | Sampled By: | Client |
| Site: | Richmond College, London | Sampling Certificate: | Not Received |
| | | Sample Type: | U100 |

| Sample Details: | Laboratory Reference: | 45262054 | 45262055 |
|---|---|---|---|
| | Client Ref: | STM3361D | STM3361D |
| | Location: | BHD | BHE |
| | Depth (m): | 5.00 | 21.00 |
| | Initial Height (mm) | 210 | 195 |
| | Initial Diameter (mm) | 103 | 103 |
| | Bulk Density (Mg/m³) | 1.95 | 1.98 |
| | Moisture Content (%) | 30 | 26 |
| | Dry Density (Mg/m³) | 1.51 | 1.57 |
| Test Conditions: | Cell Pressure (kPa) | 100 | 420 |
| | Rate of Strain (%/min.) | 1.19 | 1.28 |
| Failure Conditions: | Load at Failure (kN) | 1.106 | 2.401 |
| | Strain at Failure (mm) | 9.60 | 6.40 |
| | Max Deviator Stress (kPa) | 121 | 255 |
| | Membrane Correction (kPa) | 0.45 | 0.34 |
| | Strain (%) | 4.6 | 3.3 |
| | Shear Strength (kPa) | 61 | 127 |

Failure Diagram:

| | | |
|---|---|---|
| Mode of Failure: | Shear/Barrel | Shear/Barrel |
| Depth of test specimen from base within original sample (mm) | 17 | 16 |
| Membrane Latex Rubber Thickness (mm) | 0.40 | 0.40 |

Sample Description:
45262054 Brown CLAY
45262055 Brown CLAY

Comments: Sample Preparation: Undisturbed
Orientation: Maintaining sample direction.

Certified that the test was carried out in accordance with BS 1377-7 :1990, Method 8
Certified that the Moisture Content was determined in accordance with BS 1377-2:1990, Method 3.2

Page 1 of 1
Date: 09.11.15

**Signed:** M. Carr

[✓] M. Carr - Section Manager
[ ] D. Berrill - Laboratory Manager

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Drayton Fields Industrial Estate
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Northants NN11 8RR
Telephone: +44 (0) 1327 703828
Facsimile: +44 (0) 1327 300154

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TEST REPORT

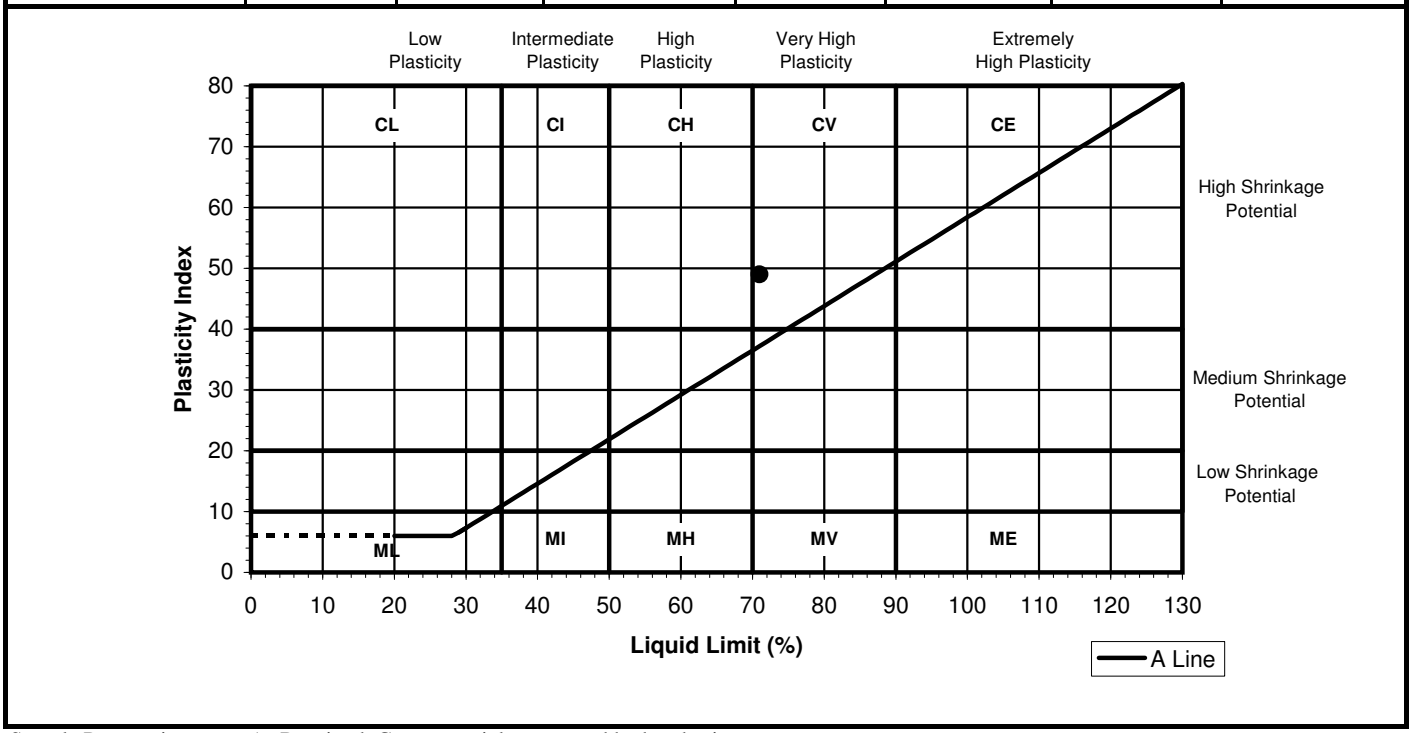
# Determination of Moisture Content and Atterberg Limits

| | | | |
|---|---|---|---|
| Client: | Soiltechnics Limited | Report No: | 51018346/15/13 |
| Client Address: | Cedar Barn, | Batch Number: | DAM0057060 |
| | White Lodge | | |
| | Walgrave | Client Reference: | STM3361D |
| Postcode: | NN6 9PY | Sampled by: | Client |
| Contact: | Andy Keeler | Date Sampled: | Not Advised |
| | | Date Received: | 03.11.15 |
| Site: | Richmond College London | Tested From: | 05.11.15-06.11.15 |
| | | Sample Type: | U100 |

**Test Results:**

Description: Grey brown slightly sandy CLAY with occasional Gravel

| Laboratory Reference | Location | Depth (m) | As Received Moisture Content (%) | Liquid Limit | Plastic Limit | Plasticity Index | % Passing 425µm |
|---|---|---|---|---|---|---|---|
| 45262056 | BHE | 5.80 | N/A | 71 | 22 | 49 | 98 |




Sample Preparation: As Received, Coarse particles removed by hand prior to test
Estimated % passing 425µm BS Test Sieve

Certified that the laboratory testing was carried out in accordance with BS 1377-2: 1990: Method 3.2, 4.4 and 5

Page: 1 of 1
Date: 09.11.15

**Signed** M. Carr

[✓] M. Carr - Section Manager
[ ] D. Berrill - Laboratory Manager

For and on behalf of Environmental Scientifics Group

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

# Final Report

| | |
|---|---|
| **Report No.:** | 15-24149-1 |
| **Initial Date of Issue:** | 23-Oct-2015 |
| **Client** | Soiltechnics Limited |
| **Client Address:** | Cedar Barn<br>White Lodge<br>Walgrave<br>Northampton<br>Northamptonshire<br>NN6 9PY |
| **Contact(s):** | Rachel Brown<br>Sara Bertholdson |
| **Project** | STM3361D - Richmond Upon Thames College, London |

| | | | |
|---|---|---|---|
| **Quotation No.:** | | **Date Received:** | 13-Oct-2015 |
| **Order No.:** | 20111 | **Date Instructed:** | 15-Oct-2015 |
| **No. of Samples:** | 3 | **Target Date:** | 23-Oct-2015 |
| **Turnaround (Wkdays):** | 7 | **Results Due:** | 23-Oct-2015 |
| **Date Approved:** | 23-Oct-2015 | | |

**Approved By:**

**Details:** Robert Monk, Technical Development Chemist

Chemtest
The right chemistry to deliver results

# Results - 2 Stage WAC

| | | | | | | | Landfill Waste Acceptance Criteria Limits | | |
|---|---|---|---|---|---|---|---|---|---|
| **Chemtest Job No:** | 15-24149 | | | | | | **Inert Waste Landfill** | **Stable Non-reactive Hazardous waste in non-hazardous Landfill** | **Hazardous Waste Landfill** |
| **Chemtest Sample ID:** | 205428 | | | | | | | | |
| **Sample Ref:** | WAC-CS1 | | | | | | | | |
| **Sample ID:** | 2-001 | | | | | | | | |
| **Top Depth(m):** | 0.00 | | | | | | | | |
| **Bottom Depth(m):** | | | | | | | | | |
| **Sampling Date:** | 13-Oct-2015 | | | | | | | | |
| **Determinand** | **SOP** | **Accred.** | **Units** | | | | | | |
| Total Organic Carbon | 2625 | U | % | | | 3.7 | 3 | 5 | 6 |
| Loss On Ignition | 2610 | U | % | | | 13 | -- | -- | 10 |
| Total BTEX | 2760 | U | mg/kg | | | < 0.010 | 6 | -- | -- |
| Total PCBs (7 Congeners) | 2815 | U | mg/kg | | | < 0.10 | 1 | -- | -- |
| TPH Total WAC (Mineral Oil) | 2670 | U | mg/kg | | | 92 | 500 | -- | -- |
| Total (Of 17) PAH's | 2700 | N | mg/kg | | | 64 | 100 | -- | -- |
| pH | 2010 | U | | | | 8.8 | -- | >6 | -- |
| Acid Neutralisation Capacity | 2015 | N | mol/kg | | | 0.030 | -- | To evaluate | To evaluate |
| **Eluate Analysis** | | | **2:1 mg/l** | **8:1 mg/l** | **2:1 mg/kg** | **Cumulative 10:1 mg/kg** | **Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg** | | |
| Arsenic | 1450 | U | 0.0079 | 0.0096 | < 0.050 | 0.094 | 0.5 | 2 | 25 |
| Barium | 1450 | U | 0.020 | 0.014 | < 0.50 | < 0.50 | 20 | 100 | 300 |
| Cadmium | 1450 | U | < 0.00010 | < 0.00010 | < 0.010 | < 0.010 | 0.04 | 1 | 5 |
| Chromium | 1450 | U | 0.0013 | 0.0020 | < 0.050 | < 0.050 | 0.5 | 10 | 70 |
| Copper | 1450 | U | 0.0035 | 0.0043 | < 0.050 | < 0.050 | 2 | 50 | 100 |
| Mercury | 1450 | U | < 0.00050 | < 0.00050 | < 0.0010 | < 0.0050 | 0.01 | 0.2 | 2 |
| Molybdenum | 1450 | U | 0.0030 | 0.0016 | < 0.050 | < 0.050 | 0.5 | 10 | 30 |
| Nickel | 1450 | U | < 0.0010 | < 0.0010 | < 0.050 | < 0.050 | 0.4 | 10 | 40 |
| Lead | 1450 | U | < 0.0010 | 0.0062 | < 0.010 | 0.055 | 0.5 | 10 | 50 |
| Antimony | 1450 | U | 0.0039 | 0.0035 | < 0.010 | 0.035 | 0.06 | 0.7 | 5 |
| Selenium | 1450 | U | 0.0018 | 0.0014 | < 0.010 | 0.014 | 0.1 | 0.5 | 7 |
| Zinc | 1450 | U | 0.0044 | 0.0074 | < 0.50 | < 0.50 | 4 | 50 | 200 |
| Chloride | 1220 | U | 2.0 | 1.6 | < 10 | 16 | 800 | 15000 | 25000 |
| Fluoride | 1220 | U | 0.89 | 0.65 | 1.8 | 6.8 | 10 | 150 | 500 |
| Sulphate | 1220 | U | 12 | < 1.0 | 24 | 14 | 1000 | 20000 | 50000 |
| Total Dissolved Solids | 1020 | N | 96 | 64 | 190 | 680 | 4000 | 60000 | 100000 |
| Phenol Index | 1920 | U | < 0.030 | < 0.030 | < 0.30 | < 0.50 | 1 | - | - |
| Dissolved Organic Carbon | 1610 | U | 10 | < 2.5 | < 50 | < 50 | 500 | 800 | 1000 |

| **Soild Information** | |
|---|---|
| Dry mass of test portion/kg | 0.175 |
| Moisture (%) | 3.9 |

| **Leachate Test Information** | |
|---|---|
| Leachant volume 1st extract/l | 0.343 |
| Leachant volume 2nd extract/l | 1.400 |
| Eluant recovered from 1st extract/l | 0.205 |

Chemtest
The right chemistry to deliver results

# Results - 2 Stage WAC

| Chemtest Job No: | | | | | | | Landfill Waste Acceptance Criteria Limits | | |
|---|---|---|---|---|---|---|---|---|---|
| Chemtest Sample ID: | 15-24149 | | | | | | | | |
| Sample Ref: | 205429 | | | | | | | | |
| Sample ID: | WAC-CS2 | | | | | | | | |
| Top Depth(m): | 2-002 | | | | | | Inert Waste Landfill | Stable Non-reactive Hazardous waste in non-hazardous Landfill | Hazardous Waste Landfill |
| Bottom Depth(m): | 0.00 | | | | | | | | |
| Sampling Date: | | | | | | | | | |
| **Determinand** | **SOP** | **Accred.** | **Units** | | | | | | |
| Total Organic Carbon | 2625 | U | % | | | 2.4 | 3 | 5 | 6 |
| Loss On Ignition | 2610 | U | % | | | 4.8 | -- | -- | 10 |
| Total BTEX | 2760 | U | mg/kg | | | < 0.010 | 6 | -- | -- |
| Total PCBs (7 Congeners) | 2815 | U | mg/kg | | | < 0.10 | 1 | -- | -- |
| TPH Total WAC (Mineral Oil) | 2670 | U | mg/kg | | | < 10 | 500 | -- | -- |
| Total (Of 17) PAH's | 2700 | N | mg/kg | | | 170 | 100 | -- | -- |
| pH | 2010 | U | | | | 8.7 | -- | >6 | -- |
| Acid Neutralisation Capacity | 2015 | N | mol/kg | | | 0.038 | -- | To evaluate | To evaluate |
| **Eluate Analysis** | | | **2:1 mg/l** | **8:1 mg/l** | **2:1 mg/kg** | **Cumulative 10:1 mg/kg** | **Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg** | | |
| Arsenic | 1450 | U | 0.0064 | 0.0059 | < 0.050 | 0.060 | 0.5 | 2 | 25 |
| Barium | 1450 | U | 0.011 | 0.0074 | < 0.50 | < 0.50 | 20 | 100 | 300 |
| Cadmium | 1450 | U | 0.00011 | < 0.00010 | < 0.010 | < 0.010 | 0.04 | 1 | 5 |
| Chromium | 1450 | U | < 0.0010 | < 0.0010 | < 0.050 | < 0.050 | 0.5 | 10 | 70 |
| Copper | 1450 | U | 0.0031 | 0.0026 | < 0.050 | < 0.050 | 2 | 50 | 100 |
| Mercury | 1450 | U | < 0.00050 | < 0.00050 | < 0.0010 | < 0.0050 | 0.01 | 0.2 | 2 |
| Molybdenum | 1450 | U | 0.0043 | 0.0014 | < 0.050 | < 0.050 | 0.5 | 10 | 30 |
| Nickel | 1450 | U | 0.0010 | < 0.0010 | < 0.050 | < 0.050 | 0.4 | 10 | 40 |
| Lead | 1450 | U | < 0.0010 | 0.0024 | < 0.010 | 0.021 | 0.5 | 10 | 50 |
| Antimony | 1450 | U | 0.0048 | 0.0023 | < 0.010 | 0.026 | 0.06 | 0.7 | 5 |
| Selenium | 1450 | U | 0.0013 | < 0.0010 | < 0.010 | < 0.010 | 0.1 | 0.5 | 7 |
| Zinc | 1450 | U | 0.0022 | 0.0025 | < 0.50 | < 0.50 | 4 | 50 | 200 |
| Chloride | 1220 | U | 4.4 | 1.9 | < 10 | 22 | 800 | 15000 | 25000 |
| Fluoride | 1220 | U | 0.86 | 0.51 | 1.7 | 5.5 | 10 | 150 | 500 |
| Sulphate | 1220 | U | 21 | 8.7 | 42 | 100 | 1000 | 20000 | 50000 |
| Total Dissolved Solids | 1020 | N | 130 | 69 | 260 | 760 | 4000 | 60000 | 100000 |
| Phenol Index | 1920 | U | < 0.030 | < 0.030 | < 0.30 | < 0.50 | 1 | - | - |
| Dissolved Organic Carbon | 1610 | U | 8.0 | 5.3 | < 50 | 56 | 500 | 800 | 1000 |

| Soild Information | |
|---|---|
| Dry mass of test portion/kg | 0.175 |
| Moisture (%) | 8.5 |

| Leachate Test Information | |
|---|---|
| Leachant volume 1st extract/l | 0.334 |
| Leachant volume 2nd extract/l | 1.400 |
| Eluant recovered from 1st extract/l | 0.210 |

Chemtest
The right chemistry to deliver results

# Results - 2 Stage WAC

| Chemtest Job No: | | | | | | | Landfill Waste Acceptance Criteria Limits | | |
|---|---|---|---|---|---|---|---|---|---|
| Chemtest Sample ID: | 15-24149 | | | | | | | | |
| Sample Ref: | 205430 | | | | | | | | |
| Sample ID: | WAC-CS3 | | | | | | | | |
| Top Depth(m): | 2-003 | | | | | | Inert Waste Landfill | Stable Non-reactive Hazardous waste in non-hazardous Landfill | Hazardous Waste Landfill |
| Bottom Depth(m): | 0.00 | | | | | | | | |
| Sampling Date: | | | | | | | | | |
| **Determinand** | **SOP** | **Accred.** | **Units** | | | | | | |
| Total Organic Carbon | 2625 | U | % | | | 11 | 3 | 5 | 6 |
| Loss On Ignition | 2610 | U | % | | | 8.6 | -- | -- | 10 |
| Total BTEX | 2760 | U | mg/kg | | | < 0.010 | 6 | -- | -- |
| Total PCBs (7 Congeners) | 2815 | U | mg/kg | | | < 0.10 | 1 | -- | -- |
| TPH Total WAC (Mineral Oil) | 2670 | U | mg/kg | | | 250 | 500 | -- | -- |
| Total (Of 17) PAH's | 2700 | N | mg/kg | | | 650 | 100 | -- | -- |
| pH | 2010 | U | | | | 9.0 | -- | >6 | -- |
| Acid Neutralisation Capacity | 2015 | N | mol/kg | | | 0.031 | -- | To evaluate | To evaluate |
| **Eluate Analysis** | | | **2:1 mg/l** | **8:1 mg/l** | **2:1 mg/kg** | **Cumulative 10:1 mg/kg** | **Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg** | | |
| Arsenic | 1450 | U | 0.0083 | 0.0057 | < 0.050 | 0.060 | 0.5 | 2 | 25 |
| Barium | 1450 | U | 0.015 | 0.0077 | < 0.50 | < 0.50 | 20 | 100 | 300 |
| Cadmium | 1450 | U | < 0.00010 | < 0.00010 | < 0.010 | < 0.010 | 0.04 | 1 | 5 |
| Chromium | 1450 | U | 0.0060 | 0.0026 | < 0.050 | < 0.050 | 0.5 | 10 | 70 |
| Copper | 1450 | U | 0.0025 | 0.0019 | < 0.050 | < 0.050 | 2 | 50 | 100 |
| Mercury | 1450 | U | < 0.00050 | < 0.00050 | < 0.0010 | < 0.0050 | 0.01 | 0.2 | 2 |
| Molybdenum | 1450 | U | 0.0057 | 0.0022 | < 0.050 | < 0.050 | 0.5 | 10 | 30 |
| Nickel | 1450 | U | < 0.0010 | < 0.0010 | < 0.050 | < 0.050 | 0.4 | 10 | 40 |
| Lead | 1450 | U | 0.0016 | 0.0024 | < 0.010 | 0.023 | 0.5 | 10 | 50 |
| Antimony | 1450 | U | 0.0023 | 0.0010 | < 0.010 | 0.012 | 0.06 | 0.7 | 5 |
| Selenium | 1450 | U | 0.0014 | < 0.0010 | < 0.010 | < 0.010 | 0.1 | 0.5 | 7 |
| Zinc | 1450 | U | 0.0041 | 0.0035 | < 0.50 | < 0.50 | 4 | 50 | 200 |
| Chloride | 1220 | U | 5.4 | 1.3 | 11 | 19 | 800 | 15000 | 25000 |
| Fluoride | 1220 | U | 0.54 | 0.23 | 1.1 | 2.7 | 10 | 150 | 500 |
| Sulphate | 1220 | U | 83 | 14 | 160 | 240 | 1000 | 20000 | 50000 |
| Total Dissolved Solids | 1020 | N | 170 | 67 | 340 | 810 | 4000 | 60000 | 100000 |
| Phenol Index | 1920 | U | < 0.030 | < 0.030 | < 0.30 | < 0.50 | 1 | - | - |
| Dissolved Organic Carbon | 1610 | U | 8.1 | < 2.5 | < 50 | < 50 | 500 | 800 | 1000 |

| Soild Information | |
|---|---|
| Dry mass of test portion/kg | 0.175 |
| Moisture (%) | 13 |

| Leachate Test Information | |
|---|---|
| Leachant volume 1st extract/l | 0.325 |
| Leachant volume 2nd extract/l | 1.400 |
| Eluant recovered from 1st extract/l | 0.241 |

Chemtest
The right chemistry to deliver results

## Report Information

### Key

| | |
|---|---|
| U | UKAS accredited |
| M | MCERTS and UKAS accredited |
| N | Unaccredited |
| S | This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis |
| SN | This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis |
| T | This analysis has been subcontracted to an unaccredited laboratory |
| I/S | Insufficient Sample |
| U/S | Unsuitable Sample |
| N/E | not evaluated |
| < | "less than" |
| > | "greater than" |

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVCOs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container

### Sample Retention and Disposal

All soil samples will be retained for a period of 60 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk

Chemtest
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Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING 2183

# Final Report

| | |
|---|---|
| **Report No.:** | 15-24153-1 |
| **Initial Date of Issue:** | 20-Oct-2015 |
| **Client** | Soiltechnics Limited |
| **Client Address:** | Cedar Barn<br>White Lodge<br>Walgrave<br>Northampton<br>Northamptonshire<br>NN6 9PY |
| **Contact(s):** | Rachel Brown<br>Sara Bertholdson |
| **Project** | STM3361D - Richmond Upon Thames College, London |

| | | | |
|---|---|---|---|
| **Quotation No.:** | | **Date Received:** | 15-Oct-2015 |
| **Order No.:** | 20110 | **Date Instructed:** | 15-Oct-2015 |
| **No. of Samples:** | 30 | **Target Date:** | 19-Oct-2015 |
| **Turnaround (Wkdays):** | 5 | **Results Due:** | 21-Oct-2015 |
| **Date Approved:** | 20-Oct-2015 | | |

**Approved By:**

**Details:** Keith Jones, Technical Manager

Chemtest
The right chemistry to deliver results

# Results - Leachate

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | | | Chemtest Job No.: | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quotation No.: | | | | Chemtest Sample ID.: | 205449 | 205450 | 205451 | 205452 | 205453 | 205455 | 205457 | 205459 | 205464 |
| Order No.: 20110 | | | | Client Sample Ref.: | DTS101 | DTS102 | DTS103 | DTS104 | DTS105 | DTS107 | DTS109 | DTS111 | DTS115 |
| | | | | Client Sample ID.: | 1-018 | 1-014 | 1-011 | 1-008 | 1-002 | 1-036 | 1-032 | 1-026 | 1-063 |
| | | | | Sample Type: | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL |
| | | | | Top Depth (m): | 0.50 | 0.50 | 0.30 | 0.35 | 0.50 | 0.60 | 0.50 | 0.40 | 0.50 |
| | | | | Bottom Depth (m): | | | | | | | | | |
| | | | | Date Sampled: | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 09-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | | | | | | | |
| pH | U | 1010 | | N/A | 9.1 | | 9.2 | | 7.9 | 7.4 | 7.5 | | 8.3 |
| Nitrate | U | 1220 | mg/l | 0.50 | < 0.50 | | < 0.50 | | 0.97 | 19 | < 0.50 | | < 0.50 |
| Sulphate | U | 1220 | mg/l | 1.0 | 10 | | 8.9 | | 2.3 | 27 | 1.7 | | 2.2 |
| Cyanide (Total) | U | 1300 | mg/l | 0.050 | < 0.050 | | < 0.050 | | < 0.050 | < 0.050 | < 0.050 | | < 0.050 |
| Cyanide (Free) | U | 1300 | mg/l | 0.050 | < 0.050 | | < 0.050 | | < 0.050 | < 0.050 | < 0.050 | | < 0.050 |
| Cyanide (Complex) | U | 1300 | mg/l | 0.050 | < 0.050 | | < 0.050 | | < 0.050 | < 0.050 | < 0.050 | | < 0.050 |
| Sulphide | U | 1325 | mg/l | 0.050 | < 0.050 | | < 0.050 | | < 0.050 | < 0.050 | < 0.050 | | < 0.050 |
| Arsenic (Dissolved) | U | 1450 | µg/l | 1.0 | 14 | | 5.9 | | 12 | 7.2 | 9.2 | | 2.2 |
| Boron (Dissolved) | U | 1450 | µg/l | 20 | < 20 | | < 20 | | < 20 | 150 | 140 | | < 20 |
| Beryllium (Dissolved) | U | 1450 | µg/l | 1.0 | < 1.0 | | < 1.0 | | < 1.0 | < 1.0 | < 1.0 | | < 1.0 |
| Cadmium (Dissolved) | U | 1450 | µg/l | 0.080 | < 0.080 | | < 0.080 | | < 0.080 | 0.15 | 0.083 | | < 0.080 |
| Chromium (Dissolved) | U | 1450 | µg/l | 1.0 | 2.1 | | < 1.0 | | < 1.0 | 6.1 | 1.6 | | < 1.0 |
| Copper (Dissolved) | U | 1450 | µg/l | 1.0 | 6.4 | | 3.2 | | 12 | 82 | 18 | | 2.8 |
| Mercury (Dissolved) | U | 1450 | µg/l | 0.50 | 0.73 | | < 0.50 | | < 0.50 | < 0.50 | 1.2 | | < 0.50 |
| Nickel (Dissolved) | U | 1450 | µg/l | 1.0 | < 1.0 | | < 1.0 | | < 1.0 | 6.5 | < 1.0 | | < 1.0 |
| Lead (Dissolved) | U | 1450 | µg/l | 1.0 | 40 | | 10 | | 47 | 39 | 60 | | 10 |
| Selenium (Dissolved) | U | 1450 | µg/l | 1.0 | < 1.0 | | < 1.0 | | < 1.0 | < 1.0 | < 1.0 | | < 1.0 |
| Vanadium (Dissolved) | U | 1450 | µg/l | 1.0 | 43 | | 22 | | 27 | 9.1 | 11 | | 2.8 |
| Zinc (Dissolved) | U | 1450 | µg/l | 1.0 | 13 | | 4.2 | | 15 | 190 | 40 | | 8.0 |
| Aliphatic TPH >C5-C6 | N | 1675 | µg/l | 0.010 | | < 0.010 | | < 0.010 | | | | < 0.010 | < 0.010 |
| Aliphatic TPH >C6-C8 | N | 1675 | µg/l | 0.010 | | < 0.010 | | < 0.010 | | | | < 0.010 | < 0.010 |
| Aliphatic TPH >C8-C10 | N | 1675 | µg/l | 0.10 | | < 0.10 | | < 0.10 | | | | < 0.10 | < 0.10 |
| Aliphatic TPH >C10-C12 | N | 1675 | µg/l | 0.10 | | < 0.10 | | < 0.10 | | | | < 0.10 | < 0.10 |
| Aliphatic TPH >C12-C16 | N | 1675 | µg/l | 0.10 | | < 0.10 | | < 0.10 | | | | < 0.10 | < 0.10 |
| Aliphatic TPH >C16-C21 | N | 1675 | µg/l | 0.10 | | < 0.10 | | < 0.10 | | | | < 0.10 | < 0.10 |
| Aliphatic TPH >C21-C35 | N | 1675 | µg/l | 0.10 | | < 0.10 | | < 0.10 | | | | < 0.10 | < 0.10 |
| Aliphatic TPH >C35-C44 | N | 1675 | µg/l | 0.10 | | < 0.10 | | < 0.10 | | | | < 0.10 | < 0.10 |
| Total Aliphatic Hydrocarbons | N | 1675 | µg/l | 1.0 | | < 1.0 | | < 1.0 | | | | < 1.0 | < 1.0 |
| Aromatic TPH >C5-C7 | N | 1675 | µg/l | 0.010 | | < 0.010 | | < 0.010 | | | | < 0.010 | < 0.010 |
| Aromatic TPH >C7-C8 | N | 1675 | µg/l | 0.010 | | < 0.010 | | < 0.010 | | | | < 0.010 | < 0.010 |
| Aromatic TPH >C8-C10 | N | 1675 | µg/l | 0.10 | | < 0.10 | | < 0.10 | | | | < 0.10 | < 0.10 |
| Aromatic TPH >C10-C12 | N | 1675 | µg/l | 0.10 | | < 0.10 | | < 0.10 | | | | 31 | < 0.10 |
| Aromatic TPH >C12-C16 | N | 1675 | µg/l | 0.10 | | < 0.10 | | < 0.10 | | | | 1000 | < 0.10 |
| Aromatic TPH >C16-C21 | N | 1675 | µg/l | 0.10 | | 8.3 | | 12 | | | | 2700 | 2.2 |
| Aromatic TPH >C21-C35 | N | 1675 | µg/l | 0.10 | | < 0.10 | | 31 | | | | 2300 | < 0.10 |
| Aromatic TPH >C35-C44 | N | 1675 | µg/l | 0.10 | | < 0.10 | | < 0.10 | | | | 180 | < 0.10 |
| Total Aromatic Hydrocarbons | N | 1675 | µg/l | 1.0 | | 8.3 | | 43 | | | | 6200 | 2.2 |

# Results - Leachate

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | | | | Chemtest Job No.: | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quotation No.: | | | | | Chemtest Sample ID.: | 205449 | 205450 | 205451 | 205452 | 205453 | 205455 | 205457 | 205459 | 205464 |
| Order No.: 20110 | | | | | Client Sample Ref.: | DTS101 | DTS102 | DTS103 | DTS104 | DTS105 | DTS107 | DTS109 | DTS111 | DTS115 |
| | | | | | Client Sample ID.: | 1-018 | 1-014 | 1-011 | 1-008 | 1-002 | 1-036 | 1-032 | 1-026 | 1-063 |
| | | | | | Sample Type: | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL |
| | | | | | Top Depth (m): | 0.50 | 0.50 | 0.30 | 0.35 | 0.50 | 0.60 | 0.50 | 0.40 | 0.50 |
| | | | | | Bottom Depth (m): | | | | | | | | | |
| | | | | | Date Sampled: | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 09-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | | | | | | | | |
| Total Petroleum Hydrocarbons | N | 1675 | µg/l | 2.0 | | 8.3 | | 43 | | | | 6200 | 2.2 | |
| Benzene | U | 1760 | µg/l | 1.0 | | < 1.0 | | < 1.0 | | | | < 1.0 | < 1.0 | |
| Toluene | U | 1760 | µg/l | 1.0 | | < 1.0 | | < 1.0 | | | | < 1.0 | < 1.0 | |
| Ethylbenzene | U | 1760 | µg/l | 1.0 | | < 1.0 | | < 1.0 | | | | < 1.0 | < 1.0 | |
| m & p-Xylene | U | 1760 | µg/l | 1.0 | | < 1.0 | | < 1.0 | | | | < 1.0 | < 1.0 | |
| o-Xylene | U | 1760 | µg/l | 1.0 | | < 1.0 | | < 1.0 | | | | < 1.0 | < 1.0 | |
| Methyl Tert-Butyl Ether | N | 1760 | µg/l | 1.0 | | < 1.0 | | < 1.0 | | | | < 1.0 | < 1.0 | |
| Naphthalene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 12 | < 0.10 | |
| Acenaphthylene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 2.3 | < 0.10 | |
| Acenaphthene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 130 | < 0.10 | |
| Fluorene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 100 | < 0.10 | |
| Phenanthrene | U | 1800 | µg/l | 0.10 | < 0.10 | 0.32 | < 0.10 | 0.42 | < 0.10 | < 0.10 | < 0.10 | 480 | < 0.10 | |
| Anthracene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | 0.11 | < 0.10 | < 0.10 | < 0.10 | 140 | < 0.10 | |
| Fluoranthene | U | 1800 | µg/l | 0.10 | 2.3 | 1.6 | < 0.10 | 0.69 | < 0.10 | < 0.10 | < 0.10 | 490 | < 0.10 | |
| Pyrene | U | 1800 | µg/l | 0.10 | 2.1 | 1.7 | < 0.10 | 0.75 | < 0.10 | < 0.10 | < 0.10 | 380 | < 0.10 | |
| Benzo[a]anthracene | U | 1800 | µg/l | 0.10 | 0.50 | 0.66 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 180 | < 0.10 | |
| Chrysene | U | 1800 | µg/l | 0.10 | 0.63 | 0.65 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 180 | < 0.10 | |
| Benzo[b]fluoranthene | U | 1800 | µg/l | 0.10 | < 0.10 | 1.2 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 160 | < 0.10 | |
| Benzo[k]fluoranthene | U | 1800 | µg/l | 0.10 | < 0.10 | 0.30 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 65 | < 0.10 | |
| Benzo[a]pyrene | U | 1800 | µg/l | 0.10 | < 0.10 | 0.52 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 140 | < 0.10 | |
| Indeno(1,2,3-c,d)Pyrene | U | 1800 | µg/l | 0.10 | < 0.10 | 0.43 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 79 | < 0.10 | |
| Dibenz(a,h)Anthracene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 13 | < 0.10 | |
| Benzo[g,h,i]perylene | U | 1800 | µg/l | 0.10 | < 0.10 | 0.56 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 61 | < 0.10 | |
| Total Of 16 PAH's | U | 1800 | µg/l | 2.0 | 5.5 | 7.9 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | 2600 | < 2.0 | |
| Total Phenols | U | 1920 | mg/l | 0.030 | < 0.030 | | < 0.030 | | < 0.030 | < 0.030 | < 0.030 | | < 0.030 | |

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# Results - Leachate

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | | | Chemtest Job No.: | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Quotation No.: | | | | Chemtest Sample ID.: | 205465 | 205466 | 205467 | 205472 | 205473 | 205474 | 205475 |
| Order No.: 20110 | | | | Client Sample Ref.: | HP01 | HP02 | TP101 | TP104 | TP105 | TP108 | TP109 |
| | | | | Client Sample ID.: | 1-055 | 1-056 | 1-021 | 1-040 | 1-038 | 1-060 | 1-058 |
| | | | | Sample Type: | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL |
| | | | | Top Depth (m): | 0.30 | 0.40 | 0.20 | 0.20 | 0.20 | 0.50 | 0.80 |
| | | | | Bottom Depth (m): | | | | | | | |
| | | | | Date Sampled: | 08-Oct-2015 | 08-Oct-2015 | 07-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 09-Oct-2015 | 09-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | | | | | |
| pH | U | 1010 | | N/A | 7.6 | | 7.7 | 6.8 | | 6.7 | |
| Nitrate | U | 1220 | mg/l | 0.50 | < 0.50 | | 3.1 | 0.73 | | < 0.50 | |
| Sulphate | U | 1220 | mg/l | 1.0 | 2.6 | | < 1.0 | 6.5 | | 22 | |
| Cyanide (Total) | U | 1300 | mg/l | 0.050 | < 0.050 | | < 0.050 | < 0.050 | | < 0.050 | |
| Cyanide (Free) | U | 1300 | mg/l | 0.050 | < 0.050 | | < 0.050 | < 0.050 | | < 0.050 | |
| Cyanide (Complex) | U | 1300 | mg/l | 0.050 | < 0.050 | | < 0.050 | < 0.050 | | < 0.050 | |
| Sulphide | U | 1325 | mg/l | 0.050 | < 0.050 | | < 0.050 | 0.053 | | 0.12 | |
| Arsenic (Dissolved) | U | 1450 | µg/l | 1.0 | 8.9 | | 5.5 | 6.6 | | 1.9 | |
| Boron (Dissolved) | U | 1450 | µg/l | 20 | 47 | | < 20 | < 20 | | 27 | |
| Beryllium (Dissolved) | U | 1450 | µg/l | 1.0 | < 1.0 | | < 1.0 | < 1.0 | | < 1.0 | |
| Cadmium (Dissolved) | U | 1450 | µg/l | 0.080 | 0.11 | | < 0.080 | 0.10 | | 0.13 | |
| Chromium (Dissolved) | U | 1450 | µg/l | 1.0 | < 1.0 | | < 1.0 | < 1.0 | | 2.8 | |
| Copper (Dissolved) | U | 1450 | µg/l | 1.0 | 30 | | 13 | 33 | | 57 | |
| Mercury (Dissolved) | U | 1450 | µg/l | 0.50 | < 0.50 | | < 0.50 | < 0.50 | | < 0.50 | |
| Nickel (Dissolved) | U | 1450 | µg/l | 1.0 | 2.8 | | 2.6 | 3.0 | | 6.7 | |
| Lead (Dissolved) | U | 1450 | µg/l | 1.0 | 77 | | 18 | 40 | | 32 | |
| Selenium (Dissolved) | U | 1450 | µg/l | 1.0 | < 1.0 | | < 1.0 | < 1.0 | | < 1.0 | |
| Vanadium (Dissolved) | U | 1450 | µg/l | 1.0 | 7.6 | | 6.6 | 6.5 | | 3.7 | |
| Zinc (Dissolved) | U | 1450 | µg/l | 1.0 | 43 | | 14 | 36 | | 59 | |
| Aliphatic TPH >C5-C6 | N | 1675 | µg/l | 0.010 | < 0.010 | < 0.010 | | | < 0.010 | | < 0.010 |
| Aliphatic TPH >C6-C8 | N | 1675 | µg/l | 0.010 | < 0.010 | < 0.010 | | | < 0.010 | | < 0.010 |
| Aliphatic TPH >C8-C10 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Aliphatic TPH >C10-C12 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Aliphatic TPH >C12-C16 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Aliphatic TPH >C16-C21 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Aliphatic TPH >C21-C35 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Aliphatic TPH >C35-C44 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Total Aliphatic Hydrocarbons | N | 1675 | µg/l | 1.0 | < 1.0 | < 1.0 | | | < 1.0 | | < 1.0 |
| Aromatic TPH >C5-C7 | N | 1675 | µg/l | 0.010 | < 0.010 | < 0.010 | | | < 0.010 | | < 0.010 |
| Aromatic TPH >C7-C8 | N | 1675 | µg/l | 0.010 | < 0.010 | < 0.010 | | | < 0.010 | | < 0.010 |
| Aromatic TPH >C8-C10 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Aromatic TPH >C10-C12 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Aromatic TPH >C12-C16 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Aromatic TPH >C16-C21 | N | 1675 | µg/l | 0.10 | 2.0 | 2.2 | | | 2.2 | | 1.5 |
| Aromatic TPH >C21-C35 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Aromatic TPH >C35-C44 | N | 1675 | µg/l | 0.10 | < 0.10 | < 0.10 | | | < 0.10 | | < 0.10 |
| Total Aromatic Hydrocarbons | N | 1675 | µg/l | 1.0 | 2.0 | 2.2 | | | 2.2 | | 1.5 |

# Results - Leachate

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | | | | Chemtest Job No.: | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Quotation No.: | | | | | Chemtest Sample ID.: | 205465 | 205466 | 205467 | 205472 | 205473 | 205474 | 205475 |
| Order No.: 20110 | | | | | Client Sample Ref.: | HP01 | HP02 | TP101 | TP104 | TP105 | TP108 | TP109 |
| | | | | | Client Sample ID.: | 1-055 | 1-056 | 1-021 | 1-040 | 1-038 | 1-060 | 1-058 |
| | | | | | Sample Type: | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL |
| | | | | | Top Depth (m): | 0.30 | 0.40 | 0.20 | 0.20 | 0.20 | 0.50 | 0.80 |
| | | | | | Bottom Depth (m): | | | | | | | |
| | | | | | Date Sampled: | 08-Oct-2015 | 08-Oct-2015 | 07-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 09-Oct-2015 | 09-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | | | | | | |
| Total Petroleum Hydrocarbons | N | 1675 | µg/l | 2.0 | < 2.0 | 2.2 | | | 2.2 | | < 2.0 |
| Benzene | U | 1760 | µg/l | 1.0 | < 1.0 | < 1.0 | | | < 1.0 | | < 1.0 |
| Toluene | U | 1760 | µg/l | 1.0 | < 1.0 | < 1.0 | | | < 1.0 | | < 1.0 |
| Ethylbenzene | U | 1760 | µg/l | 1.0 | < 1.0 | < 1.0 | | | < 1.0 | | < 1.0 |
| m & p-Xylene | U | 1760 | µg/l | 1.0 | < 1.0 | < 1.0 | | | < 1.0 | | < 1.0 |
| o-Xylene | U | 1760 | µg/l | 1.0 | < 1.0 | < 1.0 | | | < 1.0 | | < 1.0 |
| Methyl Tert-Butyl Ether | N | 1760 | µg/l | 1.0 | < 1.0 | < 1.0 | | | < 1.0 | | < 1.0 |
| Naphthalene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Acenaphthylene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Acenaphthene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Fluorene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Phenanthrene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Anthracene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Fluoranthene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Pyrene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Benzo[a]anthracene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Chrysene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Benzo[b]fluoranthene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Benzo[k]fluoranthene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Benzo[a]pyrene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Indeno(1,2,3-c,d)Pyrene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Dibenz(a,h)Anthracene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Benzo[g,h,i]perylene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Total Of 16 PAH's | U | 1800 | µg/l | 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 | < 2.0 |
| Total Phenols | U | 1920 | mg/l | 0.030 | < 0.030 | | < 0.030 | < 0.030 | | < 0.030 | |

Chemtest
The right chemistry to deliver results

# Results - Soil

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | | | Chemtest Job No.: | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quotation No.: | | | | Chemtest Sample ID.: | 205448 | 205449 | 205450 | 205451 | 205452 | 205453 | 205454 | 205455 | 205456 |
| Order No.: 20110 | | | | Client Sample Ref.: | DTS101 | DTS101 | DTS102 | DTS103 | DTS104 | DTS105 | DTS106 | DTS107 | DTS108 |
| | | | | Client Sample ID.: | 1-017 | 1-018 | 1-014 | 1-011 | 1-008 | 1-002 | 1-005 | 1-036 | 1-030 |
| | | | | Sample Type: | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL |
| | | | | Top Depth (m): | 0.25 | 0.50 | 0.50 | 0.30 | 0.35 | 0.50 | 0.60 | 0.60 | 0.50 |
| | | | | Bottom Depth (m): | | | | | | | | | |
| | | | | Date Sampled: | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | | | | | | | |
| ACM Type | U | 2192 | | N/A | - | | | | | | | | - |
| Asbestos Identification | U | 2192 | | N/A | No Asbestos Detected | | | | | | | | No Asbestos Detected |
| Moisture | N | 2030 | % | 0.020 | | 6.5 | 20 | 6.4 | 15 | 15 | 13 | 18 | 15 |
| Soil Colour | N | | | N/A | | Brown | Brown | Brown | Brown | Brown | Brown | Brown | Brown |
| Other Material | N | | | N/A | | Stones, Roots | Stones | Stones, Roots | NONE | Roots, Fill, Stones | Stones | NONE | Stones |
| Soil Texture | N | | | N/A | | Sand | Sand | Sand | Loam | Loam | Sand | Sand | Loam |
| pH | M | 2010 | | N/A | | 8.8 | 9.0 | 9.0 | 8.2 | 7.7 | 7.9 | 7.3 | 7.1 |
| Boron (Hot Water Soluble) | M | 2120 | mg/kg | 0.40 | | 0.65 | < 0.40 | < 0.40 | 0.72 | 0.95 | 1.3 | 2.5 | 1.2 |
| Cyanide (Complex) | M | 2300 | mg/kg | 0.50 | | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 |
| Cyanide (Free) | M | 2300 | mg/kg | 0.50 | | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 |
| Cyanide (Total) | M | 2300 | mg/kg | 0.50 | | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 |
| Arsenic | M | 2450 | mg/kg | 1.0 | | 34 | 27 | 36 | 18 | 25 | 22 | 15 | 14 |
| Beryllium | U | 2450 | mg/kg | 1.0 | | 1.4 | < 1.0 | < 1.0 | < 1.0 | 1.3 | < 1.0 | < 1.0 | < 1.0 |
| Cadmium | M | 2450 | mg/kg | 0.10 | | 0.22 | 0.18 | 0.96 | 0.15 | 0.14 | 0.23 | 0.19 | 0.20 |
| Chromium | M | 2450 | mg/kg | 1.0 | | 26 | 15 | 13 | 30 | 30 | 38 | 89 | 30 |
| Copper | M | 2450 | mg/kg | 0.50 | | 69 | 18 | 16 | 35 | 65 | 47 | 110 | 30 |
| Mercury | M | 2450 | mg/kg | 0.10 | | 2.0 | 0.30 | < 0.10 | 5.8 | 1.9 | 0.67 | 1.0 | 0.59 |
| Nickel | M | 2450 | mg/kg | 0.50 | | 41 | 13 | 14 | 20 | 23 | 23 | 19 | 17 |
| Lead | M | 2450 | mg/kg | 0.50 | | 130 | 290 | 180 | 190 | 360 | 170 | 160 | 93 |
| Selenium | M | 2450 | mg/kg | 0.20 | | < 0.20 | 0.58 | < 0.20 | < 0.20 | 0.46 | 0.49 | 0.37 | 0.34 |
| Vanadium | U | 2450 | mg/kg | 5.0 | | 82 | 34 | 35 | 55 | 55 | 54 | 45 | 45 |
| Zinc | M | 2450 | mg/kg | 0.50 | | 140 | 120 | 130 | 120 | 150 | 170 | 210 | 71 |
| Chromium (Hexavalent) | N | 2490 | mg/kg | 0.50 | | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 |
| Organic Matter | M | 2625 | % | 0.40 | | 22 | 1.4 | 2.6 | 6.7 | 5.3 | 3.6 | 3.6 | 2.2 |
| Aliphatic TPH >C5-C6 | N | 2680 | mg/kg | 0.010 | | | < 0.010 | | < 0.010 | | | | |
| Aliphatic TPH >C6-C8 | N | 2680 | mg/kg | 0.010 | | | < 0.010 | | < 0.010 | | | | |
| Aliphatic TPH >C8-C10 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | < 0.10 | | | | |
| Aliphatic TPH >C10-C12 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | < 0.10 | | | | |
| Aliphatic TPH >C12-C16 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | < 0.10 | | | | |
| Aliphatic TPH >C16-C21 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | < 0.10 | | | | |
| Aliphatic TPH >C21-C35 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | < 0.10 | | | | |
| Aliphatic TPH >C35-C44 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | < 0.10 | | | | |
| Total Aliphatic Hydrocarbons | N | 2680 | mg/kg | 1.0 | | | < 1.0 | | < 1.0 | | | | |
| Aromatic TPH >C5-C7 | N | 2680 | mg/kg | 0.010 | | | < 0.010 | | < 0.010 | | | | |
| Aromatic TPH >C7-C8 | N | 2680 | mg/kg | 0.010 | | | < 0.010 | | < 0.010 | | | | |

# Results - Soil

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | | | | Chemtest Job No.: | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quotation No.: | | | | | Chemtest Sample ID.: | 205448 | 205449 | 205450 | 205451 | 205452 | 205453 | 205454 | 205455 | 205456 |
| Order No.: 20110 | | | | | Client Sample Ref.: | DTS101 | DTS101 | DTS102 | DTS103 | DTS104 | DTS105 | DTS106 | DTS107 | DTS108 |
| | | | | | Client Sample ID.: | 1-017 | 1-018 | 1-014 | 1-011 | 1-008 | 1-002 | 1-005 | 1-036 | 1-030 |
| | | | | | Sample Type: | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL |
| | | | | | Top Depth (m): | 0.25 | 0.50 | 0.50 | 0.30 | 0.35 | 0.50 | 0.60 | 0.60 | 0.50 |
| | | | | | Bottom Depth (m): | | | | | | | | | |
| | | | | | Date Sampled: | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | | | | | | | | |
| Aromatic TPH >C8-C10 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | < 0.10 | | | | | |
| Aromatic TPH >C10-C12 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | < 0.10 | | | | | |
| Aromatic TPH >C12-C16 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | < 0.10 | | | | | |
| Aromatic TPH >C16-C21 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | 7.2 | | | | | |
| Aromatic TPH >C21-C35 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | 36 | | | | | |
| Aromatic TPH >C35-C44 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | 1.7 | | | | | |
| Total Aromatic Hydrocarbons | N | 2680 | mg/kg | 1.0 | | | < 1.0 | | 45 | | | | | |
| Total Petroleum Hydrocarbons | N | 2680 | mg/kg | 2.0 | | | < 2.0 | | 45 | | | | | |
| Benzene | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | < 1.0 | | | | | |
| Toluene | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | < 1.0 | | | | | |
| Ethylbenzene | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | < 1.0 | | | | | |
| m & p-Xylene | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | < 1.0 | | | | | |
| o-Xylene | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | < 1.0 | | | | | |
| Methyl Tert-Butyl Ether | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | < 1.0 | | | | | |
| Naphthalene | M | 2800 | mg/kg | 0.10 | | 0.42 | < 0.10 | < 0.10 | 0.66 | 0.25 | 0.27 | < 0.10 | < 0.10 | |
| Acenaphthylene | N | 2800 | mg/kg | 0.10 | | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | 0.25 | 0.14 | < 0.10 | |
| Acenaphthene | M | 2800 | mg/kg | 0.10 | | < 0.10 | < 0.10 | < 0.10 | 0.59 | < 0.10 | 0.13 | < 0.10 | < 0.10 | |
| Fluorene | M | 2800 | mg/kg | 0.10 | | < 0.10 | < 0.10 | < 0.10 | 0.32 | < 0.10 | 0.23 | < 0.10 | < 0.10 | |
| Phenanthrene | M | 2800 | mg/kg | 0.10 | | 0.87 | 0.10 | < 0.10 | 5.3 | 0.24 | 0.83 | 0.72 | 0.22 | |
| Anthracene | M | 2800 | mg/kg | 0.10 | | 0.15 | < 0.10 | < 0.10 | 1.5 | < 0.10 | 0.22 | 0.11 | < 0.10 | |
| Fluoranthene | M | 2800 | mg/kg | 0.10 | | 1.1 | 0.16 | < 0.10 | 7.9 | 0.56 | 1.3 | 1.8 | 0.23 | |
| Pyrene | M | 2800 | mg/kg | 0.10 | | 1.2 | 0.18 | < 0.10 | 7.8 | 0.46 | 1.2 | 1.4 | 0.15 | |
| Benzo[a]anthracene | M | 2800 | mg/kg | 0.10 | | 0.72 | < 0.10 | < 0.10 | 7.2 | 0.11 | 0.27 | 0.23 | < 0.10 | |
| Chrysene | M | 2800 | mg/kg | 0.10 | | 0.74 | < 0.10 | < 0.10 | 7.8 | 0.14 | 0.47 | 0.45 | < 0.10 | |
| Benzo[b]fluoranthene | M | 2800 | mg/kg | 0.10 | | 1.5 | < 0.10 | < 0.10 | 14 | 0.24 | 0.43 | 0.62 | < 0.10 | |
| Benzo[k]fluoranthene | M | 2800 | mg/kg | 0.10 | | 0.34 | < 0.10 | < 0.10 | 5.8 | < 0.10 | 0.15 | 0.15 | < 0.10 | |
| Benzo[a]pyrene | M | 2800 | mg/kg | 0.10 | | 1.8 | < 0.10 | < 0.10 | 16 | 0.22 | 0.35 | 0.42 | < 0.10 | |
| Indeno(1,2,3-c,d)Pyrene | M | 2800 | mg/kg | 0.10 | | 1.2 | < 0.10 | < 0.10 | 12 | 0.12 | 0.25 | 0.34 | < 0.10 | |
| Dibenz(a,h)Anthracene | N | 2800 | mg/kg | 0.10 | | 0.18 | < 0.10 | < 0.10 | 2.5 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | |
| Benzo[g,h,i]perylene | M | 2800 | mg/kg | 0.10 | | 1.5 | < 0.10 | < 0.10 | 10 | 0.16 | 0.31 | 0.43 | < 0.10 | |
| Total Of 16 PAH's | N | 2800 | mg/kg | 2.0 | | 12 | < 2.0 | < 2.0 | 99 | 2.5 | 6.7 | 6.8 | < 2.0 | |
| Total Phenols | M | 2920 | mg/kg | 0.30 | | < 0.30 | < 0.30 | < 0.30 | < 0.30 | < 0.30 | < 0.30 | < 0.30 | < 0.30 | |

Chemtest
The right chemistry to deliver results

# Results - Soil

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | Chemtest Job No.: | | | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quotation No.: | | Chemtest Sample ID.: | | | 205457 | 205458 | 205459 | 205460 | 205461 | 205462 | 205463 | 205464 | 205465 |
| Order No.: 20110 | | Client Sample Ref.: | | | DTS109 | DTS110 | DTS111 | DTS112 | DTS113 | DTS114 | DTS115 | DTS115 | HP01 |
| | | Client Sample ID.: | | | 1-032 | 1-024 | 1-026 | 1-048 | 1-051 | 1-067 | 1-062 | 1-063 | 1-055 |
| | | Sample Type: | | | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL |
| | | Top Depth (m): | | | 0.50 | 0.50 | 0.40 | 0.70 | 0.60 | 0.50 | 0.10 | 0.50 | 0.30 |
| | | Bottom Depth (m): | | | | | | | | | | | |
| | | Date Sampled: | | | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 09-Oct-2015 | 09-Oct-2015 | 09-Oct-2015 | 08-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | | | | | | | |
| ACM Type | U | 2192 | | N/A | | | | | | | - | | |
| Asbestos Identification | U | 2192 | | N/A | | | | | | | No Asbestos Detected | | |
| Moisture | N | 2030 | % | 0.020 | 14 | 20 | 10 | 14 | 7.7 | 14 | | 6.4 | 6.7 |
| Soil Colour | N | | | N/A | Brown | Brown | Black, Red | Brown | Brown | Brown | | Brown | Brown |
| Other Material | N | | | N/A | NONE | NONE | Stones | Stones | NONE | NONE | | Stones | Stones, Roots |
| Soil Texture | N | | | N/A | Sand | Sand | Sand, | Loam | Sand | Sand | | Sand | Sand |
| pH | M | 2010 | | N/A | 8.0 | 7.1 | 8.6 | 8.2 | 7.3 | 7.3 | | 8.0 | 7.6 |
| Boron (Hot Water Soluble) | M | 2120 | mg/kg | 0.40 | 2.3 | 3.4 | < 0.40 | 0.80 | 0.61 | 0.70 | | < 0.40 | 1.6 |
| Cyanide (Complex) | M | 2300 | mg/kg | 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | | < 0.50 | < 0.50 |
| Cyanide (Free) | M | 2300 | mg/kg | 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | | < 0.50 | < 0.50 |
| Cyanide (Total) | M | 2300 | mg/kg | 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | | < 0.50 | < 0.50 |
| Arsenic | M | 2450 | mg/kg | 1.0 | 13 | 21 | 31 | 18 | 11 | 19 | | 16 | 22 |
| Beryllium | U | 2450 | mg/kg | 1.0 | < 1.0 | < 1.0 | 1.4 | < 1.0 | < 1.0 | < 1.0 | | < 1.0 | 1.1 |
| Cadmium | M | 2450 | mg/kg | 0.10 | < 0.10 | 0.13 | 0.67 | < 0.10 | < 0.10 | 0.11 | | 0.11 | 0.34 |
| Chromium | M | 2450 | mg/kg | 1.0 | 28 | 32 | 28 | 33 | 28 | 39 | | 25 | 32 |
| Copper | M | 2450 | mg/kg | 0.50 | 16 | 51 | 58 | 16 | 13 | 28 | | 11 | 75 |
| Mercury | M | 2450 | mg/kg | 0.10 | 0.22 | 1.2 | 0.12 | < 0.10 | < 0.10 | 0.13 | | < 0.10 | 0.88 |
| Nickel | M | 2450 | mg/kg | 0.50 | 17 | 19 | 28 | 19 | 15 | 24 | | 28 | 27 |
| Lead | M | 2450 | mg/kg | 0.50 | 52 | 190 | 320 | 38 | 22 | 42 | | 9.9 | 390 |
| Selenium | M | 2450 | mg/kg | 0.20 | 0.23 | 0.42 | < 0.20 | 0.20 | 0.22 | 0.23 | | < 0.20 | 0.37 |
| Vanadium | U | 2450 | mg/kg | 5.0 | 47 | 52 | 52 | 55 | 45 | 60 | | 45 | 53 |
| Zinc | M | 2450 | mg/kg | 0.50 | 48 | 150 | 95 | 42 | 48 | 75 | | 31 | 230 |
| Chromium (Hexavalent) | N | 2490 | mg/kg | 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | < 0.50 | | < 0.50 | < 0.50 |
| Organic Matter | M | 2625 | % | 0.40 | 2.2 | 5.5 | 22 | 0.91 | 1.2 | 1.2 | | < 0.40 | 4.8 |
| Aliphatic TPH >C5-C6 | N | 2680 | mg/kg | 0.010 | | | < 0.010 | | | | | < 0.010 | < 0.010 |
| Aliphatic TPH >C6-C8 | N | 2680 | mg/kg | 0.010 | | | < 0.010 | | | | | < 0.010 | < 0.010 |
| Aliphatic TPH >C8-C10 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | | | | < 0.10 | < 0.10 |
| Aliphatic TPH >C10-C12 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | | | | < 0.10 | < 0.10 |
| Aliphatic TPH >C12-C16 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | | | | < 0.10 | < 0.10 |
| Aliphatic TPH >C16-C21 | N | 2680 | mg/kg | 0.10 | | | 140 | | | | | < 0.10 | < 0.10 |
| Aliphatic TPH >C21-C35 | N | 2680 | mg/kg | 0.10 | | | 490 | | | | | < 0.10 | < 0.10 |
| Aliphatic TPH >C35-C44 | N | 2680 | mg/kg | 0.10 | | | 110 | | | | | < 0.10 | < 0.10 |
| Total Aliphatic Hydrocarbons | N | 2680 | mg/kg | 1.0 | | | 740 | | | | | < 1.0 | < 1.0 |
| Aromatic TPH >C5-C7 | N | 2680 | mg/kg | 0.010 | | | < 0.010 | | | | | < 0.010 | < 0.010 |
| Aromatic TPH >C7-C8 | N | 2680 | mg/kg | 0.010 | | | < 0.010 | | | | | < 0.010 | < 0.010 |

# Results - Soil

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | | | | Chemtest Job No.: | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quotation No.: | | | | | Chemtest Sample ID.: | 205457 | 205458 | 205459 | 205460 | 205461 | 205462 | 205463 | 205464 | 205465 |
| Order No.: 20110 | | | | | Client Sample Ref.: | DTS109 | DTS110 | DTS111 | DTS112 | DTS113 | DTS114 | DTS115 | DTS115 | HP01 |
| | | | | | Client Sample ID.: | 1-032 | 1-024 | 1-026 | 1-048 | 1-051 | 1-067 | 1-062 | 1-063 | 1-055 |
| | | | | | Sample Type: | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL |
| | | | | | Top Depth (m): | 0.50 | 0.50 | 0.40 | 0.70 | 0.60 | 0.50 | 0.10 | 0.50 | 0.30 |
| | | | | | Bottom Depth (m): | | | | | | | | | |
| | | | | | Date Sampled: | 07-Oct-2015 | 07-Oct-2015 | 07-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 09-Oct-2015 | 09-Oct-2015 | 09-Oct-2015 | 08-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | | | | | | | | |
| Aromatic TPH >C8-C10 | N | 2680 | mg/kg | 0.10 | | | < 0.10 | | | | | < 0.10 | < 0.10 | |
| Aromatic TPH >C10-C12 | N | 2680 | mg/kg | 0.10 | | | 9.4 | | | | | < 0.10 | < 0.10 | |
| Aromatic TPH >C12-C16 | N | 2680 | mg/kg | 0.10 | | | 670 | | | | | < 0.10 | < 0.10 | |
| Aromatic TPH >C16-C21 | N | 2680 | mg/kg | 0.10 | | | 3600 | | | | | 16 | 11 | |
| Aromatic TPH >C21-C35 | N | 2680 | mg/kg | 0.10 | | | 7000 | | | | | 32 | 36 | |
| Aromatic TPH >C35-C44 | N | 2680 | mg/kg | 0.10 | | | 210 | | | | | < 0.10 | < 0.10 | |
| Total Aromatic Hydrocarbons | N | 2680 | mg/kg | 1.0 | | | 12000 | | | | | 48 | 47 | |
| Total Petroleum Hydrocarbons | N | 2680 | mg/kg | 2.0 | | | 12000 | | | | | 48 | 47 | |
| Benzene | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | | | | < 1.0 | < 1.0 | |
| Toluene | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | | | | < 1.0 | < 1.0 | |
| Ethylbenzene | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | | | | < 1.0 | < 1.0 | |
| m & p-Xylene | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | | | | < 1.0 | < 1.0 | |
| o-Xylene | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | | | | < 1.0 | < 1.0 | |
| Methyl Tert-Butyl Ether | M | 2760 | µg/kg | 1.0 | | | < 1.0 | | | | | < 1.0 | < 1.0 | |
| Naphthalene | M | 2800 | mg/kg | 0.10 | < 0.10 | 0.30 | 6.1 | < 0.10 | < 0.10 | < 0.10 | | < 0.10 | 0.14 | |
| Acenaphthylene | N | 2800 | mg/kg | 0.10 | < 0.10 | < 0.10 | 1.8 | < 0.10 | < 0.10 | < 0.10 | | < 0.10 | 0.12 | |
| Acenaphthene | M | 2800 | mg/kg | 0.10 | < 0.10 | < 0.10 | 45 | 0.46 | < 0.10 | < 0.10 | | < 0.10 | 0.15 | |
| Fluorene | M | 2800 | mg/kg | 0.10 | < 0.10 | < 0.10 | 45 | 0.57 | < 0.10 | < 0.10 | | < 0.10 | 0.13 | |
| Phenanthrene | M | 2800 | mg/kg | 0.10 | 0.10 | 1.4 | 270 | 4.8 | 0.89 | 0.48 | | 0.41 | 3.3 | |
| Anthracene | M | 2800 | mg/kg | 0.10 | < 0.10 | 0.19 | 110 | 1.5 | 0.12 | < 0.10 | | < 0.10 | 0.41 | |
| Fluoranthene | M | 2800 | mg/kg | 0.10 | 0.10 | 1.9 | 290 | 5.4 | 0.73 | 0.44 | | 0.24 | 3.6 | |
| Pyrene | M | 2800 | mg/kg | 0.10 | < 0.10 | 1.6 | 240 | 4.3 | 0.60 | 0.38 | | 0.15 | 3.2 | |
| Benzo[a]anthracene | M | 2800 | mg/kg | 0.10 | < 0.10 | 0.28 | 120 | 1.6 | < 0.10 | < 0.10 | | < 0.10 | 0.92 | |
| Chrysene | M | 2800 | mg/kg | 0.10 | < 0.10 | 0.54 | 110 | 1.7 | < 0.10 | < 0.10 | | < 0.10 | 1.7 | |
| Benzo[b]fluoranthene | M | 2800 | mg/kg | 0.10 | < 0.10 | 0.57 | 120 | 1.6 | < 0.10 | < 0.10 | | < 0.10 | 1.7 | |
| Benzo[k]fluoranthene | M | 2800 | mg/kg | 0.10 | < 0.10 | 0.10 | 60 | 0.50 | < 0.10 | < 0.10 | | < 0.10 | 0.52 | |
| Benzo[a]pyrene | M | 2800 | mg/kg | 0.10 | < 0.10 | 0.32 | 110 | 1.5 | < 0.10 | < 0.10 | | < 0.10 | 1.1 | |
| Indeno(1,2,3-c,d)Pyrene | M | 2800 | mg/kg | 0.10 | < 0.10 | 0.29 | 67 | 0.82 | < 0.10 | < 0.10 | | < 0.10 | 0.80 | |
| Dibenz(a,h)Anthracene | N | 2800 | mg/kg | 0.10 | < 0.10 | < 0.10 | 16 | < 0.10 | < 0.10 | < 0.10 | | < 0.10 | < 0.10 | |
| Benzo[g,h,i]perylene | M | 2800 | mg/kg | 0.10 | < 0.10 | 0.36 | 55 | 0.76 | < 0.10 | < 0.10 | | < 0.10 | 0.77 | |
| Total Of 16 PAH's | N | 2800 | mg/kg | 2.0 | < 2.0 | 7.9 | 1700 | 26 | 2.3 | < 2.0 | | < 2.0 | 19 | |
| Total Phenols | M | 2920 | mg/kg | 0.30 | < 0.30 | < 0.30 | 0.49 | < 0.30 | < 0.30 | < 0.30 | | < 0.30 | < 0.30 | |

Chemtest
The right chemistry to deliver results

# Results - Soil

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | | | Chemtest Job No.: | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quotation No.: | | | | Chemtest Sample ID.: | 205466 | 205467 | 205468 | 205469 | 205470 | 205471 | 205472 | 205473 | 205474 |
| Order No.: 20110 | | | | Client Sample Ref.: | HP02 | TP101 | TP103 | TP103 | TP103A | TP103A | TP104 | TP105 | TP108 |
| | | | | Client Sample ID.: | 1-056 | 1-021 | 1-042 | 1-043 | 1-045 | 1-046 | 1-040 | 1-038 | 1-060 |
| | | | | Sample Type: | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL |
| | | | | Top Depth (m): | 0.40 | 0.20 | 0.20 | 0.60 | 0.30 | 0.60 | 0.20 | 0.20 | 0.50 |
| | | | | Bottom Depth (m): | | | | | | | | | |
| | | | | Date Sampled: | 08-Oct-2015 | 07-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 09-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | | | | | | | |
| ACM Type | U | 2192 | | N/A | | - | - | - | - | Concrete | | | - |
| Asbestos Identification | U | 2192 | | N/A | | No Asbestos Detected | No Asbestos Detected | No Asbestos Detected | No Asbestos Detected | No Asbestos Detected | | | No Asbestos Detected |
| Moisture | N | 2030 | % | 0.020 | 10 | 13 | | | | | 18 | 16 | 12 |
| Soil Colour | N | | | N/A | Brown | Brown | | | | | Brown | Brown | Brown |
| Other Material | N | | | N/A | Stones | Roots, Stones | | | | | Roots, Stones | NONE | Roots |
| Soil Texture | N | | | N/A | Sand | Sand | | | | | Sand | Sand | Sand |
| pH | M | 2010 | | N/A | 6.3 | 6.2 | | | | | 6.2 | | 6.1 |
| Boron (Hot Water Soluble) | M | 2120 | mg/kg | 0.40 | 1.2 | 1.8 | | | | | 1.2 | | 1.7 |
| Cyanide (Complex) | M | 2300 | mg/kg | 0.50 | < 0.50 | < 0.50 | | | | | < 0.50 | | < 0.50 |
| Cyanide (Free) | M | 2300 | mg/kg | 0.50 | < 0.50 | < 0.50 | | | | | < 0.50 | | < 0.50 |
| Cyanide (Total) | M | 2300 | mg/kg | 0.50 | < 0.50 | < 0.50 | | | | | < 0.50 | | < 0.50 |
| Arsenic | M | 2450 | mg/kg | 1.0 | 21 | 23 | | | | | 21 | | 18 |
| Beryllium | U | 2450 | mg/kg | 1.0 | 1.2 | 1.3 | | | | | 1.1 | | 1.1 |
| Cadmium | M | 2450 | mg/kg | 0.10 | 0.19 | 0.25 | | | | | 0.25 | | 0.16 |
| Chromium | M | 2450 | mg/kg | 1.0 | 30 | 36 | | | | | 41 | | 62 |
| Copper | M | 2450 | mg/kg | 0.50 | 64 | 57 | | | | | 59 | | 64 |
| Mercury | M | 2450 | mg/kg | 0.10 | 0.83 | 1.0 | | | | | 0.68 | | 0.42 |
| Nickel | M | 2450 | mg/kg | 0.50 | 23 | 23 | | | | | 22 | | 23 |
| Lead | M | 2450 | mg/kg | 0.50 | 240 | 250 | | | | | 210 | | 110 |
| Selenium | M | 2450 | mg/kg | 0.20 | 0.42 | 0.46 | | | | | 0.39 | | 0.48 |
| Vanadium | U | 2450 | mg/kg | 5.0 | 52 | 57 | | | | | 52 | | 72 |
| Zinc | M | 2450 | mg/kg | 0.50 | 160 | 150 | | | | | 180 | | 140 |
| Chromium (Hexavalent) | N | 2490 | mg/kg | 0.50 | < 0.50 | < 0.50 | | | | | < 0.50 | | < 0.50 |
| Organic Matter | M | 2625 | % | 0.40 | 6.6 | 6.4 | | | | | 6.6 | 3.1 | 4.0 |
| Aliphatic TPH >C5-C6 | N | 2680 | mg/kg | 0.010 | < 0.010 | | | | | | | < 0.010 | |
| Aliphatic TPH >C6-C8 | N | 2680 | mg/kg | 0.010 | < 0.010 | | | | | | | < 0.010 | |
| Aliphatic TPH >C8-C10 | N | 2680 | mg/kg | 0.10 | < 0.10 | | | | | | | < 0.10 | |
| Aliphatic TPH >C10-C12 | N | 2680 | mg/kg | 0.10 | < 0.10 | | | | | | | < 0.10 | |
| Aliphatic TPH >C12-C16 | N | 2680 | mg/kg | 0.10 | < 0.10 | | | | | | | < 0.10 | |
| Aliphatic TPH >C16-C21 | N | 2680 | mg/kg | 0.10 | < 0.10 | | | | | | | < 0.10 | |
| Aliphatic TPH >C21-C35 | N | 2680 | mg/kg | 0.10 | < 0.10 | | | | | | | < 0.10 | |
| Aliphatic TPH >C35-C44 | N | 2680 | mg/kg | 0.10 | < 0.10 | | | | | | | < 0.10 | |
| Total Aliphatic Hydrocarbons | N | 2680 | mg/kg | 1.0 | < 1.0 | | | | | | | < 1.0 | |
| Aromatic TPH >C5-C7 | N | 2680 | mg/kg | 0.010 | < 0.010 | | | | | | | < 0.010 | |
| Aromatic TPH >C7-C8 | N | 2680 | mg/kg | 0.010 | < 0.010 | | | | | | | < 0.010 | |

# Results - Soil

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | | | | Chemtest Job No.: | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Quotation No.: | | | | | Chemtest Sample ID.: | 205466 | 205467 | 205468 | 205469 | 205470 | 205471 | 205472 | 205473 | 205474 |
| Order No.: 20110 | | | | | Client Sample Ref.: | HP02 | TP101 | TP103 | TP103 | TP103A | TP103A | TP104 | TP105 | TP108 |
| | | | | | Client Sample ID.: | 1-056 | 1-021 | 1-042 | 1-043 | 1-045 | 1-046 | 1-040 | 1-038 | 1-060 |
| | | | | | Sample Type: | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL | SOIL |
| | | | | | Top Depth (m): | 0.40 | 0.20 | 0.20 | 0.60 | 0.30 | 0.60 | 0.20 | 0.20 | 0.50 |
| | | | | | Bottom Depth (m): | | | | | | | | | |
| | | | | | Date Sampled: | 08-Oct-2015 | 07-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 | 09-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | | | | | | | | |
| Aromatic TPH >C8-C10 | N | 2680 | mg/kg | 0.10 | < 0.10 | | | | | | | < 0.10 | |
| Aromatic TPH >C10-C12 | N | 2680 | mg/kg | 0.10 | < 0.10 | | | | | | | < 0.10 | |
| Aromatic TPH >C12-C16 | N | 2680 | mg/kg | 0.10 | < 0.10 | | | | | | | < 0.10 | |
| Aromatic TPH >C16-C21 | N | 2680 | mg/kg | 0.10 | 25 | | | | | | | 8.7 | |
| Aromatic TPH >C21-C35 | N | 2680 | mg/kg | 0.10 | 47 | | | | | | | 16 | |
| Aromatic TPH >C35-C44 | N | 2680 | mg/kg | 0.10 | < 0.10 | | | | | | | < 0.10 | |
| Total Aromatic Hydrocarbons | N | 2680 | mg/kg | 1.0 | 72 | | | | | | | 25 | |
| Total Petroleum Hydrocarbons | N | 2680 | mg/kg | 2.0 | 72 | | | | | | | 25 | |
| Benzene | M | 2760 | µg/kg | 1.0 | < 1.0 | | | | | | | < 1.0 | |
| Toluene | M | 2760 | µg/kg | 1.0 | < 1.0 | | | | | | | < 1.0 | |
| Ethylbenzene | M | 2760 | µg/kg | 1.0 | < 1.0 | | | | | | | < 1.0 | |
| m & p-Xylene | M | 2760 | µg/kg | 1.0 | < 1.0 | | | | | | | < 1.0 | |
| o-Xylene | M | 2760 | µg/kg | 1.0 | < 1.0 | | | | | | | < 1.0 | |
| Methyl Tert-Butyl Ether | M | 2760 | µg/kg | 1.0 | < 1.0 | | | | | | | < 1.0 | |
| Naphthalene | M | 2800 | mg/kg | 0.10 | 0.11 | < 0.10 | | | | | 0.28 | 0.35 | 0.11 |
| Acenaphthylene | N | 2800 | mg/kg | 0.10 | 0.19 | < 0.10 | | | | | 0.77 | 0.12 | < 0.10 |
| Acenaphthene | M | 2800 | mg/kg | 0.10 | 0.17 | < 0.10 | | | | | < 0.10 | < 0.10 | < 0.10 |
| Fluorene | M | 2800 | mg/kg | 0.10 | 0.24 | < 0.10 | | | | | < 0.10 | < 0.10 | < 0.10 |
| Phenanthrene | M | 2800 | mg/kg | 0.10 | 4.8 | 0.25 | | | | | 3.0 | 1.1 | 0.15 |
| Anthracene | M | 2800 | mg/kg | 0.10 | 0.62 | < 0.10 | | | | | 0.60 | 0.18 | < 0.10 |
| Fluoranthene | M | 2800 | mg/kg | 0.10 | 5.5 | 0.80 | | | | | 8.3 | 1.9 | 0.37 |
| Pyrene | M | 2800 | mg/kg | 0.10 | 4.4 | 0.79 | | | | | 7.5 | 1.8 | 0.36 |
| Benzo[a]anthracene | M | 2800 | mg/kg | 0.10 | 1.5 | < 0.10 | | | | | 3.5 | 0.55 | < 0.10 |
| Chrysene | M | 2800 | mg/kg | 0.10 | 2.0 | 0.21 | | | | | 4.5 | 0.74 | < 0.10 |
| Benzo[b]fluoranthene | M | 2800 | mg/kg | 0.10 | 2.3 | < 0.10 | | | | | 5.4 | 0.99 | < 0.10 |
| Benzo[k]fluoranthene | M | 2800 | mg/kg | 0.10 | 0.60 | < 0.10 | | | | | 2.5 | 0.20 | < 0.10 |
| Benzo[a]pyrene | M | 2800 | mg/kg | 0.10 | 1.6 | < 0.10 | | | | | 5.0 | 0.81 | < 0.10 |
| Indeno(1,2,3-c,d)Pyrene | M | 2800 | mg/kg | 0.10 | 1.1 | < 0.10 | | | | | 3.2 | 0.53 | < 0.10 |
| Dibenz(a,h)Anthracene | N | 2800 | mg/kg | 0.10 | < 0.10 | < 0.10 | | | | | 0.32 | < 0.10 | < 0.10 |
| Benzo[g,h,i]perylene | M | 2800 | mg/kg | 0.10 | 1.1 | < 0.10 | | | | | 3.3 | 0.63 | < 0.10 |
| Total Of 16 PAH's | N | 2800 | mg/kg | 2.0 | 26 | 2.1 | | | | | 48 | 9.9 | < 2.0 |
| Total Phenols | M | 2920 | mg/kg | 0.30 | 4.1 | < 0.30 | | | | | < 0.30 | | < 0.30 |

# Results - Soil

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | Chemtest Job No.: | | | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|
| Quotation No.: | | Chemtest Sample ID.: | | | 205475 | 205476 | 205477 |
| Order No.: 20110 | | Client Sample Ref.: | | | TP109 | TP201 | TP201 |
| | | Client Sample ID.: | | | 1-058 | 1-053 | 1-054 |
| | | Sample Type: | | | SOIL | SOIL | SOIL |
| | | Top Depth (m): | | | 0.80 | 0.10 | 0.60 |
| | | Bottom Depth (m): | | | | | |
| | | Date Sampled: | | | 09-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | |
| ACM Type | U | 2192 | | N/A | - | - | - |
| Asbestos Identification | U | 2192 | | N/A | No Asbestos Detected | No Asbestos Detected | No Asbestos Detected |
| Moisture | N | 2030 | % | 0.020 | 18 | | 7.6 |
| Soil Colour | N | | | N/A | Brown | | Brown |
| Other Material | N | | | N/A | NONE | | Roots, Stones |
| Soil Texture | N | | | N/A | Clay | | Sand |
| pH | M | 2010 | | N/A | | | 6.4 |
| Boron (Hot Water Soluble) | M | 2120 | mg/kg | 0.40 | | | 0.81 |
| Cyanide (Complex) | M | 2300 | mg/kg | 0.50 | | | < 0.50 |
| Cyanide (Free) | M | 2300 | mg/kg | 0.50 | | | < 0.50 |
| Cyanide (Total) | M | 2300 | mg/kg | 0.50 | | | < 0.50 |
| Arsenic | M | 2450 | mg/kg | 1.0 | | | 15 |
| Beryllium | U | 2450 | mg/kg | 1.0 | | | < 1.0 |
| Cadmium | M | 2450 | mg/kg | 0.10 | | | < 0.10 |
| Chromium | M | 2450 | mg/kg | 1.0 | | | 31 |
| Copper | M | 2450 | mg/kg | 0.50 | | | 14 |
| Mercury | M | 2450 | mg/kg | 0.10 | | | 0.17 |
| Nickel | M | 2450 | mg/kg | 0.50 | | | 20 |
| Lead | M | 2450 | mg/kg | 0.50 | | | 32 |
| Selenium | M | 2450 | mg/kg | 0.20 | | | 0.21 |
| Vanadium | U | 2450 | mg/kg | 5.0 | | | 50 |
| Zinc | M | 2450 | mg/kg | 0.50 | | | 52 |
| Chromium (Hexavalent) | N | 2490 | mg/kg | 0.50 | | | < 0.50 |
| Organic Matter | M | 2625 | % | 0.40 | 0.71 | | 1.7 |
| Aliphatic TPH >C5-C6 | N | 2680 | mg/kg | 0.010 | < 0.010 | | |
| Aliphatic TPH >C6-C8 | N | 2680 | mg/kg | 0.010 | < 0.010 | | |
| Aliphatic TPH >C8-C10 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Aliphatic TPH >C10-C12 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Aliphatic TPH >C12-C16 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Aliphatic TPH >C16-C21 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Aliphatic TPH >C21-C35 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Aliphatic TPH >C35-C44 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Total Aliphatic Hydrocarbons | N | 2680 | mg/kg | 1.0 | < 1.0 | | |
| Aromatic TPH >C5-C7 | N | 2680 | mg/kg | 0.010 | < 0.010 | | |
| Aromatic TPH >C7-C8 | N | 2680 | mg/kg | 0.010 | < 0.010 | | |

# Results - Soil

**Project: STM3361D - Richmond Upon Thames College, London**

| Client: Soiltechnics Limited | | Chemtest Job No.: | | | 15-24153 | 15-24153 | 15-24153 |
|---|---|---|---|---|---|---|---|
| Quotation No.: | | Chemtest Sample ID.: | | | 205475 | 205476 | 205477 |
| Order No.: 20110 | | Client Sample Ref.: | | | TP109 | TP201 | TP201 |
| | | Client Sample ID.: | | | 1-058 | 1-053 | 1-054 |
| | | Sample Type: | | | SOIL | SOIL | SOIL |
| | | Top Depth (m): | | | 0.80 | 0.10 | 0.60 |
| | | Bottom Depth (m): | | | | | |
| | | Date Sampled: | | | 09-Oct-2015 | 08-Oct-2015 | 08-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | |
| Aromatic TPH >C8-C10 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Aromatic TPH >C10-C12 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Aromatic TPH >C12-C16 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Aromatic TPH >C16-C21 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Aromatic TPH >C21-C35 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Aromatic TPH >C35-C44 | N | 2680 | mg/kg | 0.10 | < 0.10 | | |
| Total Aromatic Hydrocarbons | N | 2680 | mg/kg | 1.0 | < 1.0 | | |
| Total Petroleum Hydrocarbons | N | 2680 | mg/kg | 2.0 | < 2.0 | | |
| Benzene | M | 2760 | µg/kg | 1.0 | < 1.0 | | |
| Toluene | M | 2760 | µg/kg | 1.0 | < 1.0 | | |
| Ethylbenzene | M | 2760 | µg/kg | 1.0 | < 1.0 | | |
| m & p-Xylene | M | 2760 | µg/kg | 1.0 | < 1.0 | | |
| o-Xylene | M | 2760 | µg/kg | 1.0 | < 1.0 | | |
| Methyl Tert-Butyl Ether | M | 2760 | µg/kg | 1.0 | < 1.0 | | |
| Naphthalene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Acenaphthylene | N | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Acenaphthene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Fluorene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Phenanthrene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Anthracene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Fluoranthene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Pyrene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Benzo[a]anthracene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Chrysene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Benzo[b]fluoranthene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Benzo[k]fluoranthene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Benzo[a]pyrene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Indeno(1,2,3-c,d)Pyrene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Dibenz(a,h)Anthracene | N | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Benzo[g,h,i]perylene | M | 2800 | mg/kg | 0.10 | < 0.10 | | < 0.10 |
| Total Of 16 PAH's | N | 2800 | mg/kg | 2.0 | < 2.0 | | < 2.0 |
| Total Phenols | M | 2920 | mg/kg | 0.30 | | | < 0.30 |

## Report Information

### Key

| | |
|---|---|
| U | UKAS accredited |
| M | MCERTS and UKAS accredited |
| N | Unaccredited |
| S | This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis |
| SN | This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis |
| T | This analysis has been subcontracted to an unaccredited laboratory |
| I/S | Insufficient Sample |
| U/S | Unsuitable Sample |
| N/E | not evaluated |
| < | "less than" |
| > | "greater than" |

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVCOs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container

### Sample Retention and Disposal

All soil samples will be retained for a period of 60 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING 2183

# Final Report

| | |
|---|---|
| **Report No.:** | 15-24607-1 |
| **Initial Date of Issue:** | 23-Oct-2015 |
| **Client** | Soiltechnics Limited |
| **Client Address:** | Cedar Barn<br>White Lodge<br>Walgrave<br>Northampton<br>Northamptonshire<br>NN6 9PY |
| **Contact(s):** | Rachel Brown<br>Sara Bertholdson |
| **Project** | STM3361D - Richmond Upon Thames College |

| | | | |
|---|---|---|---|
| **Quotation No.:** | | **Date Received:** | 21-Oct-2015 |
| **Order No.:** | 20162 | **Date Instructed:** | 21-Oct-2015 |
| **No. of Samples:** | 1 | **Target Date:** | 23-Oct-2015 |
| **Turnaround (Wkdays):** | 5 | **Results Due:** | 27-Oct-2015 |
| **Date Approved:** | 23-Oct-2015 | | |

**Approved By:**

**Details:** Keith Jones, Technical Manager

Chemtest
The right chemistry to deliver results

# Results - Soil

**Project: STM3361D - Richmond Upon Thames College**

| Client: Soiltechnics Limited | | | Chemtest Job No.: | | 15-24607 |
|---|---|---|---|---|---|
| Quotation No.: | | | Chemtest Sample ID.: | | 207707 |
| Order No.: 20162 | | | Client Sample Ref.: | | BHC |
| | | | Client Sample ID.: | | 2-066 |
| | | | Sample Type: | | SOIL |
| | | | Top Depth (m): | | 0.30 |
| | | | Bottom Depth (m): | | |
| | | | Date Sampled: | | 15-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | |
| Moisture | N | 2030 | % | 0.020 | 7.4 |
| Soil Colour | N | | | N/A | Brown |
| Other Material | N | | | N/A | Stones, Roots |
| Soil Texture | N | | | N/A | Sand |
| pH | M | 2010 | | N/A | 8.0 |
| Boron (Hot Water Soluble) | M | 2120 | mg/kg | 0.40 | 0.85 |
| Cyanide (Complex) | M | 2300 | mg/kg | 0.50 | 1.4 |
| Cyanide (Free) | M | 2300 | mg/kg | 0.50 | < 0.50 |
| Cyanide (Total) | M | 2300 | mg/kg | 0.50 | 1.4 |
| Arsenic | M | 2450 | mg/kg | 1.0 | 21 |
| Beryllium | U | 2450 | mg/kg | 1.0 | < 1.0 |
| Cadmium | M | 2450 | mg/kg | 0.10 | 0.19 |
| Chromium | M | 2450 | mg/kg | 1.0 | 25 |
| Copper | M | 2450 | mg/kg | 0.50 | 120 |
| Mercury | M | 2450 | mg/kg | 0.10 | 0.43 |
| Nickel | M | 2450 | mg/kg | 0.50 | 27 |
| Lead | M | 2450 | mg/kg | 0.50 | 160 |
| Selenium | M | 2450 | mg/kg | 0.20 | < 0.20 |
| Vanadium | U | 2450 | mg/kg | 5.0 | 40 |
| Zinc | M | 2450 | mg/kg | 0.50 | 96 |
| Chromium (Hexavalent) | N | 2490 | mg/kg | 0.50 | < 0.50 |
| Organic Matter | M | 2625 | % | 0.40 | 2.2 |
| Naphthalene | M | 2800 | mg/kg | 0.10 | 0.14 |
| Acenaphthylene | N | 2800 | mg/kg | 0.10 | 0.23 |
| Acenaphthene | M | 2800 | mg/kg | 0.10 | < 0.10 |
| Fluorene | M | 2800 | mg/kg | 0.10 | < 0.10 |
| Phenanthrene | M | 2800 | mg/kg | 0.10 | 1.4 |
| Anthracene | M | 2800 | mg/kg | 0.10 | 0.23 |
| Fluoranthene | M | 2800 | mg/kg | 0.10 | 3.8 |
| Pyrene | M | 2800 | mg/kg | 0.10 | 3.7 |
| Benzo[a]anthracene | M | 2800 | mg/kg | 0.10 | 1.6 |
| Chrysene | M | 2800 | mg/kg | 0.10 | 1.8 |
| Benzo[b]fluoranthene | M | 2800 | mg/kg | 0.10 | 2.5 |
| Benzo[k]fluoranthene | M | 2800 | mg/kg | 0.10 | 0.69 |
| Benzo[a]pyrene | M | 2800 | mg/kg | 0.10 | 1.6 |
| Indeno(1,2,3-c,d)Pyrene | M | 2800 | mg/kg | 0.10 | 1.2 |
| Dibenz(a,h)Anthracene | N | 2800 | mg/kg | 0.10 | < 0.10 |

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# Results - Soil

**Project: STM3361D - Richmond Upon Thames College**

| **Client: Soiltechnics Limited** | | | | **Chemtest Job No.:** | 15-24607 |
|---|---|---|---|---|---|
| Quotation No.: | | | | **Chemtest Sample ID.:** | 207707 |
| Order No.: 20162 | | | | Client Sample Ref.: | BHC |
| | | | | Client Sample ID.: | 2-066 |
| | | | | Sample Type: | SOIL |
| | | | | Top Depth (m): | 0.30 |
| | | | | Bottom Depth (m): | |
| | | | | Date Sampled: | 15-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | |
| Benzo[g,h,i]perylene | M | 2800 | mg/kg | 0.10 | 1.4 |
| Total Of 16 PAH's | N | 2800 | mg/kg | 2.0 | 20 |
| Total Phenols | M | 2920 | mg/kg | 0.30 | < 0.30 |

## Report Information

### Key

| | |
|---|---|
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| SN | This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis |
| T | This analysis has been subcontracted to an unaccredited laboratory |
| I/S | Insufficient Sample |
| U/S | Unsuitable Sample |
| N/E | not evaluated |
| < | "less than" |
| > | "greater than" |

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For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container

### Sample Retention and Disposal

All soil samples will be retained for a period of 60 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk

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Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING 2183

# Final Report

| | |
|---|---|
| **Report No.:** | 15-25764-1 |
| **Initial Date of Issue:** | 06-Nov-2015 |
| **Client** | Soiltechnics Limited |
| **Client Address:** | Cedar Barn<br>White Lodge<br>Walgrave<br>Northampton<br>Northamptonshire<br>NN6 9PY |
| **Contact(s):** | Rachel Brown |
| **Project** | STM3361D Richmond Upon Thames College |

| | | | |
|---|---|---|---|
| **Quotation No.:** | | **Date Received:** | 03-Nov-2015 |
| **Order No.:** | 20260 | **Date Instructed:** | 03-Nov-2015 |
| **No. of Samples:** | 1 | **Target Date:** | 05-Nov-2015 |
| **Turnaround (Wkdays):** | 5 | **Results Due:** | 09-Nov-2015 |
| **Date Approved:** | 06-Nov-2015 | | |

**Approved By:**

**Details:** Keith Jones, Technical Manager

Chemtest
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# Results - Soil

## Project: STM3361D Richmond Upon Thames College

| Client: Soiltechnics Limited | | | Chemtest Job No.: | | 15-25764 |
|---|---|---|---|---|---|
| Quotation No.: | | | Chemtest Sample ID.: | | 213794 |
| Order No.: 20260 | | | Client Sample Ref.: | | BHE |
| | | | Client Sample ID.: | | 3-001 |
| | | | Sample Type: | | SOIL |
| | | | Top Depth (m): | | 0.50 |
| | | | Bottom Depth (m): | | |
| | | | Date Sampled: | | 13-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | |
| Moisture | N | 2030 | % | 0.020 | 16 |
| Soil Colour | N | 2040 | | N/A | Brown |
| Other Material | N | 2040 | | N/A | Stones |
| Soil Texture | N | 2040 | | N/A | Clay |
| pH | M | 2010 | | N/A | 7.7 |
| Sulphate (2:1 Water Soluble) as SO4 | M | 2120 | g/l | 0.010 | 0.070 |
| Total Sulphur | M | 2175 | % | 0.010 | 0.030 |
| Sulphate (Acid Soluble) | M | 2430 | % | 0.010 | 0.030 |
| Organic Matter | M | 2625 | % | 0.40 | 1.9 |
| Total Organic Carbon | M | 2625 | % | 0.20 | 1.1 |
| Aliphatic TPH >C5-C6 | N | 2680 | mg/kg | 0.010 | [B] < 0.010 |
| Aliphatic TPH >C6-C8 | N | 2680 | mg/kg | 0.010 | [B] < 0.010 |
| Aliphatic TPH >C8-C10 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Aliphatic TPH >C10-C12 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Aliphatic TPH >C12-C16 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Aliphatic TPH >C16-C21 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Aliphatic TPH >C21-C35 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Aliphatic TPH >C35-C44 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Total Aliphatic Hydrocarbons | N | 2680 | mg/kg | 1.0 | [B] < 1.0 |
| Aromatic TPH >C5-C7 | N | 2680 | mg/kg | 0.010 | [B] < 0.010 |
| Aromatic TPH >C7-C8 | N | 2680 | mg/kg | 0.010 | [B] < 0.010 |
| Aromatic TPH >C8-C10 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Aromatic TPH >C10-C12 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Aromatic TPH >C12-C16 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Aromatic TPH >C16-C21 | N | 2680 | mg/kg | 0.10 | [B] 1.1 |
| Aromatic TPH >C21-C35 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Aromatic TPH >C35-C44 | N | 2680 | mg/kg | 0.10 | [B] < 0.10 |
| Total Aromatic Hydrocarbons | N | 2680 | mg/kg | 1.0 | [B] 1.1 |
| Total Petroleum Hydrocarbons | N | 2680 | mg/kg | 2.0 | [B] < 2.0 |
| Benzene | M | 2760 | µg/kg | 1.0 | [B] < 1.0 |
| Toluene | M | 2760 | µg/kg | 1.0 | [B] < 1.0 |
| Ethylbenzene | M | 2760 | µg/kg | 1.0 | [B] < 1.0 |
| m & p-Xylene | M | 2760 | µg/kg | 1.0 | [B] < 1.0 |
| o-Xylene | M | 2760 | µg/kg | 1.0 | [B] < 1.0 |

## Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

| Sample ID: | Sample Ref: | Sample ID: | Sampled Date: | Deviation Code(s): | Containers Received: |
|---|---|---|---|---|---|
| 213794 | BHE | 3-001 | 13-Oct-2015 | B | Amber Glass 250ml |
| 213794 | BHE | 3-001 | 13-Oct-2015 | B | Plastic Bag |

## Report Information

### Key

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| T | This analysis has been subcontracted to an unaccredited laboratory |
| I/S | Insufficient Sample |
| U/S | Unsuitable Sample |
| N/E | not evaluated |
| < | "less than" |
| > | "greater than" |

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None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVCOs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at our Coventry laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

### Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container

### Sample Retention and Disposal

All soil samples will be retained for a period of 60 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.co.uk

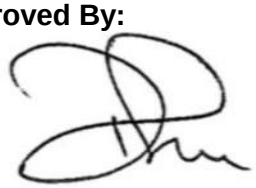
Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

# Final Report

| | |
|---|---|
| **Report No.:** | 15-26191-1 |
| **Initial Date of Issue:** | 12-Nov-2015 |
| **Client** | Soiltechnics Limited |
| **Client Address:** | Cedar Barn<br>White Lodge<br>Walgrave<br>Northampton<br>Northamptonshire<br>NN6 9PY |
| **Contact(s):** | Rachel Brown |
| **Project** | STM3361D - Richmond Upon Thames College |

| | | | |
|---|---|---|---|
| **Quotation No.:** | | **Date Received:** | 06-Nov-2015 |
| **Order No.:** | 20290 | **Date Instructed:** | 09-Nov-2015 |
| **No. of Samples:** | 3 | **Target Date:** | 11-Nov-2015 |
| **Turnaround (Wkdays):** | 5 | **Results Due:** | 13-Nov-2015 |
| **Date Approved:** | 12-Nov-2015 | | |

**Approved By:**



**Details:** Darrell Hall, Laboratory Director

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# Results - Water

**Project: STM3361D - Richmond Upon Thames College**

| Client: Soiltechnics Limited | | | | Chemtest Job No.: | 15-26191 | 15-26191 | 15-26191 |
|---|---|---|---|---|---|---|---|
| Quotation No.: | | | | Chemtest Sample ID.: | 216301 | 216302 | 216303 |
| Order No.: 20290 | | | | Client Sample Ref.: | BHB | BHD | BHE |
| | | | | Client Sample ID.: | 4-002 | 4-001 | 4-003 |
| | | | | Sample Type: | WATER | WATER | WATER |
| | | | | Top Depth (m): | 1.61 | 1.70 | 1.30 |
| | | | | Bottom Depth (m): | | | |
| | | | | Date Sampled: | 04-Nov-2015 | 04-Nov-2015 | 04-Nov-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | | |
| pH | U | 1010 | | N/A | 8.0 | 8.3 | 8.4 |
| Nitrate | U | 1220 | mg/l | 0.50 | < 0.50 | < 0.50 | 22 |
| Sulphate | U | 1220 | mg/l | 1.0 | 58 | 270 | 64 |
| Cyanide (Total) | U | 1300 | mg/l | 0.050 | < 0.050 | < 0.050 | < 0.050 |
| Cyanide (Free) | U | 1300 | mg/l | 0.050 | < 0.050 | < 0.050 | < 0.050 |
| Cyanide (Complex) | U | 1300 | mg/l | 0.050 | < 0.050 | < 0.050 | < 0.050 |
| Sulphide | U | 1325 | mg/l | 0.050 | < 0.050 | < 0.050 | < 0.050 |
| Arsenic (Dissolved) | U | 1450 | µg/l | 1.0 | 1.4 | 3.6 | < 1.0 |
| Boron (Dissolved) | U | 1450 | µg/l | 20 | 880 | 720 | 680 |
| Beryllium (Dissolved) | U | 1450 | µg/l | 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Cadmium (Dissolved) | U | 1450 | µg/l | 0.080 | < 0.080 | 0.11 | < 0.080 |
| Chromium (Dissolved) | U | 1450 | µg/l | 1.0 | 2.4 | 1.7 | 1.6 |
| Copper (Dissolved) | U | 1450 | µg/l | 1.0 | 1.8 | < 1.0 | < 1.0 |
| Mercury (Dissolved) | U | 1450 | µg/l | 0.50 | < 0.50 | 0.85 | 0.57 |
| Nickel (Dissolved) | U | 1450 | µg/l | 1.0 | 5.6 | 5.4 | 1.7 |
| Lead (Dissolved) | U | 1450 | µg/l | 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Selenium (Dissolved) | U | 1450 | µg/l | 1.0 | 2.1 | 1.7 | 1.1 |
| Vanadium (Dissolved) | U | 1450 | µg/l | 1.0 | < 1.0 | < 1.0 | < 1.0 |
| Zinc (Dissolved) | U | 1450 | µg/l | 1.0 | 3.0 | 6.6 | 3.5 |
| Naphthalene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Acenaphthylene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Acenaphthene | U | 1800 | µg/l | 0.10 | < 0.10 | 4.5 | < 0.10 |
| Fluorene | U | 1800 | µg/l | 0.10 | < 0.10 | 0.19 | < 0.10 |
| Phenanthrene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Anthracene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Fluoranthene | U | 1800 | µg/l | 0.10 | < 0.10 | 1.5 | < 0.10 |
| Pyrene | U | 1800 | µg/l | 0.10 | < 0.10 | 0.30 | < 0.10 |
| Benzo[a]anthracene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Chrysene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Benzo[b]fluoranthene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Benzo[k]fluoranthene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Benzo[a]pyrene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Indeno(1,2,3-c,d)Pyrene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Dibenz(a,h)Anthracene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Benzo[g,h,i]perylene | U | 1800 | µg/l | 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Total Of 16 PAH's | U | 1800 | µg/l | 2.0 | < 2.0 | 6.4 | < 2.0 |
| Total Phenols | U | 1920 | mg/l | 0.030 | < 0.030 | < 0.030 | < 0.030 |

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## Report Information

### Key

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Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.co.uk

UKAS TESTING 2183

# Final Report

| | |
|---|---|
| **Report No.:** | 15-27052-1 |
| **Initial Date of Issue:** | 20-Nov-2015 |
| **Client** | Soiltechnics Limited |
| **Client Address:** | Cedar Barn<br>White Lodge<br>Walgrave<br>Northampton<br>Northamptonshire<br>NN6 9PY |
| **Contact(s):** | Rachel Brown<br>Sara Bertholdson |
| **Project** | STM3361D - Richmond Upon Thames College |

| | | | |
|---|---|---|---|
| **Quotation No.:** | | **Date Received:** | 18-Nov-2015 |
| **Order No.:** | 20367 | **Date Instructed:** | 18-Nov-2015 |
| **No. of Samples:** | 2 | **Target Date:** | 20-Nov-2015 |
| **Turnaround (Wkdays):** | 3 | **Results Due:** | 20-Nov-2015 |
| **Date Approved:** | 20-Nov-2015 | | |

**Approved By:**

**Details:** Keith Jones, Technical Manager

# Results - Soil

## Project: STM3361D - Richmond Upon Thames College

| Client: Soiltechnics Limited | | | | Chemtest Job No.: | 15-27052 | 15-27052 |
|---|---|---|---|---|---|---|
| Quotation No.: | | | | Chemtest Sample ID.: | 220731 | 220732 |
| Order No.: 20367 | | | | Client Sample Ref.: | BHA | BHA |
| | | | | Client Sample ID.: | 2-101 | 2-103 |
| | | | | Sample Type: | SOIL | SOIL |
| | | | | Top Depth (m): | 0.20 | 7.00 |
| | | | | Bottom Depth (m): | | |
| | | | | Date Sampled: | 13-Oct-2015 | 13-Oct-2015 |
| **Determinand** | **Accred.** | **SOP** | **Units** | **LOD** | | |
| Moisture | N | 2030 | % | 0.020 | 10 | 19 |
| Soil Colour | N | 2040 | | N/A | Brown | Brown |
| Other Material | N | 2040 | | N/A | NONE | NONE |
| Soil Texture | N | 2040 | | N/A | Sand | Clay |
| pH | M | 2010 | | N/A | 8.1 | 8.8 |
| Sulphate (2:1 Water Soluble) as SO4 | M | 2120 | g/l | 0.010 | 0.023 | 0.14 |
| Total Sulphur | M | 2175 | % | 0.010 | 0.062 | 0.67 |
| Sulphate (Acid Soluble) | M | 2430 | % | 0.010 | 0.083 | 0.12 |

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customerservices@chemtest.co.uk

soiltechnics
environmental and geotechnical consultants

# Analysis of test data in relation to concentrations of inorganic chemical contaminants

**Adopted Model:** Residential without plant uptake
**Receptor:** Current and proposed site user of COLLEGE area

| Test procedure | | | Summary of test data | | | | | Initial comparison | Outlier test | | | | Normality test | | | UCL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contaminant | Guideline source | Guideline value mg/kg | No. of tests | Min. mg/kg | Max. mg/kg | Mean mg/kg | No. of tests above guideline value | Initial screening | Pass outlier test? | Number of outliers | Location of outlier | Depth | Concentration mg/kg | Shapiro-Wilk Normality test | Probability plot test | Data normally distributed? | 95% UCL of mean mg/kg | Contaminant |
| **Arsenic** | SSV | 35 | 20 | 11.0 | 36.0 | 21.2 | 1 | Mean value below guideline | y | 0 | | | | normal | normal | y | 23.8 | **Arsenic** |
| **Beryllium** | SSV | 51 | 20 | 1.0 | 1.4 | 1.1 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 1.2 | **Beryllium** |
| **Boron** | SSV | 1030 | 20 | 0.4 | 3.4 | 1.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | n | 2.0 | **Boron** |
| **Cadmium** | SSV | 17.7 | 20 | 0.1 | 1.0 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.4 | **Cadmium** |
| **Chromium** | SSV | 3000 | 20 | 13.0 | 89.0 | 33.8 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 49.5 | **Chromium** |
| **Copper** | SSV | 6200 | 20 | 13.0 | 120.0 | 48.3 | 0 | Mean value below guideline | y | 0 | | | | not normal | normal | n | 78.7 | **Copper** |
| **Cyanide (total)** | ATK | 34 | 20 | 0.5 | 1.4 | 0.5 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.7 | **Cyanide (total)** |
| **Lead** | ATK | 383 | 20 | 22.0 | 390.0 | 171.0 | 1 | Mean value below guideline | y | 0 | | | | normal | normal | y | 213.8 | **Lead** |
| **Mercury#** | SSV | 11 | 20 | 0.1 | 5.8 | 0.9 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | n | 2.2 | **Mercury#** |
| **Nickel** | SSV | 130 | 20 | 13.0 | 41.0 | 21.8 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | n | 27.8 | **Nickel** |
| **Selenium** | SSV | 595 | 20 | 0.2 | 0.6 | 0.3 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 0.4 | **Selenium** |
| **Vanadium** | SSV | 188 | 20 | 34.0 | 82.0 | 52.0 | 0 | Mean value below guideline | n | 0 | | | | normal | normal | y | 56.3 | **Vanadium** |
| **Zinc** | SSV | 40400 | 20 | 42.0 | 230.0 | 119.9 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 140.6 | **Zinc** |

| | |
|---|---|
| SGV | Soil Guideline Value as published by the Environment Agency 2009 |
| GAC | Generic Assessment Criterion as published by LQM and CIEH |
| SSV | Soil Screening Value as derived by Soiltechnics |
| ATK | Soil Screening Value derived by Atkins |
| NGV | No Guideline Value |
| BPG5 | Guideline from BPG Note 5 as published by Forest Research |
| # | Assumed to be methyl mercury as initial screening value |

| Title | Table number |
|---|---|
| Analysis of test data in relation to concentrations of inorganic chemical contaminants. | 1 |

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# Analysis of test data in relation to concentrations of organic chemical contaminants

**Adopted model:** Residential without plant uptake
**Receptor:** Current and proposed site user of COLLEGE area

| Test procedure | | | Summary of test data | | | | | Initial Screening | Outlier test | | | | Normality test | | | UCL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contaminant | Guideline source | Guideline value mg/kg | No. of tests | Min. mg/kg | Max. mg/kg | Mean mg/kg | No. of tests above guideline value | Initial screening | Pass outlier test? | Number of outliers | Location of outlier | Depth | Concentration mg/kg | Shapiro-Wilk Normality test | Probability plot test | Data normally distributed? | 95% UCL of mean mg/kg | Contaminant |
| Acenaphthene | SSV | 70000 | 20 | 0.1 | 45.0 | 2.4 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 45 | | | | | Acenaphthene |
| **Acenaphthene** | SSV | 70000 | 19 | 0.1 | 0.6 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.3 | **Acenaphthene** |
| Acenaphthylene | SSV | 65800 | 20 | 0.1 | 1.8 | 0.2 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 1.8 | | | | | Acenaphthylene |
| **Acenaphthylene** | SSV | 65800 | 19 | 0.1 | 0.3 | 0.1 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.2 | **Acenaphthylene** |
| Anthracene | SSV | 2130000 | 20 | 0.1 | 110.0 | 5.8 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 110 | | | | | Anthracene |
| **Anthracene** | SSV | 2130000 | 19 | 0.1 | 1.5 | 0.3 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.8 | **Anthracene** |
| Benzo(a)anthracene | SSV | 48.8 | 20 | 0.1 | 120.0 | 6.8 | 1 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 120 | | | | | Benzo(a)anthracene |
| **Benzo(a)anthracene** | SSV | 48.8 | 19 | 0.1 | 7.2 | 0.8 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 2.4 | **Benzo(a)anthracene** |
| Benzo(a)pyrene | SSV | 10.1 | 20 | 0.1 | 110.0 | 6.8 | 2 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 110 | | | | | Benzo(a)pyrene |
| **Benzo(a)pyrene** | SSV | 10.1 | 19 | 0.1 | 16.0 | 1.4 | 1 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 5.0 | **Benzo(a)pyrene** |
| Benzo(b)fluoranthene | SSV | 71.2 | 20 | 0.1 | 120.0 | 7.3 | 1 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 120 | | | | | Benzo(b)fluoranthene |
| **Benzo(b)fluoranthene** | SSV | 71.2 | 19 | 0.1 | 14.0 | 1.4 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 4.5 | **Benzo(b)fluoranthene** |
| Benzo(g,h,i)perylene | SSV | 465 | 20 | 0.1 | 55.0 | 3.6 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 55 | | | | | Benzo(g,h,i)perylene |
| **Benzo(g,h,i)perylene** | SSV | 465 | 19 | 0.1 | 10.0 | 0.9 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 3.2 | **Benzo(g,h,i)perylene** |
| Benzo(k)fluoranthene | SSV | 101 | 20 | 0.1 | 60.0 | 3.5 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 60 | | | | | Benzo(k)fluoranthene |
| **Benzo(k)fluoranthene** | SSV | 101 | 19 | 0.1 | 5.8 | 0.5 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 1.8 | **Benzo(k)fluoranthene** |
| Chrysene | SSV | 94.7 | 20 | 0.1 | 110.0 | 6.4 | 1 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 110 | | | | | Chrysene |
| **Chrysene** | SSV | 94.7 | 19 | 0.1 | 7.8 | 1.0 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 2.8 | **Chrysene** |
| Dibenzo(a,h)anthracene | SSV | 8.87 | 20 | 0.1 | 16.0 | 1.0 | 1 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 16 | | | | | Dibenzo(a,h)anthracene |
| **Dibenzo(a,h)anthracene** | SSV | 8.87 | 19 | 0.1 | 2.5 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.8 | **Dibenzo(a,h)anthracene** |
| Fluoranthene | SSV | 444000 | 20 | 0.1 | 290.0 | 16.3 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 290 | | | | | Fluoranthene |
| **Fluoranthene** | SSV | 444000 | 19 | 0.1 | 7.9 | 1.9 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 4.2 | **Fluoranthene** |
| Fluorene | SSV | 87700 | 20 | 0.1 | 45.0 | 2.4 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 45 | | | | | Fluorene |
| **Fluorene** | SSV | 87700 | 19 | 0.1 | 0.6 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.3 | **Fluorene** |
| Indeno(1,2,3-cd)pyrene | SSV | 42.5 | 20 | 0.1 | 67.0 | 4.3 | 1 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 67 | | | | | Indeno(1,2,3-cd)pyrene |
| **Indeno(1,2,3-cd)pyrene** | SSV | 42.5 | 19 | 0.1 | 12.0 | 1.0 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 3.7 | **Indeno(1,2,3-cd)pyrene** |
| Naphthalene | SSV | 21.3 | 20 | 0.1 | 6.1 | 0.5 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 6.1 | | | | | Naphthalene |
| **Naphthalene** | SSV | 21.3 | 19 | 0.1 | 0.7 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.3 | **Naphthalene** |
| Phenanthrene | SSV | 98500 | 20 | 0.1 | 270.0 | 14.8 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 270 | | | | | Phenanthrene |
| **Phenanthrene** | SSV | 98500 | 19 | 0.1 | 5.3 | 1.4 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 3.1 | **Phenanthrene** |
| **Phenols** | SSV | 5580 | 20 | 0.3 | 4.1 | 0.5 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 1.3 | **Phenols** |
| Pyrene | SSV | 1030000 | 20 | 0.1 | 240.0 | 13.6 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 240 | | | | | Pyrene |
| **Pyrene** | SSV | 1030000 | 19 | 0.1 | 5.3 | 1.4 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 3.8 | **Pyrene** |

**Notes**

SGV Soil Guideline Value as published by the Environment Agency
GAC Generic Assessment Criterion as published by LQM and CIEH
SSV Soil Screening Value as derived by Soiltechnics - CLEA model used to derive an accurate value taking into account exposure time

Title
Analysis of test data in relation to concentrations of organic chemical contaminants.

Table number
2

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# Analysis of test data in relation to concentrations of inorganic chemical contaminants

**Adopted Model:** Residential
**Receptor:** Proposed site user of RESIDENTIAL area

| Test procedure | | | Summary of test data | | | | | Initial comparison | Outlier test | | | | | Normality test | | | UCL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contaminant | Guideline source | Guideline value mg/kg | No. of tests | Min. mg/kg | Max. mg/kg | Mean mg/kg | No. of tests above guideline value | Initial screening | Pass outlier test? | Number of outliers | Location of outlier | Depth | Concentration mg/kg | Shapiro-Wilk Normality test | Probability plot test | Data normally distributed? | 95% UCL of mean mg/kg | Contaminant |
| **Arsenic** | SGV | 32 | 7 | 8.8 | 24.0 | 16.5 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 20.6 | **Arsenic** |
| **Beryllium** | GAC | 51 | 7 | 0.6 | 4.4 | 1.5 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | n | 3.7 | **Beryllium** |
| **Boron** | GAC | 291 | 7 | 0.4 | 1.2 | 0.8 | 0 | Mean value below guideline | y | 0 | | | | not mornal | normal | n | 2.5 | **Boron** |
| **Cadmium** | SGV | 10 | 7 | 0.1 | 0.9 | 0.5 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 0.7 | **Cadmium** |
| **Chromium** | GAC | 3000 | 7 | 13.0 | 41.0 | 27.1 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 33.5 | **Chromium** |
| **Copper** | GAC | 2330 | 7 | 11.0 | 59.0 | 35.0 | 0 | Mean value below guideline | y | 0 | | | | non normal | normal | y | 186.5 | **Copper** |
| **Cyanide (total)** | ATK | 34 | 7 | 0.5 | 1.0 | 0.9 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 1.3 | **Cyanide (total)** |
| **Lead** | ATK | 276 | 7 | 9.9 | 400.0 | 186.0 | 3 | Mean value below guideline | y | 0 | | | | normal | normal | y | 299.0 | **Lead** |
| **Mercury#** | SGV | 11 | 7 | 0.1 | 1.9 | 0.8 | 0 | Mean value below guideline | n | 0 | | | | normal | not normal | n | 1.7 | **Mercury#** |
| **Nickel** | SGV | 130 | 7 | 13.0 | 30.0 | 21.6 | 0 | Mean value below guideline | y | 0 | | | | normal | not normal | n | 32.5 | **Nickel** |
| **Selenium** | SGV | 350 | 7 | 0.2 | 2.5 | 1.9 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 3.6 | **Selenium** |
| **Vanadium** | GAC | 75 | 7 | 23.0 | 58.0 | 43.6 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 52.0 | **Vanadium** |
| **Zinc** | GAC | 3750 | 7 | 31.0 | 180.0 | 105.5 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 575.9 | **Zinc** |

* It should be noted that five test results used in the previous report dated 2008 have been used to improve the reliability of statistical analysis

SGV Soil Guideline Value as published by the Environment Agency 2009
GAC Generic Assessment Criterion as published by LQM and CIEH
SSV Soil Screening Value as derived by Soiltechnics
ATK Soil Screening Value derived by Atkins
NGV No Guideline Value
BPG5 Guideline from BPG Note 5 as published by Forest Research

\# Assumed to be methyl mercury as initial screening value

Title: Analysis of test data in relation to concentrations of inorganic chemical contaminants.
Table number: 3

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# Analysis of test data in relation to concentrations of organic chemical contaminants

**Adopted model:** Residential
**Receptor:** Proposed site user of RESIDENTIAL area

| Test procedure | | | Summary of test data | | | | | Initial Screening | Outlier test | | | | Normality test | | | UCL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contaminant | Guideline source | Guideline value mg/kg | No. of tests | Min. mg/kg | Max. mg/kg | Mean mg/kg | No. of tests above guideline value | Initial screening | Pass outlier test? | Number of outliers | Location of outlier | Depth | Concentration mg/kg | Shapiro-Wilk Normality test | Probability plot test | Data normally distributed? | 95% UCL of mean mg/kg | Contaminant |
| Acenaphthene | GAC | 210 | 8 | 0.1 | 23.0 | 3.0 | 0 | Mean value below guideline | n | 1 | DTS05 | 0.2 | 23 | | | | | Acenaphthene |
| **Acenaphthene** | GAC | 210 | 7 | 0.1 | 0.2 | 0.1 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.2 | **Acenaphthene** |
| Acenaphthylene | GAC | 170 | 8 | 0.1 | 16.0 | 2.2 | 0 | Mean value below guideline | n | 1 | DTS05 | 0.2 | 16 | | | | | Acenaphthylene |
| **Acenaphthylene** | GAC | 170 | 7 | 0.1 | 0.8 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.6 | **Acenaphthylene** |
| Anthracene | GAC | 2300 | 8 | 0.1 | 52.0 | 6.7 | 0 | Mean value below guideline | n | 1 | DTS05 | 0.2 | 52 | | | | | Anthracene |
| **Anthracene** | GAC | 2300 | 7 | 0.1 | 0.6 | 0.3 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 0.6 | **Anthracene** |
| Benzo(a)anthracene | GAC | 3.1 | 8 | 0.1 | 68.0 | 9.3 | 2 | Mean value above guideline | | 1 | DTS05 | 0.2 | 68 | | | | | Benzo(a)anthracene |
| **Benzo(a)anthracene** | GAC | 3.1 | 7 | 0.1 | 3.5 | 0.9 | 1 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 2.9 | **Benzo(a)anthracene** |
| Benzo(a)pyrene | GAC | 0.83 | 8 | 0.1 | 58.0 | 8.3 | 4 | Mean value above guideline | | 1 | DTS05 | 0.2 | 58 | | | | | Benzo(a)pyrene |
| Benzo(a)pyrene | GAC | 0.83 | 7 | 0.1 | 5.0 | 1.2 | 3 | Mean value above guideline | | 2 | TP104 | 0.2 | 5 | | | | | Benzo(a)pyrene |
| **Benzo(a)pyrene** | GAC | 0.83 | 6 | 0.1 | 1.1 | 0.5 | 2 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 1.3 | **Benzo(a)pyrene** |
| Benzo(b)fluoranthene | GAC | 5.6 | 8 | 0.1 | 74.0 | 10.5 | 1 | Mean value above guideline | | 1 | DTS05 | 0.2 | 74 | | | | | Benzo(b)fluoranthene |
| **Benzo(b)fluoranthene** | GAC | 5.6 | 7 | 0.1 | 5.4 | 1.4 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 4.5 | **Benzo(b)fluoranthene** |
| Benzo(g,h,i)perylene | GAC | 44 | 8 | 0.1 | 26.0 | 3.9 | 0 | Mean value below guideline | n | 1 | DTS05 | 0.2 | 26 | | | | | Benzo(g,h,i)perylene |
| **Benzo(g,h,i)perylene** | GAC | 44 | 7 | 0.1 | 3.3 | 0.7 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 2.6 | **Benzo(g,h,i)perylene** |
| Benzo(k)fluoranthene | GAC | 8.5 | 8 | 0.1 | 28.0 | 4.0 | 1 | Mean value below guideline | n | 1 | DTS05 | 0.2 | 28 | | | | | Benzo(k)fluoranthene |
| **Benzo(k)fluoranthene** | GAC | 8.5 | 7 | 0.1 | 2.5 | 0.6 | 0 | Mean value below guideline | | 0 | | | | not normal | not normal | n | 2.0 | **Benzo(k)fluoranthene** |
| Chrysene | GAC | 6 | 8 | 0.1 | 64.0 | 9.0 | 1 | Mean value above guideline | | 1 | DTS05 | 0.2 | 64 | | | | | Chrysene |
| **Chrysene** | GAC | 6 | 7 | 0.1 | 4.5 | 1.1 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 3.7 | **Chrysene** |
| Dibenzo(a,h)anthracene | GAC | 0.76 | 8 | 0.1 | 6.4 | 0.9 | 1 | Mean value above guideline | | 1 | DTS05 | 0.2 | 6.4 | | | | | Dibenzo(a,h)anthracene |
| **Dibenzo(a,h)anthracene** | GAC | 0.76 | 7 | 0.1 | 0.3 | 0.1 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.3 | **Dibenzo(a,h)anthracene** |
| Fluoranthene | GAC | 260 | 8 | 0.1 | 200.0 | 26.9 | 0 | Mean value below guideline | n | 1 | DTS05 | 0.2 | 200 | | | | | Fluoranthene |
| **Fluoranthene** | GAC | 260 | 7 | 0.1 | 8.3 | 2.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 7.0 | **Fluoranthene** |
| Fluorene | GAC | 160 | 8 | 0.1 | 24.0 | 3.1 | 0 | Mean value below guideline | n | 1 | DTS05 | 0.2 | 24 | | | | | Fluorene |
| **Fluorene** | GAC | 160 | 7 | 0.1 | 0.1 | 0.1 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.1 | **Fluorene** |
| Indeno(1,2,3-cd)pyrene | GAC | 3.2 | 8 | 0.1 | 26.0 | 3.9 | 1 | Mean value above guideline | | 1 | DTS05 | 0.2 | 26 | | | | | Indeno(1,2,3-cd)pyrene |
| **Indeno(1,2,3-cd)pyrene** | GAC | 3.2 | 7 | 0.1 | 3.2 | 0.7 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 2.5 | **Indeno(1,2,3-cd)pyrene** |
| Naphthalene | GAC | 1.5 | 8 | 0.1 | 2.2 | 0.4 | 1 | Mean value below guideline | n | 1 | DTS05 | 0.2 | 2.2 | | | | | Naphthalene |
| **Naphthalene** | GAC | 1.5 | 7 | 0.1 | 0.3 | 0.1 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.2 | **Naphthalene** |
| Phenanthrene | GAC | 92 | 8 | 0.1 | 130.0 | 17.2 | 1 | Mean value below guideline | n | 1 | DTS05 | 0.2 | 130 | | | | | Phenanthrene |
| **Phenanthrene** | GAC | 92 | 7 | 0.1 | 3.0 | 1.0 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 2.8 | **Phenanthrene** |
| **Phenols** | SGV | 420 | 2 | 0.3 | 0.3 | 0.3 | 0 | Mean value below guideline | | | | | | | | | | |
| Pyrene | GAC | 560 | 8 | 0.1 | 150.0 | 20.4 | 0 | Mean value below guideline | n | 1 | DTS05 | 0.2 | 150 | | | | | Pyrene |
| **Pyrene** | GAC | 560 | 7 | 0.1 | 3.0 | 1.0 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 6.2 | **Pyrene** |

**Notes**

| | |
|---|---|
| SGV | Soil Guideline Value as published by the Environment Agency |
| GAC | Generic Assessment Criterion as published by LQM and CIEH |
| SSV | Soil Screening Value as derived by Soiltechnics - CLEA model used to derive an accurate value taking into account exposure time |

Title
Analysis of test data in relation to concentrations of organic chemical contaminants.

Table number
4

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# Analysis of test data in relation to concentrations of inorganic chemical contaminants

**Adopted Model:** Construction operatives
**Receptor:** Construction operative

| Test procedure | | | Summary of test data | | | | | Initial comparison | Outlier test | | | | Normality test | | | UCL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contaminant | Guideline source | Guideline value mg/kg | No. of tests | Min. mg/kg | Max. mg/kg | Mean mg/kg | No. of tests above guideline value | Initial screening | Pass outlier test? | Number of outliers | Location of outlier | Depth | Concentration mg/kg | Shapiro-Wilk Normality test | Probability plot test | Data normally distributed? | 95% UCL of mean mg/kg | Contaminant |
| **Arsenic** | SGV | 640 | 22 | 11.0 | 36.0 | 21.0 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 23.3 | **Arsenic** |
| **Beryllium** | GAC | 420 | 22 | 1.0 | 1.4 | 1.1 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 1.2 | **Beryllium** |
| **Boron** | GAC | 192000 | 22 | 0.4 | 3.4 | 1.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | n | 1.9 | **Boron** |
| **Cadmium** | SGV | 230 | 22 | 0.1 | 1.0 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.4 | **Cadmium** |
| **Chromium** | GAC | 30400 | 22 | 13.0 | 89.0 | 33.7 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 48.2 | **Chromium** |
| **Copper** | GAC | 71700 | 22 | 11.0 | 120.0 | 47.1 | 0 | Mean value below guideline | y | 0 | | | | not normal | normal | n | 75.7 | **Copper** |
| **Cyanide (total)** | ATK | 34 | 22 | 0.5 | 1.4 | 0.5 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.7 | **Cyanide (total)** |
| **Lead** | ATK | 6490 | 22 | 9.9 | 390.0 | 165.4 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 206.3 | **Lead** |
| **Mercury#** | SGV | 26 | 22 | 0.1 | 5.8 | 0.9 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | n | 2.0 | **Mercury#** |
| **Nickel** | SGV | 1800 | 22 | 13.0 | 41.0 | 22.0 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | n | 27.7 | **Nickel** |
| **Selenium** | SGV | 13000 | 22 | 0.2 | 0.6 | 0.3 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 0.4 | **Selenium** |
| **Vanadium** | GAC | 3160 | 22 | 34.0 | 82.0 | 51.7 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | y | 55.6 | **Vanadium** |
| **Zinc** | GAC | 665000 | 22 | 31.0 | 230.0 | 118.5 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 139.1 | **Zinc** |

| | |
|---|---|
| SGV | Soil Guideline Value as published by the Environment Agency 2009 |
| GAC | Generic Assessment Criterion as published by LQM and CIEH |
| SSV | Soil Screening Value as derived by Soiltechnics |
| ATK | Soil Screening Value derived by Atkins |
| NGV | No Guideline Value |
| BPG5 | Guideline from BPG Note 5 as published by Forest Research |
| # | Assumed to be elemental mercury as initial screening value |

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# Analysis of test data in relation to concentrations of organic chemical contaminants

**Adopted model:** Construction
**Receptor:** Construction operative and vegetation

| Test procedure | | | Summary of test data | | | | | Initial Screening | Outlier test | | | | Normality test | | | UCL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contaminant | Guideline source | Guideline value mg/kg | No. of tests | Min. mg/kg | Max. mg/kg | Mean mg/kg | No. of tests above guideline value | Initial screening | Pass outlier test? | Number of outliers | Location of outlier | Depth | Concentration mg/kg | Shapiro-Wilk Normality test | Probability plot test | Data normally distributed? | 95% UCL of mean mg/kg | Contaminant |
| Acenaphthene | GAC | 85000 | 22 | 0.1 | 45.0 | 2.2 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 45 | | | | | Acenaphthene |
| **Acenaphthene** | GAC | 85000 | 21 | 0.1 | 0.6 | 0.1 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.3 | **Acenaphthene** |
| Acenaphthylene | GAC | 84000 | 22 | 0.1 | 1.8 | 0.2 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 1.8 | | | | | Acenaphthylene |
| **Acenaphthylene** | GAC | 84000 | 21 | 0.1 | 0.8 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.3 | **Acenaphthylene** |
| Anthracene | GAC | 530000 | 22 | 0.1 | 110.0 | 5.3 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 110 | | | | | Anthracene |
| **Anthracene** | GAC | 530000 | 21 | 0.1 | 1.5 | 0.3 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.7 | **Anthracene** |
| Benzo(a)anthracene | GAC | 90 | 22 | 0.1 | 120.0 | 6.3 | 1 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 120 | | | | | Benzo(a)anthracene |
| **Benzo(a)anthracene** | GAC | 90 | 21 | 0.1 | 7.2 | 0.9 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 2.5 | **Benzo(a)anthracene** |
| Benzo(a)pyrene | GAC | 14 | 22 | 0.1 | 110.0 | 6.4 | 2 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 110 | | | | | Benzo(a)pyrene |
| **Benzo(a)pyrene** | GAC | 14 | 21 | 0.1 | 16.0 | 1.5 | 1 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 4.8 | **Benzo(a)pyrene** |
| Benzo(b)fluoranthene | GAC | 100 | 22 | 0.1 | 120.0 | 6.9 | 1 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 120 | | | | | Benzo(b)fluoranthene |
| **Benzo(b)fluoranthene** | GAC | 100 | 21 | 0.1 | 14.0 | 1.5 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 4.5 | **Benzo(b)fluoranthene** |
| Benzo(g,h,i)perylene | GAC | 650 | 22 | 0.1 | 55.0 | 3.5 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 55 | | | | | Benzo(g,h,i)perylene |
| **Benzo(g,h,i)perylene** | GAC | 650 | 21 | 0.1 | 10.0 | 1.0 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 3.1 | **Benzo(g,h,i)perylene** |
| Benzo(k)fluoranthene | GAC | 140 | 22 | 0.1 | 60.0 | 3.3 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 60 | | | | | Benzo(k)fluoranthene |
| **Benzo(k)fluoranthene** | GAC | 140 | 21 | 0.1 | 5.8 | 0.6 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 1.8 | **Benzo(k)fluoranthene** |
| Chrysene | GAC | 140 | 22 | 0.1 | 110.0 | 6.0 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 110 | | | | | Chrysene |
| **Chrysene** | GAC | 140 | 21 | 0.1 | 7.8 | 1.1 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 2.9 | **Chrysene** |
| Dibenzo(a,h)anthracene | GAC | 13 | 22 | 0.1 | 16.0 | 0.9 | 1 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 16 | | | | | Dibenzo(a,h)anthracene |
| **Dibenzo(a,h)anthracene** | GAC | 13 | 21 | 0.1 | 2.5 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.7 | **Dibenzo(a,h)anthracene** |
| Fluoranthene | GAC | 23000 | 22 | 0.1 | 290.0 | 15.2 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 290 | | | | | Fluoranthene |
| **Fluoranthene** | GAC | 23000 | 21 | 0.1 | 8.3 | 2.1 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 4.6 | **Fluoranthene** |
| Fluorene | GAC | 64000 | 22 | 0.1 | 45.0 | 2.2 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 45 | | | | | Fluorene |
| **Fluorene** | GAC | 64000 | 21 | 0.1 | 0.6 | 0.1 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.3 | **Fluorene** |
| Indeno(1,2,3-cd)pyrene | GAC | 60 | 22 | 0.1 | 67.0 | 4.1 | 1 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 67 | | | | | Indeno(1,2,3-cd)pyrene |
| **Indeno(1,2,3-cd)pyrene** | GAC | 60 | 21 | 0.1 | 12.0 | 1.1 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 3.5 | **Indeno(1,2,3-cd)pyrene** |
| Naphthalene | GAC | 200 | 22 | 0.1 | 6.1 | 0.4 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 6.1 | | | | | Naphthalene |
| **Naphthalene** | GAC | 200 | 21 | 0.1 | 0.7 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.3 | **Naphthalene** |
| Phenanthrene | GAC | 22000 | 22 | 0.1 | 270.0 | 13.6 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 270 | | | | | Phenanthrene |
| **Phenanthrene** | GAC | 22000 | 21 | 0.1 | 5.3 | 1.4 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 3.1 | **Phenanthrene** |
| **Phenols** | SGV | 3200 | 22 | 0.3 | 4.1 | 0.5 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 1.2 | **Phenols** |
| Pyrene | GAC | 54000 | 22 | 0.1 | 240.0 | 12.7 | 0 | Mean value below guideline | n | 1 | DTS111 | 0.4 | 240 | | | | | Pyrene |
| **Pyrene** | GAC | 54000 | 21 | 0.1 | 5.3 | 1.4 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 4.1 | **Pyrene** |

**Notes**

| | |
|---|---|
| SGV | Soil Guideline Value as published by the Environment Agency |
| GAC | Generic Assessment Criterion as published by LQM and CIEH |
| SSV | Soil Screening Value as derived by Soiltechnics |

Title
Analysis of test data in relation to concentrations of organic chemical contaminants.

Table number
6

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# Analysis of test data in relation to concentrations of inorganic chemical contaminants

**Adopted Model:** Industrial/Commercial and BPG5
**Receptor:** Vegetation

| Test procedure | | | Summary of test data | | | | | Initial comparison | Outlier test | | | | Normality test | | | UCL | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Contaminant | Guideline source | Guideline value mg/kg | No. of tests | Min. mg/kg | Max. mg/kg | Mean mg/kg | No. of tests above guideline value | Initial screening | Pass outlier test? | Number of outliers | Location of outlier | Depth | Concentration mg/kg | Shapiro-Wilk Normality test | Probability plot test | Data normally distributed? | 95% UCL of mean mg/kg | Contaminant |
| **Arsenic** | SGV | 640 | 22 | 11.0 | 36.0 | 21.0 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 23.3 | **Arsenic** |
| **Beryllium** | GAC | 420 | 22 | 1.0 | 1.4 | 1.1 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 1.2 | **Beryllium** |
| **Boron** | GAC | 192000 | 22 | 0.4 | 3.4 | 1.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | n | 1.9 | **Boron** |
| **Cadmium** | SGV | 230 | 22 | 0.1 | 1.0 | 0.2 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.4 | **Cadmium** |
| **Chromium** | GAC | 30400 | 22 | 13.0 | 89.0 | 33.7 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 48.2 | **Chromium** |
| **Copper** | BPG5 | 130 | 22 | 11.0 | 120.0 | 47.1 | 0 | Mean value below guideline | y | 0 | | | | not normal | normal | n | 75.7 | **Copper** |
| **Cyanide (total)** | ATK | 34 | 22 | 0.5 | 1.4 | 0.5 | 0 | Mean value below guideline | n | 0 | | | | not normal | not normal | n | 0.7 | **Cyanide (total)** |
| **Lead** | ATK | 6490 | 22 | 9.9 | 390.0 | 165.4 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 206.3 | **Lead** |
| **Mercury#** | SGV | 26 | 22 | 0.1 | 5.8 | 0.9 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | n | 2.0 | **Mercury#** |
| **Nickel** | SGV | 1800 | 22 | 13.0 | 41.0 | 22.0 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | n | 27.7 | **Nickel** |
| **Selenium** | SGV | 13000 | 22 | 0.2 | 0.6 | 0.3 | 0 | Mean value below guideline | y | 0 | | | | not normal | not normal | n | 0.4 | **Selenium** |
| **Vanadium** | GAC | 3160 | 22 | 34.0 | 82.0 | 51.7 | 0 | Mean value below guideline | n | 0 | | | | not normal | normal | y | 55.6 | **Vanadium** |
| **Zinc** | BPG5 | 300 | 22 | 31.0 | 230.0 | 118.5 | 0 | Mean value below guideline | y | 0 | | | | normal | normal | y | 139.1 | **Zinc** |

| | |
|---|---|
| SGV | Soil Guideline Value as published by the Environment Agency 2009 |
| GAC | Generic Assessment Criterion as published by LQM and CIEH |
| SSV | Soil Screening Value as derived by Soiltechnics |
| ATK | Soil Screening Value derived by Atkins |
| NGV | No Guideline Value |
| BPG5 | Guideline from BPG Note 5 as published by Forest Research |
| # | Assumed to be elemental mercury as initial screening value |

Title: Analysis of test data in relation to concentrations of inorganic chemical contaminants.
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# Summary of leachate test results

| | | | |
|---|---|---|---|
| **Receptor** | **Groundwater** | | |
| **Water type** | **Freshwater** | | |
| **Fish type** | **Cyprinid** | | |
| **Water hardness** | **>250** | **mg/l** | **259 mg/l Taken from Thames Water website** |

| Contaminant | Guideline value (µg/l) | Guideline source | Location | DTS101 | DTS102 | DTS103 | DTS104 |
|---|---|---|---|---|---|---|---|
| | | | Depth (m) | 0.5 | 0.5 | 0.3 | 0.35 |
| **Inorganics (µg/l)** | | | | | | | |
| Arsenic | 50 | EQS (f) | | 14 | | 6 | |
| Boron | 2000 | EQS (f) | | < 20 | | < 20 | |
| Cadmium | 5 | EQS (f) | | < 0.080 | | < 0.080 | |
| Chromium | 250 | EQS (f) | | 2 | | < 1.0 | |
| Copper | 28 | EQS (f) | | 6 | | 3 | |
| Lead | 250 | EQS (f) | | 40 | | 10 | |
| Mercury | 1 | EQS (f) | | 1 | | < 0.50 | |
| Nickel | 200 | EQS (f) | | < 1.0 | | < 1.0 | |
| Selenium[1] | 10 | UKDWS | | < 1.0 | | < 1.0 | |
| Vanadium[2] | 60 | EQS (f) | | 43 | | 22 | |
| Zinc | 500 | EQS (f) | | 13 | | 4 | |
| Free Cyanide[1] | 50 | UKDWS | | <50 | | <50 | |
| Nitrate as N | 50000 | UKDWS | | <500 | | <500 | |
| Sulphate as SO4 | 400000 | EQS(f) | | | | | |
| **PAH (µg/l)** | | | | | | | |
| Benzo(a)pyrene[1,4] | 0.01 | UKDWS | | < 0.10 | 0.52 | < 0.10 | < 0.10 |
| Naphthalene[2] | 10 | EQS (f) | | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Sum of 4 PAH[1] | 0.1 | UKDWS | | <0.1* | <0.1* | <0.1* | <0.1* |
| **TPH (µg/l)** | | | | | | | |
| Hydrocarbons[1] | 10 | UKDWS | | | 8 | | 43 |
| Benzene | 30 | EQS (f) | | | < 1.0 | | < 1.0 |
| Toluene[2] | 50 | EQS (f) | | | < 1.0 | | < 1.0 |
| Ethyl benzene[3] | 300 | WHO | | | < 1.0 | | < 1.0 |
| Xylene[2] | 30 | EQS (f) | | | | | |

Notes

1 EQS values not available
2 UKDWS not available
3 Lower detectable limit above UKDWS. Concentrations below detectable limits are not considered further.
* Taken as lower detection limit
# Taken as lower detection limit of a single compound
$ Hardness data presented by the Environment Agency

UKDWS UK Drinking Water Standard Guideline taken from "The Water Supply (Water Quality) Regulations 2000"
EQS (f) Environmental Quality Standard for freshwater published by the Environment Agency
EQS (s) Environmental Quality Standard for saltwater published by the Environment Agency

| Title | Table number |
|---|---|
| Comparison of measured concentrations with guideline values for water receptors. | 8.1 |

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# Summary of test results

| | | | |
|---|---|---|---|
| **Receptor** | **Groundwater** | | |
| **Water type** | **Freshwater** | | |
| **Fish type** | **Cyprinid** | | |
| **Water hardness** | **>250** | **mg/l** | **259 mg/l Taken from Thames Water website** |

| Contaminant | Guideline value (µg/l) | Guideline source | DTS105 0.5 | DTS107 0.6 | DTS109 0.5 | DTS111 0.4 | DTS115 0.5 | HP01 0.3 |
|---|---|---|---|---|---|---|---|---|
| **Inorganics (µg/l)** | | | | | | | | |
| Arsenic | 50 | EQS (f) | 12 | 7 | 9 | | 2 | 9 |
| Boron | 2000 | EQS (f) | < 20 | 150 | 140 | | < 20 | 47 |
| Cadmium | 5 | EQS (f) | < 0.080 | 0 | 0 | | < 0.080 | 0 |
| Chromium | 250 | EQS (f) | < 1.0 | 6 | 2 | | < 1.0 | < 1.0 |
| Copper | 28 | EQS (f) | 12 | 82 | 18 | | 3 | 30 |
| Lead | 250 | EQS (f) | 47 | 39 | 60 | | 10 | 77 |
| Mercury | 1 | EQS (f) | < 0.50 | < 0.50 | 1 | | < 0.50 | < 0.50 |
| Nickel | 200 | EQS (f) | < 1.0 | 7 | < 1.0 | | < 1.0 | 3 |
| Selenium[1] | 10 | UKDWS | < 1.0 | < 1.0 | < 1.0 | | < 1.0 | < 1.0 |
| Vanadium[2] | 60 | EQS (f) | 27 | 9 | 11 | | 3 | 8 |
| Zinc | 500 | EQS (f) | 15 | 190 | 40 | | 8 | 43 |
| Free Cyanide[1] | 50 | UKDWS | <50 | <50 | <50 | | <50 | <50 |
| Nitrate as N | 50000 | UKDWS | 970 | 19000 | <500 | | <500 | <500 |
| Sulphate as SO4 | 400000 | EQS(f) | | | | | | |
| **PAH (µg/l)** | | | | | | | | |
| Benzo(a)pyrene[1,4] | 0.01 | UKDWS | < 0.10 | < 0.10 | < 0.10 | 140.00 | < 0.10 | < 0.10 |
| Naphthalene[2] | 10 | EQS (f) | < 0.10 | < 0.10 | < 0.10 | 12.0 | < 0.10 | < 0.10 |
| Sum of 4 PAH[1] | 0.1 | UKDWS | <0.1* | <0.1* | <0.1* | 365.0 | <0.1* | <0.1* |
| **TPH (µg/l)** | | | | | | | | |
| Hydrocarbons[1] | 10 | UKDWS | | | | 6200 | 2 | < 2.0 |
| Benzene | 30 | EQS (f) | | | | < 1.0 | < 1.0 | < 1.0 |
| Toluene[2] | 50 | EQS (f) | | | | < 1.0 | < 1.0 | < 1.0 |
| Ethyl benzene[3] | 300 | WHO | | | | < 1.0 | < 1.0 | < 1.0 |
| Xylene[2] | 30 | EQS (f) | | | | | | |

Notes

1 EQS values not available
2 UKDWS not available
3 Lower detectable limit above UKDWS. Concentrations below detectable limits are not considered further.
* Taken as lower detection limit
# Taken as lower detection limit of a single compound
$ Hardness data presented by the Environment Agency

UKDWS UK Drinking Water Standard Guideline taken from "The Water Supply (Water Quality) Regulations 2000"
EQS (f) Environmental Quality Standard for freshwater published by the Environment Agency
EQS (s) Environmental Quality Standard for saltwater published by the Environment Agency

| Title | Table number |
|---|---|
| Comparison of measured concentrations with guideline values for | 8.2 |

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# Summary of test results

| | | | |
|---|---|---|---|
| **Receptor** | **Groundwater** | | |
| **Water type** | **Freshwater** | | |
| **Fish type** | **Cyprinid** | | |
| **Water hardness** | **>250** | **mg/l** | **259 mg/l Taken from Thames Water website** |

| Contaminant | Guideline value (µg/l) | Guideline source | HP02 0.4 | TP101 0.2 | TP104 0.2 | TP105 0.2 | TP108 0.5 |
|---|---|---|---|---|---|---|---|
| **Inorganics (µg/l)** | | | | | | | |
| Arsenic | 50 | EQS (f) | | 6 | 7 | | 2 |
| Boron | 2000 | EQS (f) | | < 20 | < 20 | | 27 |
| Cadmium | 5 | EQS (f) | | < 0.080 | 0 | | 0 |
| Chromium | 250 | EQS (f) | | < 1.0 | < 1.0 | | 3 |
| Copper | 28 | EQS (f) | | 13 | 33 | | 57 |
| Lead | 250 | EQS (f) | | 18 | 40 | | 32 |
| Mercury | 1 | EQS (f) | | < 0.50 | < 0.50 | | < 0.50 |
| Nickel | 200 | EQS (f) | | 3 | 3 | | 7 |
| Selenium[1] | 10 | UKDWS | | < 1.0 | < 1.0 | | < 1.0 |
| Vanadium[2] | 60 | EQS (f) | | 7 | 7 | | 4 |
| Zinc | 500 | EQS (f) | | 14 | 36 | | 59 |
| Free Cyanide[1] | 50 | UKDWS | | <50 | <50 | | <50 |
| Nitrate as N | 50000 | UKDWS | | 3100 | 730 | | <500 |
| Sulphate as SO4 | 400000 | EQS(f) | | | | | |
| **PAH (µg/l)** | | | | | | | |
| Benzo(a)pyrene[1,4] | 0.01 | UKDWS | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Naphthalene[2] | 10 | EQS (f) | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| Sum of 4 PAH[1] | 0.1 | UKDWS | <0.1* | <0.1* | <0.1* | <0.1* | <0.1* |
| **TPH (µg/l)** | | | | | | | |
| Hydrocarbons[1] | 10 | UKDWS | 2 | | | 2 | |
| Benzene | 30 | EQS (f) | < 1.0 | | | < 1.0 | |
| Toluene[2] | 50 | EQS (f) | < 1.0 | | | < 1.0 | |
| Ethyl benzene[3] | 300 | WHO | < 1.0 | | | < 1.0 | |
| Xylene[2] | 30 | EQS (f) | | | | | |

Notes

1 EQS values not available
2 UKDWS not available
3 Lower detectable limit above UKDWS. Concentrations below detectable limits are not considered further.
* Taken as lower detection limit
# Taken as lower detection limit of a single compound
$ Hardness data presented by the Environment Agency

UKDWS UK Drinking Water Standard Guideline taken from "The Water Supply (Water Quality) Regulations 2000"
EQS (f) Environmental Quality Standard for freshwater published by the Environment Agency
EQS (s) Environmental Quality Standard for saltwater published by the Environment Agency

| Title | Table number |
|---|---|
| Comparison of measured concentrations with guideline values for water receptors. | 8.3 |

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# Summary of test results

| | | | |
|---|---|---|---|
| **Receptor** | **Groundwater** | | |
| **Water type** | **Freshwater** | | |
| **Fish type** | **Cyprinid** | | |
| **Water hardness** | **>250** | **mg/l** | **259 mg/l Taken from Thames Water website** |

| Contaminant | Guideline value (µg/l) | Guideline source | TP109 0.8 |
|---|---|---|---|
| **Inorganics (µg/l)** | | | |
| Arsenic | 50 | EQS (f) | |
| Boron | 2000 | EQS (f) | |
| Cadmium | 5 | EQS (f) | |
| Chromium | 250 | EQS (f) | |
| Copper | 28 | EQS (f) | |
| Lead | 250 | EQS (f) | |
| Mercury | 1 | EQS (f) | |
| Nickel | 200 | EQS (f) | |
| Selenium[1] | 10 | UKDWS | |
| Vanadium[2] | 60 | EQS (f) | |
| Zinc | 500 | EQS (f) | |
| Free Cyanide[1] | 50 | UKDWS | |
| Nitrate as N | 50000 | UKDWS | |
| Sulphate as SO4 | 400000 | EQS(f) | |
| **PAH (µg/l)** | | | |
| Benzo(a)pyrene[1,4] | 0.01 | UKDWS | < 0.10 |
| Naphthalene[2] | 10 | EQS (f) | < 0.10 |
| Sum of 4 PAH[1] | 0.1 | UKDWS | <0.1* |
| **TPH (µg/l)** | | | |
| Hydrocarbons[1] | 10 | UKDWS | < 2.0 |
| Benzene | 30 | EQS (f) | < 1.0 |
| Toluene[2] | 50 | EQS (f) | < 1.0 |
| Ethyl benzene[3] | 300 | WHO | < 1.0 |
| Xylene[2] | 30 | EQS (f) | |

Notes

1 EQS values not available
2 UKDWS not available
3 Lower detectable limit above UKDWS. Concentrations below detectable limits are not considered further.
* Taken as lower detection limit
# Taken as lower detection limit of a single compound
$ Hardness data presented by the Environment Agency

UKDWS UK Drinking Water Standard Guideline taken from "The Water Supply (Water Quality) Regulations 2000"
EQS (f) Environmental Quality Standard for freshwater published by the Environment Agency
EQS (s) Environmental Quality Standard for saltwater published by the Environment Agency

| Title | Table number |
|---|---|
| Comparison of measured concentrations with guideline values for water receptors. | 8.4 |

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# Summary of groundwater test results

| | | | |
|---|---|---|---|
| **Receptor** | **Groundwater** | | |
| **Water type** | **Freshwater** | | |
| **Fish type** | **Cyprinid** | | |
| **Water hardness** | **>250** | **mg/l** | **259 mg/l Taken from Thames Water website** |

| Contaminant | Guideline value (µg/l) | Guideline source | Location / Depth (m) | BHB 1.61 | BHD 1.7 | BHE 1.3 |
|---|---|---|---|---|---|---|
| **Inorganics (µg/l)** | | | | | | |
| Arsenic | 50 | EQS (f) | | 1 | 4 | < 1.0 |
| Boron | 2000 | EQS (f) | | 880 | 720 | 680 |
| Cadmium | 5 | EQS (f) | | < 0.080 | 0 | < 0.080 |
| Chromium | 250 | EQS (f) | | 2 | 2 | 2 |
| Copper | 28 | EQS (f) | | 2 | < 1.0 | < 1.0 |
| Lead | 250 | EQS (f) | | < 1.0 | < 1.0 | < 1.0 |
| Mercury | 1 | EQS (f) | | < 0.50 | 1 | 1 |
| Nickel | 200 | EQS (f) | | 6 | 5 | 2 |
| Selenium[1] | 10 | UKDWS | | 2 | 2 | 1 |
| Vanadium[2] | 60 | EQS (f) | | < 1.0 | < 1.0 | < 1.0 |
| Zinc | 500 | EQS (f) | | 3 | 7 | 4 |
| Free Cyanide[1] | 50 | UKDWS | | <50 | <50 | <50 |
| Nitrate as N | 50000 | UKDWS | | <500 | <500 | 22000 |
| Sulphate as SO4 | 400000 | EQS(f) | | | | |
| **PAH (µg/l)** | | | | | | |
| Benzo(a)pyrene[1,4] | 0.01 | UKDWS | | < 0.10 | < 0.10 | < 0.10 |
| Naphthalene[2] | 10 | EQS (f) | | < 0.10 | < 0.10 | < 0.10 |
| Sum of 4 PAH[1] | 0.1 | UKDWS | | <0.1* | <0.1* | <0.1* |
| **TPH (µg/l)** | | | | | | |
| Hydrocarbons[1] | 10 | UKDWS | | | | |
| Benzene | 30 | EQS (f) | | | | |
| Toluene[2] | 50 | EQS (f) | | No TPH testing undertaken | | |
| Ethyl benzene[3] | 300 | WHO | | | | |
| Xylene[2] | 30 | EQS (f) | | | | |

Notes

1 EQS values not available
2 UKDWS not available
3 Lower detectable limit above UKDWS. Concentrations below detectable limits are not considered further.
* Taken as lower detection limit
# Taken as lower detection limit of a single compound
$ Hardness data presented by the Environment Agency

UKDWS UK Drinking Water Standard Guideline taken from "The Water Supply (Water Quality) Regulations 2000"
EQS (f) Environmental Quality Standard for freshwater published by the Environment Agency
EQS (s) Environmental Quality Standard for saltwater published by the Environment Agency

| Title | Table number |
|---|---|
| Comparison of measured concentrations with guideline values for water receptors. | 9 |

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# Summary of petroleum hydrocarbon test results

## BTEX (Red highlights indicate exceedance of guideline value)

| Indicator | unit | Guideline value | Concentration | | | | |
|---|---|---|---|---|---|---|---|
| | | | BHE | DTS102 | DTS104 | DTS111 | DTS115 |
| | | | 0.50 | 0.50 | 0.35 | 0.40 | 0.50 |
| Benzene | mg/kg | 0.33 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Toluene | mg/kg | 610 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Ethylbenzene | mg/kg | 350 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| o-Xylene | mg/kg | 250 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| m,p-Xylene | mg/kg | 230 | < 0.001 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |

## Hydrocarbon banding (Red highlights indicate exceedance of GAC value)

| Fraction | unit | GAC | Concentration | | | | |
|---|---|---|---|---|---|---|---|
| | | | BHE | DTS102 | DTS104 | DTS111 | DTS115 |
| | | | 0.50 | 0.50 | 0.35 | 0.40 | 0.50 |
| **Aliphatic** | | | | | | | |
| EC 5 - 6 | mg/kg | 30 | < 0.010 | < 0.010 | < 0.010 | < 0.010 | < 0.010 |
| EC >6 - 8 | mg/kg | 73 | < 0.010 | < 0.010 | < 0.010 | < 0.010 | < 0.010 |
| EC >8 - 10 | mg/kg | 19 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >10 - 12 | mg/kg | 93 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >12 - 16 | mg/kg | 740 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >16 - 35 | mg/kg | 45000 | < 0.10 | < 0.10 | < 0.10 | 630 | < 0.10 |
| EC >35 - 44 | mg/kg | 45000 | < 0.10 | < 0.10 | < 0.10 | 110 | < 0.10 |
| **Aromatic** | | | | | | | |
| EC 5 - 7 (benzene) | mg/kg | 65 | < 0.010 | < 0.010 | < 0.010 | < 0.010 | < 0.010 |
| EC >7 - 8 (toluene) | mg/kg | 120 | < 0.010 | < 0.010 | < 0.010 | < 0.010 | < 0.010 |
| EC >8 - 10 | mg/kg | 27 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >10 - 12 | mg/kg | 69 | < 0.10 | < 0.10 | < 0.10 | 9.4 | < 0.10 |
| EC >12 - 16 | mg/kg | 140 | < 0.10 | < 0.10 | < 0.10 | 670 | < 0.10 |
| EC >16 - 21 | mg/kg | 250 | 1.1 | < 0.10 | 7.2 | 3600 | 16 |
| EC >21 - 35 | mg/kg | 890 | < 0.10 | < 0.10 | 36 | 7000 | 32 |
| EC >35 - 44 | mg/kg | 890 | < 0.10 | < 0.10 | 1.7 | 210 | < 0.10 |

Notes

1. Generic Assessment Criteria (GAC) as presented in "Generic Assessment Criteria for Human Health Risk Assessment" published by Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH).

| Title | Table number |
|---|---|
| Comparison of measured concentrations of petroleum hydrocarbons with guideline values. | 10.1 |

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# Summary of petroleum hydrocarbon test results

## BTEX (Red highlights indicate exceedance of guideline value)

| Indicator | unit | Guideline value | Concentration | | | |
|---|---|---|---|---|---|---|
| | | | HP01 | HP02 | TP105 | TP109 |
| | | | 0.30 | 0.40 | 0.20 | 0.80 |
| Benzene | mg/kg | 0.33 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Toluene | mg/kg | 610 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Ethylbenzene | mg/kg | 350 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| o-Xylene | mg/kg | 250 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| m,p-Xylene | mg/kg | 230 | < 0.001 | < 0.001 | < 0.001 | < 0.001 |

## Hydrocarbon banding (Red highlights indicate exceedance of GAC value)

| Fraction | unit | GAC | Concentration | | | |
|---|---|---|---|---|---|---|
| | | | HP01 | HP02 | TP105 | TP109 |
| | | | 0.30 | 0.40 | 0.20 | 0.80 |
| **Aliphatic** | | | | | | |
| EC 5 - 6 | mg/kg | 30 | < 0.010 | < 0.010 | < 0.010 | < 0.010 |
| EC >6 - 8 | mg/kg | 73 | < 0.010 | < 0.010 | < 0.010 | < 0.010 |
| EC >8 - 10 | mg/kg | 19 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >10 - 12 | mg/kg | 93 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >12 - 16 | mg/kg | 740 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >16 - 35 | mg/kg | 45000 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >35 - 44 | mg/kg | 45000 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| **Aromatic** | | | | | | |
| EC 5 - 7 (benzene) | mg/kg | 65 | < 0.010 | < 0.010 | < 0.010 | < 0.010 |
| EC >7 - 8 (toluene) | mg/kg | 120 | < 0.010 | < 0.010 | < 0.010 | < 0.010 |
| EC >8 - 10 | mg/kg | 27 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >10 - 12 | mg/kg | 69 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >12 - 16 | mg/kg | 140 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |
| EC >16 - 21 | mg/kg | 250 | 11 | 25 | 8.7 | < 0.10 |
| EC >21 - 35 | mg/kg | 890 | 36 | 47 | 16 | < 0.10 |
| EC >35 - 44 | mg/kg | 890 | < 0.10 | < 0.10 | < 0.10 | < 0.10 |

Notes

1. Generic Assessment Criteria (GAC) as presented in "Generic Assessment Criteria for Human Health Risk Assessment" published by Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH).

| Title | Table number |
|---|---|
| Comparison of measured concentrations of petroleum hydrocarbons with guideline | 10.2 |

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# Initial Conceptual Model (based on desk study information)

**Current site use** residential without plant uptake
**Proposed site use** residential

| Source | Pathway | | | | | | | | | | Receptor | | Risk assessment to CIRIA C552 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Humans | | | | | | Vegetation | Water | | | | | Consequence of risk occurring via most likely pathway | Risk |
| | Ingestion of air-borne dusts | Ingestion of soil | Ingestion of vegetables and soil attached to vegetables | Inhalation of air-borne dusts | Inhalation of vapours | Dermal contact with soil and dust | Root uptake, deposition to shoots and foliage contact | Percolation of water through contaminated soils | Near-surface water run-off through contaminated | Saturation of contaminated soils by flood waters | | | | |
| **Soils** | | | | | | | | | | | | | | |
| **Asbestos** | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Current site users | Child | Severe | High |
| | Likely | Likely | Likely | Likely | Likely | Likely | - | - | - | - | Proposed site users | Child | Severe | High |
| | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Construction operatives | Adult | Severe | High |
| | - | - | - | - | - | - | Likely | - | - | - | Vegetation (current and proposed) | - | Minor | Low |
| | - | - | - | - | - | - | - | High likelihood | High likelihood | Unlikely | Water (current and proposed) | - | Mild | Moderate |
| **Made Ground** (organics, inorganics) | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Current site users | Child | Mild | Low/moderate |
| | Likely | Likely | Likely | Likely | Likely | Likely | - | - | - | - | Proposed site users | Child | Mild | Low/moderate |
| | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Construction operatives | Adult | Mild | Low/moderate |
| | - | - | - | - | - | - | Likely | - | - | - | Vegetation (current and proposed) | - | Minor | Low |
| | - | - | - | - | - | - | - | High likelihood | High likelihood | Unlikely | Water (current and proposed) | - | Minor | Low/moderate |
| **Former tramline** (organics, inorganics, asbestos) | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Current site users | Child | Mild | Low/moderate |
| | Likely | Likely | Likely | Likely | Likely | Likely | - | - | - | - | Proposed site users | Child | Mild | Low/moderate |
| | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Construction operatives | Adult | Mild | Low/moderate |
| | - | - | - | - | - | - | Likely | - | - | - | Vegetation (current and proposed) | - | Minor | Low |
| | - | - | - | - | - | - | - | High likelihood | High likelihood | Unlikely | Water (current and proposed) | - | Minor | Low/moderate |
| **Sewage works** (organics, inorganics, microorganisms) | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Current site users | Child | Minor | Low |
| | Likely | Likely | Likely | Likely | Likely | Likely | - | - | - | - | Proposed site users | Child | Minor | Low |
| | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Construction operatives | Adult | Minor | Low |
| | - | - | - | - | - | - | Likely | - | - | - | Vegetation (current and proposed) | - | Minor | Low |
| | - | - | - | - | - | - | - | low liklihood | low liklihood | Unlikely | Water (current and proposed) | - | Minor | Very low |

| Title | Table number |
|---|---|
| Initial Conceptual Site Model | 1 |

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# Updated Conceptual Model (following lab testing)

**Current site use** residential without plant uptake
**Proposed site use** residential

| Source | Pathway | | | | | | | | | | Receptor | | Risk assessment to CIRIA C552 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Humans | | | | | | Vegetation | Water | | | | | Consequence of risk occurring via most likely pathway | Risk |
| | Ingestion of air-borne dusts | Ingestion of soil | Ingestion of vegetables and soil attached to vegetables | Inhalation of air-borne dusts | Inhalation of vapours | Dermal contact with soil and dust | Root uptake, deposition to shoots and foliage contact | Percolation of water through contaminated soils | Near-surface water run-off through contaminated | Saturation of contaminated soils by flood waters | | | | |
| **Soils** | | | | | | | | | | | | | | |
| **Asbestos** | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Current site users | Child | Minor | Low |
| | Likely | Likely | Likely | Likely | Likely | Likely | - | - | - | - | Proposed site users | Child | Minor | Low |
| | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Construction operatives | Adult | Minor | Low |
| | - | - | - | - | - | - | Likely | - | - | - | Vegetation (current and proposed) | - | Minor | Low |
| | - | - | - | - | - | - | - | High likelihood | High likelihood | Unlikely | Water (current and proposed) | - | Minor | Low/moderate |
| **Made Ground** (organics, inorganics) | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Current site users | Child | Mild | Low/moderate |
| | Likely | Likely | Likely | Likely | Likely | Likely | - | - | - | - | Proposed site users | Child | Mild | Low/moderate |
| | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Construction operatives | Adult | Mild | Low/moderate |
| | - | - | - | - | - | - | Likely | - | - | - | Vegetation (current and proposed) | - | Minor | Low |
| | - | - | - | - | - | - | - | High likelihood | High likelihood | Unlikely | Water (current and proposed) | - | Minor | Low/moderate |
| **Former tramline** (organics, inorganics, asbestos) | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Current site users | Child | Mild | Low/moderate |
| | Likely | Likely | Likely | Likely | Likely | Likely | - | - | - | - | Proposed site users | Child | Mild | Low/moderate |
| | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Construction operatives | Adult | Mild | Low/moderate |
| | - | - | - | - | - | - | Likely | - | - | - | Vegetation (current and proposed) | - | Minor | Low |
| | - | - | - | - | - | - | - | High likelihood | High likelihood | Unlikely | Water (current and proposed) | - | Minor | Low/moderate |
| **Sewage works** (organics, inorganics, microorganisms) | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Current site users | Child | Minor | Low |
| | Likely | Likely | Likely | Likely | Likely | Likely | - | - | - | - | Proposed site users | Child | Minor | Low |
| | Likely | Likely | Unlikely | Likely | Likely | Likely | - | - | - | - | Construction operatives | Adult | Minor | Low |
| | - | - | - | - | - | - | Likely | - | - | - | Vegetation (current and proposed) | - | Minor | Low |
| | - | - | - | - | - | - | - | low liklihood | low liklihood | Unlikely | Water (current and proposed) | - | Minor | Very low |

| Title | Table number |
|---|---|
| Updated Conceptual Site Model | 2 |

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# Record of INITIAL in-situ gas and water level monitoring results

| Date/Time | Location | Atmospheric pressure (mB) | | Temperature (°C) | Methane, $CH_4$ (%v/v) *Chg* | | Carbon Dioxide, $CO_2$ (%v/v) *Chg* | | Oxygen, $O_2$ (%v/v) | | Balance | Lower Explosive Limit | Gas Flow (q) | | Peak hazardous gas flow rate *Qhgs* | | Steady hazardous gas flow rate *Qhgs* | | NHBC Guideline | NHBC Guideline | Characteristic gas situation | Potentially Explosive | Water Level (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Peak | Steady | Peak | Steady | Minimum | Average | (%v/v) | (% LEL) | (l/Hr) | | $CH_4$ | $CO_2$ | $CH_4$ | $CO_2$ | (Peak) | (Steady) | | | |
| 04/11/2015 11:52 | DTS114 | 1012 | High | 14.0 | 0.0 | 0.0 | 3.3 | 3.2 | 16.1 | 16.1 | 80.7 | 0.0 | 0.1 | 0.1 | 0.0000 | 0.0033 | 0.0000 | 0.0032 | GREEN | GREEN | ONE | NO | DRY |
| 04/11/2015 12:31 | BHB | 1012 | High | 14.0 | 0.0 | 0.0 | 3.6 | 3.6 | 15.5 | 15.5 | 80.9 | 0.0 | 0.1 | 0.1 | 0.0000 | 0.0036 | 0.0000 | 0.0036 | GREEN | GREEN | ONE | NO | 1.45 |
| 04/11/2015 10:58 | BHD | 1012 | High | 14.0 | 0.0 | 0.0 | 3.3 | 3.2 | 1.7 | 1.7 | 95.1 | 0.0 | 0.4 | 0.4 | 0.0000 | 0.0132 | 0.0000 | 0.0128 | GREEN | GREEN | ONE | NO | 1.7 |
| 04/11/2015 09:41 | BHE | 1012 | High | 14.0 | 0.0 | 0.0 | 2.8 | 2.7 | 14.6 | 14.6 | 82.7 | 0.0 | 0.1 | 0.1 | 0.0000 | 0.0028 | 0.0000 | 0.0027 | GREEN | GREEN | ONE | NO | 1.3 |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 18/11/2015 09:13 | DTS114 | 1011 | High | 11.0 | 0.0 | 0.0 | 3.1 | 3.1 | 15.8 | 15.8 | 81.1 | 0.0 | 0.1 | 0.1 | 0.0000 | 0.0031 | 0.0000 | 0.0031 | GREEN | GREEN | ONE | NO | DRY |
| 18/11/2015 08:37 | BHB | 1011 | High | 11.0 | 0.0 | 0.0 | 4.4 | 4.4 | 15.4 | 15.4 | 80.2 | 0.0 | 0.1 | 0.1 | 0.0000 | 0.0044 | 0.0000 | 0.0044 | GREEN | GREEN | ONE | NO | 1.33 |
| 18/11/2015 08:55 | BHD | 1011 | High | 11.0 | 0.0 | 0.0 | 2.3 | 2.3 | 3.4 | 3.5 | 94.2 | 0.0 | 0.1 | 0.1 | 0.0000 | 0.0023 | 0.0000 | 0.0023 | GREEN | GREEN | ONE | NO | 1.55 |
| 18/11/2015 08:20 | BHE | 1012 | High | 11.0 | 0.0 | 0.0 | 1.8 | 1.1 | 18.1 | 19.0 | 79.9 | 0.0 | -0.1 | 0.1 | 0.0000 | 0.0018 | 0.0000 | 0.0011 | GREEN | GREEN | ONE | NO | 1.1 |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 04/12/2015 10:41 | DTS114 | 1026 | High | 9.0 | 0.0 | 0.0 | 2.0 | 2.0 | 19.2 | 19.2 | 78.8 | 0.0 | -0.2 | 0.2 | 0.0000 | 0.0040 | 0.0000 | 0.0040 | GREEN | GREEN | ONE | NO | DRY |
| 04/12/2015 09:42 | BHB | 1025 | High | 9.0 | 0.0 | 0.0 | 4.5 | 4.5 | 13.7 | 13.7 | 81.8 | 0.0 | -0.1 | 0.1 | 0.0000 | 0.0045 | 0.0000 | 0.0045 | GREEN | GREEN | ONE | NO | 1.2 |
| 04/12/2015 10:18 | BHD | 1025 | High | 9.0 | 0.0 | 0.0 | 3.2 | 2.5 | 3.6 | 6.4 | 91.1 | 0.0 | -0.2 | 0.2 | 0.0000 | 0.0064 | 0.0000 | 0.0050 | GREEN | GREEN | ONE | NO | 1.54 |
| 04/12/2015 09:56 | BHE | 1025 | High | 9.0 | 0.0 | 0.0 | 3.0 | 2.3 | 16.3 | 17.2 | 80.5 | 0.0 | -0.2 | 0.2 | 0.0000 | 0.0060 | 0.0000 | 0.0046 | GREEN | GREEN | ONE | NO | 1.22 |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 10/12/2015 07:51 | DTS114 | 1024 | High | 9.0 | 0.0 | 0.0 | 3.2 | 3.2 | 14.7 | 14.7 | 82.1 | 0.0 | -0.9 | 0.9 | 0.0000 | 0.0288 | 0.0000 | 0.0288 | GREEN | GREEN | ONE | NO | 2.4 |
| 10/12/2015 08:24 | BHB | 1024 | High | 9.0 | 0.1 | 0.0 | 4.4 | 4.4 | 14.2 | 14.2 | 81.4 | 0.0 | -0.7 | 0.7 | 0.0007 | 0.0308 | 0.0000 | 0.0308 | GREEN | GREEN | ONE | NO | 1.32 |
| 10/12/2015 07:34 | BHD | 1024 | High | 9.0 | 0.0 | 0.0 | 2.7 | 2.7 | 8.7 | 8.7 | 88.6 | 0.0 | -1.0 | 1 | 0.0000 | 0.0270 | 0.0000 | 0.0270 | GREEN | GREEN | ONE | NO | 1.54 |
| 10/12/2015 08:06 | BHE | 1024 | High | 9.0 | 0.0 | 0.0 | 3.2 | 2.2 | 16.6 | 17.6 | 80.2 | 0.0 | -0.8 | 0.8 | 0.0000 | 0.0256 | 0.0000 | 0.0176 | GREEN | GREEN | ONE | NO | 1.21 |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 15/01/2016 14:09 | DTS114 | 1018 | High | 5.0 | 0.0 | 0.0 | 3.8 | 3.8 | 8.2 | 8.2 | 88.0 | 0.0 | 0.1 | 0.1 | 0.0000 | 0.0038 | 0.0000 | 0.0038 | GREEN | GREEN | ONE | NO | 2.48 |
| 15/01/2016 13:25 | BHB | 1018 | High | 5.0 | 0.0 | 0.0 | 4.7 | 4.6 | 11.4 | 11.4 | 84.0 | 0.0 | 0.1 | 0.1 | 0.0000 | 0.0047 | 0.0000 | 0.0046 | GREEN | GREEN | ONE | NO | 1.04 |
| 15/01/2016 13:39 | BHD | 1018 | High | 5.0 | 0.0 | 0.0 | 1.7 | 1.7 | 13.1 | 13.1 | 85.2 | 0.0 | 0.1 | 0.1 | 0.0000 | 0.0017 | 0.0000 | 0.0017 | GREEN | GREEN | ONE | NO | 1.31 |
| 15/01/2016 13:07 | BHE | 1018 | High | 5.0 | 0.0 | 0.0 | 1.7 | 1.7 | 14.8 | 14.9 | 83.4 | 0.0 | 0.1 | 0.1 | 0.0000 | 0.0017 | 0.0000 | 0.0017 | GREEN | GREEN | ONE | NO | 0.82 |
| | | | | | | | | | | | | | | | | | | | | | | | |
| 25/01/2016 09:45 | DTS114 | 1020 | High | 10.0 | 0.1 | 0.0 | 2.5 | 2.4 | 14.7 | 14.8 | 82.8 | 0.0 | 0.1 | 0.1 | 0.0001 | 0.0025 | 0.0000 | 0.0024 | GREEN | GREEN | ONE | NO | 2.52 |
| 25/01/2016 10:28 | BHB | 1016 | High | 10.0 | 0.1 | 0.0 | 5.9 | 5.9 | 10.1 | 10.4 | 83.7 | 0.0 | 0.1 | 0.1 | 0.0001 | 0.0059 | 0.0000 | 0.0059 | AMBER 1 | AMBER 1 | TWO | NO | 1.29 |
| 25/01/2016 10:43 | BHD | 1017 | High | 10.0 | 0.0 | 0.0 | 2.6 | 2.5 | 8.8 | 8.9 | 88.6 | 0.0 | -0.1 | 0.1 | 0.0000 | 0.0026 | 0.0000 | 0.0025 | GREEN | GREEN | ONE | NO | 1.47 |
| 25/01/2016 10:09 | BHE | 1016 | High | 10.0 | 0.0 | 0.0 | 1.1 | 0.6 | 18.3 | 19.0 | 80.4 | 0.0 | -0.1 | 0.1 | 0.0000 | 0.0011 | 0.0000 | 0.0006 | GREEN | GREEN | ONE | NO | 1.05 |
| | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | 0.1 | 0.0 | 5.9 | 5.9 | 1.7 | 1.7 | 95.1 | 0.0 | 1.00 | | 0.0010 | 0.0590 | 0.0000 | 0.0590 | AMBER1 | AMBER 1 | TWO | Worst case scenario | |
| | | | | | 0.0 | 0.0 | 3.1 | 2.9 | 12.8 | 13.1 | 84.0 | 0.0 | 0.25 | | 0.0000 | 0.0078 | 0.0000 | 0.0074 | GREEN | GREEN | ONE | Average site scenario | |

Additonal considerations:

Notes:
Gas Screening Value (GSV) derived by multiplying the peak gas concentration (%) by the peak flow rate (l/h).

The gas analyser is capable of measuring flow to an accuracy of 0.1l/h. Below this value the analyser records zero flow. Adopting a precautionary approach we have used a flow rate of 0.1l/h when the analyser records zero with this flow rate used to determine the gas screening value.

| Title | Revision |
|---|---|
| Record of in-situ gas monitoring results. | Final |

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# Record of ADDITIONAL in-situ gas and water level monitoring results

| Date/Time | Location | Atmospheric pressure (mB) | Temperature (°C) | Methane, $CH_4$ (%v/v) *Chg* | | Carbon Dioxide, $CO_2$ (%v/v) *Chg* | | Oxygen, $O_2$ (%v/v) | | Balance | Lower Explosive Limit | Gas Flow (q) | Peak hazardous gas flow rate *Qhgs* | | Steady hazardous gas flow rate *Qhgs* | | NHBC Guideline | NHBC Guideline | Characteristic gas situation | Potentially Explosive | Water Level (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Peak | Steady | Peak | Steady | Minimum | Average | (%v/v) | (% LEL) | (l/Hr) | $CH_4$ | $CO_2$ | $CH_4$ | $CO_2$ | (Peak) | (Steady) | | | |
| 15/03/2016 10:53 | DTS114 | 1028 | 10.0 | 0.0 | 0.0 | 1.8 | 1.4 | 17.5 | 17.9 | 80.7 | 0.0 | 0.1 | 0.00 | 0.00 | 0.00 | 0.00 | GREEN | GREEN | ONE | NO | DRY |
| 15/03/2016 11:43 | BHB | 1028 | 10.0 | 0.0 | 0.0 | 6.6 | 6.6 | 10.0 | 10.0 | 83.4 | 0.0 | 0.1 | 0.00 | 0.01 | 0.00 | 0.01 | AMBER 1 | AMBER 1 | TWO | NO | 1.28 |
| 15/03/2016 12:02 | BHD | 1028 | 10.0 | 0.0 | 0.0 | 2.4 | 2.2 | 13.3 | 13.8 | 84.0 | 0.0 | 0.1 | 0.00 | 0.00 | 0.00 | 0.00 | GREEN | GREEN | ONE | NO | 1.49 |
| 15/03/2016 12:24 | BHE | 1027 | 10.0 | 0.0 | 0.0 | 1.9 | 1.7 | 16.5 | 16.8 | 81.5 | 0.0 | 0.1 | 0.00 | 0.00 | 0.00 | 0.00 | GREEN | GREEN | ONE | NO | 1.1 |
| | | | | | | | | | | | | | | | | | | | | | |
| 30/03/2016 12:28 | BHB | 1009 | 8.0 | 0.1 | 0.1 | 6.8 | 6.7 | 12.7 | 12.8 | 80.4 | 2.0 | 4.8 | 0.00 | 0.33 | 0.00 | 0.32 | AMBER 1 | AMBER 1 | TWO | NO | 0.98 |
| 30/03/2016 13:29 | BHD | 1009 | 8.0 | 0.1 | 0.0 | 2.3 | 2.2 | 11.8 | 11.8 | 86.0 | 0.0 | 0.1 | 0.00 | 0.00 | 0.00 | 0.00 | GREEN | GREEN | ONE | NO | 1.26 |
| 30/03/2016 14:26 | BHE | 1009 | 8.0 | 0.1 | 0.1 | 2.5 | 2.4 | 16.5 | 16.5 | 81.0 | 2.0 | 0.1 | 0.00 | 0.00 | 0.00 | 0.00 | GREEN | GREEN | ONE | NO | 0.87 |
| | | | | | | | | | | | | | | | | | | | | | |
| 14/04/2016 13:35 | DTS114 | 1008 | 17.0 | 0.0 | 0.0 | 3.2 | 2.9 | 16.8 | 16.8 | 80.3 | 0.0 | 0.1 | 0.00 | 0.00 | 0.00 | 0.00 | GREEN | GREEN | ONE | NO | 2.47 |
| 14/04/2016 14:40 | BHB | 1009 | 17.0 | 0.1 | 0.0 | 7.9 | 7.9 | 7.0 | 7.1 | 85.0 | 0.0 | 0.1 | 0.00 | 0.01 | 0.00 | 0.01 | AMBER 1 | AMBER 1 | TWO | NO | 1.29 |
| 14/04/2016 14:18 | BHD | 1008 | 17.0 | 0.0 | 0.0 | 2.0 | 1.3 | 14.1 | 15.1 | 83.6 | 0.0 | 0.1 | 0.00 | 0.00 | 0.00 | 0.00 | GREEN | GREEN | ONE | NO | 1.41 |
| 14/04/2016 14:00 | BHE | 1008 | 17.0 | 0.0 | 0.0 | 1.2 | 1.1 | 17.7 | 17.7 | 81.2 | 0.0 | 0.1 | 0.00 | 0.00 | 0.00 | 0.00 | GREEN | GREEN | ONE | NO | 1 |
| | | | | | | | | | | | | | | | | | | | | | |
| 0.1 | 0.1 | 7.9 | 7.9 | 7.0 | 7.1 | 86.0 | 2.0 | 4.80 | 0.00 | 0.38 | 0.00 | 0.38 | AMBER1 | AMBER 1 | TWO | **Worst case scenario** | | | | | |
| 0.0 | 0.0 | 3.5 | 3.3 | 14.0 | 14.2 | 82.5 | 0.4 | 0.53 | 0.00 | 0.02 | 0.00 | 0.02 | GREEN | GREEN | ONE | **Average site scenario** | | | | | |

Additonal considerations:

Notes:
Gas Screening Value (GSV) derived by multiplying the peak gas concentration (%) by the peak flow rate (l/h).

The gas analyser is capable of measuring flow to an accuracy of 0.1l/h. Below this value the analyser records zero flow. Adopting a precautionary approach we have used a flow rate of 0.1l/h when the analyser records zero with this flow rate used to determine the gas screening value.

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## Table comparing cumulative compound concentrations with hazardous waste threshold values for WAC CS1 soils

| Category of danger | | Irritant | Harmful | Toxic | | Carcinogenic | | Corrosive | | Toxic for reproduction | | Mutagenic | | Ecotoxic | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ∑N : R50-53/0.25 | ∑N : 50-53 | ∑N : 50-53 |
| | | | | | | | | | | | | | | +∑N : R51-53/2.5 | +∑N : R50 | +∑N : 51-53 |
| | | | | | | Carc Cat 1 | | | | Repr Cat 1 or | | | | +∑N : R52-53/25 | | +∑N : 52-53 |
| Risk Phrase | | Xi | Xn | T+ | T | or 2 | Carc Cat 3 | C R34 | C R35 | 2 | Repr Cat 3 | Muta Cat 2 | Muta Cat 3 | | | +∑N : R53 |
| Contaminant | Highest concentration | H4 (%) | H5 (%) | H6 (%) | H6 (%) | H7 (%) | H7 (%) | H8 (%) | H8 (%) | H10 (%) | H10 (%) | H11 (%) | H11 (%) | H14 | H14 | H14 |
| **Metals** | | | | | | | | | | | | | | | | |
| Arsenic | 23.00 | | | 0.0030 | 0.0035 | 0.0035 | | | | | | | | 0.6734 | 0.0035 | 0.0035 |
| Beryllium | 1.30 | 0.0004 | | 0.0004 | 0.0004 | 0.0004 | | | | | | | | | | 0.0004 |
| Copper | 120.00 | 0.0300 | 0.0300 | | | | | | | | | | | | 0.0300 | 0.0300 |
| Cadmium | 0.34 | | 0.0000 | | 0.0000 | 0.0000 | | | | | | | | | | |
| Chromium | 62.00 | | | | | 0.0100 | | | | | | | | | 0.0100 | 0.0100 |
| Lead | 390.00 | | 0.0420 | | | | | | | 0.0420 | 0.0420 | | | | 0.0420 | 0.0420 |
| Mercury | 5.80 | | | 0.0006 | | | | | | | | | | | 0.0006 | 0.0006 |
| Nickel | 28.00 | | 0.0140 | | | | 0.0140 | | | | 0.0140 | | | | 0.0140 | 0.0140 |
| Selenium | 0.48 | | | | 0.0000 | | | | | | | | | | 0.0000 | 0.0000 |
| Zinc | 230.00 | 0.0621 | 0.1668 | | | 0.0637 | | 0.0480 | | | | | 0.1081 | | 0.0621 | 0.0621 |
| Vanadium | 72.00 | 0.0106 | | | 0.0106 | | | | | | 0.0106 | | 0.0106 | | | 0.0106 |
| **PAH** | | | | | | | | | | | | | | | | |
| Naphthalene | 0.66 | | 0.0001 | | | | | | | | | | | | 0.0001 | 0.0001 |
| Benzo(a)anthracene | 7.20 | | | | 0.0007 | 0.0007 | | | | | | | | | 0.0007 | 0.0007 |
| Chrysene | 7.80 | | | | 0.0008 | 0.0008 | | | | | | | 0.0008 | | 0.0008 | 0.0008 |
| Benzo(b)fluoranthene | 14.00 | | | | 0.0014 | 0.0014 | | | | | | | | | 0.0014 | 0.0014 |
| Benzo(k)fluoranthene | 5.80 | | | | 0.0006 | 0.0006 | | | | | | | | | 0.0006 | 0.0006 |
| Benzo(a)pyrene | 16.00 | | | | | 0.0016 | | | | 0.0016 | | 0.0016 | | | 0.0016 | 0.0016 |
| Dibenzo(a,h)anthracene | 2.50 | | | | 0.0003 | 0.0003 | | | | | | | | | 0.0003 | 0.0003 |
| **TPH** | | | | | | | | | | | | | | | | |
| Benzene | 0.00 | | | | 0.0000 | 0.0000 | | | | | | | | | | |
| 1,2,4-trimethylbenzene | 0.00 | 0.0000 | 0.0000 | | | | | | | | | | | | | 0.0000 |
| PRO (C6 - C10) | 0.00 | | 0.0000 | | | 0.0000 | | | | | | | | | | 0.0000 |
| DRO (C10 - C35) | 72.00 | | 0.0072 | | | | 0.0072 | | | | | | | | | 0.0072 |
| Total (or greatest) | | 0.1030 | 0.2601 | 0.0040 | 0.0183 | (0.0637) | (0.014) | 0.0480 | 0.0000 | (0.042) | (0.0000) | (0.0016) | (0.1081) | 0.6734 | 0.1677 | 0.1859 |
| Threshold | | 20% | 25% | 0.10% | 3% | 0.10% | 1% | 5% | 1% | 0.50% | 5% | 0.10% | 1% | 1 | 25% | 25% |
| Exceeded Y/N | | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |

| Title | Table number |
|---|---|
| Hazard assessment spreadsheet | 1 of 3 |

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## Table comparing cumulative compound concentrations with hazardous waste threshold values for WAC CS2 soils

| Category of danger | | Irritant | Harmful | Toxic | | Carcinogenic | | Corrosive | | Toxic for reproduction | | Mutagenic | | Ecotoxic | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ∑N : R50-53/0.25 | ∑N : 50-53 | ∑N : 50-53 |
| | | | | | | | | | | | | | | +∑N : R51-53/2.5 | +∑N : R50 | +∑N : 51-53 |
| | | | | | | Carc Cat 1 | | | | Repr Cat 1 or | | | | +∑N : R52-53/25 | | +∑N : 52-53 |
| Risk Phrase | | Xi | Xn | T+ | T | or 2 | Carc Cat 3 | C R34 | C R35 | 2 | Repr Cat 3 | Muta Cat 2 | Muta Cat 3 | | | +∑N : R53 |
| Contaminant | Highest concentration | H4 (%) | H5 (%) | H6 (%) | H6 (%) | H7 (%) | H7 (%) | H8 (%) | H8 (%) | H10 (%) | H10 (%) | H11 (%) | H11 (%) | H14 | H14 | H14 |
| **Metals** | | | | | | | | | | | | | | | | |
| Arsenic | 36.00 | | | 0.0048 | 0.0055 | 0.0055 | | | | | | | | 0.7295 | 0.0055 | 0.0055 |
| Beryllium | 1.40 | 0.0004 | | 0.0004 | 0.0004 | 0.0004 | | | | | | | | | | 0.0004 |
| Copper | 69.00 | 0.0173 | 0.0173 | | | | | | | | | | | | 0.0173 | 0.0173 |
| Cadmium | 0.96 | | 0.0001 | | 0.0001 | 0.0001 | | | | | | | | | | |
| Chromium | 30.00 | | | | | 0.0048 | | | | | | | | | 0.0048 | 0.0048 |
| Lead | 360.00 | | 0.0388 | | | | | | | 0.0388 | 0.0388 | | | | 0.0388 | 0.0388 |
| Mercury | 2.00 | | | 0.0002 | | | | | | | | | | | 0.0002 | 0.0002 |
| Nickel | 41.00 | | 0.0205 | | | | 0.0205 | | | | 0.0205 | | | | 0.0205 | 0.0205 |
| Selenium | 0.58 | | | | 0.0001 | | | | | | | | | | 0.0001 | 0.0001 |
| Zinc | 150.00 | 0.0405 | 0.1088 | | | 0.0416 | | 0.0313 | | | | | 0.0705 | | 0.0405 | 0.0405 |
| Vanadium | 82.00 | 0.0121 | | | 0.0121 | | | | | | 0.0121 | | 0.0121 | | | 0.0121 |
| **PAH** | | | | | | | | | | | | | | | | |
| Naphthalene | 6.10 | | 0.0006 | | | | | | | | | | | | 0.0006 | 0.0006 |
| Benzo(a)anthracene | 120.00 | | | | 0.0120 | 0.0120 | | | | | | | | | 0.0120 | 0.0120 |
| Chrysene | 110.00 | | | | 0.0110 | 0.0110 | | | | | | | 0.0110 | | 0.0110 | 0.0110 |
| Benzo(b)fluoranthene | 120.00 | | | | 0.0120 | 0.0120 | | | | | | | | | 0.0120 | 0.0120 |
| Benzo(k)fluoranthene | 60.00 | | | | 0.0060 | 0.0060 | | | | | | | | | 0.0060 | 0.0060 |
| Benzo(a)pyrene | 110.00 | | | | | 0.0110 | | | | 0.0110 | | 0.0110 | | | 0.0110 | 0.0110 |
| Dibenzo(a,h)anthracene | 16.00 | | | | 0.0016 | 0.0016 | | | | | | | | | 0.0016 | 0.0016 |
| **TPH** | | | | | | | | | | | | | | | | |
| Benzene | 0.00 | | | | 0.0000 | 0.0000 | | | | | | | | | | |
| 1,2,4-trimethylbenzene | 0.00 | 0.0000 | 0.0000 | | | | | | | | | | | | | 0.0000 |
| PRO (C6 - C10) | 0.00 | | 0.0000 | | | 0.0000 | | | | | | | | | | 0.0000 |
| DRO (C10 - C35) | 10819.40 | | 1.0819 | | | | 1.0819 | | | | | | | | | 1.0819 |
| Total (or greatest) | | 0.0702 | 1.2680 | 0.0054 | 0.0607 | (0.0416) | (1.0819) | 0.0313 | 0.0000 | (0.0388) | (0.0000) | (0.011) | (0.0705) | 0.7295 | 0.1819 | 1.2763 |
| Threshold | | 20% | 25% | 0.10% | 3% | 0.10% | 1% | 5% | 1% | 0.50% | 5% | 0.10% | 1% | 1 | 25% | 25% |
| Exceeded Y/N | | N | N | N | N | N | Y | N | N | N | N | N | N | N | N | N |

| Title | Table number |
|---|---|
| Hazard assessment spreadsheet | 2 of 3 |

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## Table comparing cumulative compound concentrations with hazardous waste threshold values forWAC CS3 soils

| Category of danger | | Irritant | Harmful | Toxic | | Carcinogenic | | Corrosive | | Toxic for reproduction | | Mutagenic | | Ecotoxic | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | ∑N : R50-53/0.25 | ∑N : 50-53 | ∑N : 50-53 |
| | | | | | | | | | | | | | | +∑N : R51-53/2.5 | +∑N : R50 | +∑N : 51-53 |
| | | | | | | Carc Cat 1 | | | | Repr Cat 1 or | | | | +∑N : R52-53/25 | | +∑N : 52-53 |
| Risk Phrase | | Xi | Xn | T+ | T | or 2 | Carc Cat 3 | C R34 | C R35 | 2 | Repr Cat 3 | Muta Cat 2 | Muta Cat 3 | | | +∑N : R53 |
| Contaminant | Highest concentration | H4 (%) | H5 (%) | H6 (%) | H6 (%) | H7 (%) | H7 (%) | H8 (%) | H8 (%) | H10 (%) | H10 (%) | H11 (%) | H11 (%) | H14 | H14 | H14 |
| **Metals** | | | | | | | | | | | | | | | | |
| Arsenic | 22.00 | | | 0.0029 | 0.0034 | 0.0034 | | | | | | | | 0.4035 | 0.0034 | 0.0034 |
| Beryllium | 0.00 | 0.0000 | | 0.0000 | 0.0000 | 0.0000 | | | | | | | | | | 0.0000 |
| Copper | 51.00 | 0.0128 | 0.0128 | | | | | | | | | | | | 0.0128 | 0.0128 |
| Cadmium | 0.23 | | 0.0000 | | 0.0000 | 0.0000 | | | | | | | | | | |
| Chromium | 38.00 | | | | | 0.0061 | | | | | | | | | 0.0061 | 0.0061 |
| Lead | 190.00 | | 0.0205 | | | | | | | 0.0205 | 0.0205 | | | | 0.0205 | 0.0205 |
| Mercury | 1.20 | | | 0.0001 | | | | | | | | | | | 0.0001 | 0.0001 |
| Nickel | 23.00 | | 0.0115 | | | | 0.0115 | | | | 0.0115 | | | | 0.0115 | 0.0115 |
| Selenium | 0.49 | | | | 0.0000 | | | | | | | | | | 0.0000 | 0.0000 |
| Zinc | 170.00 | 0.0459 | 0.1233 | | | 0.0471 | | 0.0354 | | | | | 0.0799 | | 0.0459 | 0.0459 |
| Vanadium | 54.00 | 0.0079 | | | 0.0079 | | | | | | 0.0079 | | 0.0079 | | | 0.0079 |
| **PAH** | | | | | | | | | | | | | | | | |
| Naphthalene | 0.30 | | 0.0000 | | | | | | | | | | | | 0.0000 | 0.0000 |
| Benzo(a)anthracene | 0.28 | | | | 0.0000 | 0.0000 | | | | | | | | | 0.0000 | 0.0000 |
| Chrysene | 0.54 | | | | 0.0001 | 0.0001 | | | | | | | 0.0001 | | 0.0001 | 0.0001 |
| Benzo(b)fluoranthene | 0.57 | | | | 0.0001 | 0.0001 | | | | | | | | | 0.0001 | 0.0001 |
| Benzo(k)fluoranthene | 0.15 | | | | 0.0000 | 0.0000 | | | | | | | | | 0.0000 | 0.0000 |
| Benzo(a)pyrene | 0.35 | | | | | 0.0000 | | | | 0.0000 | | 0.0000 | | | 0.0000 | 0.0000 |
| Dibenzo(a,h)anthracene | 0.00 | | | | 0.0000 | 0.0000 | | | | | | | | | 0.0000 | 0.0000 |
| **TPH** | | | | | | | | | | | | | | | | |
| Benzene | 0.00 | | | | 0.0000 | 0.0000 | | | | | | | | | | |
| 1,2,4-trimethylbenzene | 0.00 | 0.0000 | 0.0000 | | | | | | | | | | | | | 0.0000 |
| PRO (C6 - C10) | 0.00 | | 0.0000 | | | 0.0000 | | | | | | | | | | 0.0000 |
| DRO (C10 - C35) | 0.00 | | 0.0000 | | | | 0.0000 | | | | | | | | | 0.0000 |
| Total (or greatest) | | 0.0666 | 0.1680 | 0.0030 | 0.0115 | (0.0000) | (0.0115) | 0.0354 | 0.0000 | (0.0000) | (0.0000) | (0.0000) | (0.0799) | 0.4035 | 0.1005 | 0.1085 |
| Threshold | | 20% | 25% | 0.10% | 3% | 0.10% | 1% | 5% | 1% | 0.50% | 5% | 0.10% | 1% | 1 | 25% | 25% |
| Exceeded Y/N | | N | N | N | N | N | N | N | N | N | N | N | N | N | N | N |

| Title | Table number |
|---|---|
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| Landfill Waste | | | | Laboratory test data | |
|---|---|---|---|---|---|
| Parameter | Inert waste landfill | Stable non-reactive hazardous waste in non-hazardous landfill | Hazardous waste landfill | WAC - CS1 | WAC - CS2 |
| **Parameters determined on the waste** | | | | | |
| Total organic carbon (w/w %) | 3% | 5% | 6%* | 3.7 | 2.4 |
| Loss on ignition | | | 10%* | 13 | 4.8 |
| BTEX (mg $kg^{-1}$) | 6 | | | < 0.010 | < 0.010 |
| PCBs (7 congeners) (mg $kg^{-1}$) | 1 | | | < 0.10 | < 0.10 |
| Mineral oil $C_{10}$ - $C_{40}$ (mg $kg^{-1}$) | 500 | | | 92 | < 10 |
| PAH (17 congeners) | 100 | | | 64 | 170 |
| pH | | >6 | | 8.8 | 8.7 |
| Acid neutralisation capacity pH 6 (mol $kg^{-1}$) | | To be evaluated | To be evaluated | 0.03 | 0.038 |
| Acid neutralisation capacity pH 4 (mol $kg^{-1}$) | | To be evaluated | To be evaluated | | |
| **Limit values (mg $kg^{-1}$) for compliance test using BN 12457-3 at L/S 10 l $kg^{-1}$** | | | | | |
| As (arsenic) | 0.5 | 2 | 25 | 0.094 | 0.06 |
| Ba (barium) | 20 | 100 | 300 | < 0.50 | < 0.50 |
| Cd (cadmium) | 0.04 | 1 | 5 | < 0.010 | < 0.010 |
| Cr (chromium (total)) | 0.5 | 10 | 70 | < 0.010 | < 0.010 |
| Cu (Copper) | 2 | 50 | 100 | < 0.050 | < 0.050 |
| Hg (mercury) | 0.01 | 0.2 | 2 | < 0.0050 | < 0.0050 |
| Mo (molybdenum) | 0.5 | 10 | 30 | < 0.050 | < 0.050 |
| Ni (nickel) | 0.4 | 10 | 40 | < 0.050 | < 0.050 |
| Pb (lead) | 0.5 | 10 | 50 | 0.055 | 0.021 |
| Sb (antimony) | 0.06 | 0.7 | 5 | 0.035 | 0.026 |
| Se (selenium) | 0.1 | 0.5 | 7 | 0.014 | < 0.010 |
| Zn (zinc) | 4 | 50 | 200 | < 0.50 | < 0.50 |
| Cl (chloride) | 800 | 15,000 | 25,000 | 16 | 22 |
| F (fluoride) | 10 | 150 | 500 | 6.8 | 5.5 |
| $SO_4$ (sulphate) | 1000# | 20,000 | 50,000 | 14 | 100 |
| Total Dissolved Solids (TDS)+ | 4,000 | 60,000 | 100,000 | 680 | 760 |
| Phenol index | 1 | | | < 0.50 | < 0.50 |
| Dissolved organic carbon at own pH or pH 7.5-8.0@ | 500 | 800 | 1000 | < 50 | 56 |

Notes

* Either TOC or LOI must be used for hazardous waste
\# If an inert waste does not meet the SO4 L/S10 limit, alternative limit values of 1500 mg l-1 SO4 at Co (initial eluate from the percolation test (prCEN/TS 14405:2003)) AND 6000 mg kg-1 SO4 at L/S10 (either from the percolation test or batch test BS EN 12457-3), can be used to demonstrate compliance with the acceptable criteria for inert wastes.
\+ The value for TDS can be used instead of the values for Cl and SO4
@ DOC at pH 7.5-8.0 abd L/S10 can be determined or eluate derived from a modified version of the pH dependence Test, prEN 14429, if the limit value at own pH (BS EN 12457 eluate) is not met

| | | |
|---|---|---|
| PRIMARY CLASSIFICATION | NON-HAZARDOUS | HAZARDOUS |
| SECONDARY CLASSIFICATION | NON-HAZARDOUS | STABLE NON-REACTIVE HAZARDOUS WASTE IN NON-HAZARDOUS LANDFILL |

Title

Comparison of test data with landfill waste acceptance criteria (table 5.1). (Seconday Assessment)

Table number

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| Landfill Waste | | | | Laboratory test data |
|---|---|---|---|---|
| **Parameter** | **Inert waste landfill** | **Stable non-reactive hazardous waste in non-hazardous landfill** | **Hazardous waste landfill** | **WAC - CS3** |
| **Parameters determined on the waste** | | | | |
| Total organic carbon (w/w %) | 3% | 5% | 6%* | 11 |
| Loss on ignition | | | 10%* | 8.6 |
| BTEX (mg $kg^{-1}$) | 6 | | | < 0.010 |
| PCBs (7 congeners) (mg $kg^{-1}$) | 1 | | | < 0.10 |
| Mineral oil $C_{10}$ - $C_{40}$ (mg $kg^{-1}$) | 500 | | | 250 |
| PAH (17 congeners) | 100 | | | 650 |
| pH | | >6 | | 9 |
| Acid neutralisation capacity pH 6 (mol $kg^{-1}$) | | To be evaluated | To be evaluated | 0.031 |
| Acid neutralisation capacity pH 4 (mol $kg^{-1}$) | | To be evaluated | To be evaluated | |
| **Limit values (mg $kg^{-1}$) for compliance test using BN 12457-3 at L/S 10 l $kg^{-1}$** | | | | |
| As (arsenic) | 0.5 | 2 | 25 | 0.06 |
| Ba (barium) | 20 | 100 | 300 | < 0.50 |
| Cd (cadmium) | 0.04 | 1 | 5 | < 0.010 |
| Cr (chromium (total)) | 0.5 | 10 | 70 | < 0.010 |
| Cu (Copper) | 2 | 50 | 100 | < 0.050 |
| Hg (mercury) | 0.01 | 0.2 | 2 | < 0.0050 |
| Mo (molybdenum) | 0.5 | 10 | 30 | < 0.050 |
| Ni (nickel) | 0.4 | 10 | 40 | < 0.050 |
| Pb (lead) | 0.5 | 10 | 50 | 0.023 |
| Sb (antimony) | 0.06 | 0.7 | 5 | 0.012 |
| Se (selenium) | 0.1 | 0.5 | 7 | < 0.010 |
| Zn (zinc) | 4 | 50 | 200 | < 0.50 |
| Cl (chloride) | 800 | 15,000 | 25,000 | 19 |
| F (fluoride) | 10 | 150 | 500 | 2.7 |
| $SO_4$ (sulphate) | 1000# | 20,000 | 50,000 | 240 |
| Total Dissolved Solids (TDS)+ | 4,000 | 60,000 | 100,000 | 810 |
| Phenol index | 1 | | | < 0.50 |
| Dissolved organic carbon at own pH or pH 7.5-8.0@ | 500 | 800 | 1000 | < 50 |

Notes

* Either TOC or LOI must be used for hazardous waste
\# If an inert waste does not meet the SO4 L/S10 limit, alternative limit values of 1500 mg l-1 SO4 at Co (initial eluate from the percolation test (prCEN/TS 14405:2003)) AND 6000 mg kg-1 SO4 at L/S10 (either from the percolation test or batch test BS EN 12457-3), can be used to demonstrate compliance with the acceptable criteria for inert wastes.
\+ The value for TDS can be used instead of the values for Cl and SO4
@ DOC at pH 7.5-8.0 abd L/S10 can be determined or eluate derived from a modified version of the pH dependence Test, prEN 14429, if the limit value at own pH (BS EN 12457 eluate) is not met

| | |
|---|---|
| **PRIMARY CLASSIFICATION** | NON-HAZARDOUS |
| **SECONDARY CLASSIFICATION** | NON-HAZARDOUS |

Title

Comparison of test data with landfill waste acceptance criteria (table 5.1). (Seconday Assessment)

Table number

2 of 2

# Basic categorisation schedule for Made Ground TYPE A soils

**Produced following the requirements of The Landfill (England and Wales) (Amendment) Regulations 2004 Part 2 (5)**

(a) *Source and origin of waste*

**Proposed development at Richmond Upon Thames College**

(b) *Process producing the waste*

**Foundation and service trench excavations / general site clearance**

(c) *Statement on waste treatment*

**Refer to pre-treatment confirmation form**

(d) *Composition of the waste*

**Dark brown, gravelly, very clayey sand. Gravels comprise quartzite, flint and brick fragments.**

(e) *Appearance of the waste*

**As above**

(f) *European waste catalogue code*

**17-05-04** (*for non-hazardous waste*)

(g) *Hazardous waste properties*

**None**

(h) *Is the waste prohibited under regulation 9?*

**No**

(i) *Landfill class*

**Non-hazardous but cannot be classified as inert due to elevated TOC and LOI**

(j) *Additional precautions required at landfill*

**None**

(k) *Can waste be recycled or recovered?*

**Yes**

(l) *Name and address of waste producer*

**Richmond upon Thames College**

(m) *Name and address of consultant*

**Soiltechnics Limited, Cedar Barn, White Lodge, Walgrave, Northampton. NN6 9PY.**
**Tel: (01604) 781877** **E-mail: mail@soiltechnics.net**
**Fax: (01604) 781007** **Website: www.soiltechnics.net**

**Schedule Date:**

**18.11.2015**

**Soiltechnics reference:**

**STM3361D**

signed

Charlotte Murray B.Sc, (Hons) FGS
Geo-environmental Engineer, Soiltechnics Limited

# Basic categorisation schedule for Made Ground TYPE B soils

**Produced following the requirements of The Landfill (England and Wales) (Amendment) Regulations 2004 Part 2 (5)**

(a) *Source and origin of waste*

**Proposed development at Richmond Upon Thames College**

(b) *Process producing the waste*

**Foundation and service trench excavations / general site clearance**

(c) *Statement on waste treatment*

**Refer to pre-treatment confirmation form**

(d) *Composition of the waste*

**Dark grey sandy gravel. Gravels comprise brick, bituminous bound material, crushed concrete and ceramic.**

(e) *Appearance of the waste*

**As above**

(f) *European waste catalogue code*

**17-05-03*** (*for hazardous waste*)

(g) *Hazardous waste properties*

**None**

(h) *Is the waste prohibited under regulation 9?*

**No**

(i) *Landfill class*

**Stable non-reactive hazardous waste in non-hazardous landfill**

(j) *Additional precautions required at landfill*

**None**

(k) *Can waste be recycled or recovered?*

**Yes**

(l) *Name and address of waste producer*

**Richmond upon Thames College**

(m) *Name and address of consultant*

**Soiltechnics Limited, Cedar Barn, White Lodge, Walgrave, Northampton. NN6 9PY.**
**Tel: (01604) 781877** **E-mail: mail@soiltechnics.net**
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signed

Charlotte Murray B.Sc, (Hons) FGS
Geo-environmental Engineer, Soiltechnics Limited

# Basic categorisation schedule for Made Ground TYPE C soils

**Produced following the requirements of The Landfill (England and Wales) (Amendment) Regulations 2004 Part 2 (5)**

(a) *Source and origin of waste*

**Proposed development at Richmond Upon Thames College**

(b) *Process producing the waste*

**Foundation and service trench excavations / general site clearance**

(c) *Statement on waste treatment*

**Refer to pre-treatment confirmation form**

(d) *Composition of the waste*

**Dark and orange brown sandy clay and clayey sand, with gravels of brick, flint and locally, whole bricks. Occasional pockets of ash observed.**

(e) *Appearance of the waste*

**As above**

(f) *European waste catalogue code*

**17-05-04** (*for non-hazardous waste*)

(g) *Hazardous waste properties*

**None**

(h) *Is the waste prohibited under regulation 9?*

**No**

(i) *Landfill class*

**Non-hazardous but cannot be classified as inert due to elevated TOC**

(j) *Additional precautions required at landfill*

**None**

(k) *Can waste be recycled or recovered?*

**Yes**

(l) *Name and address of waste producer*

**Richmond upon Thames College**

(m) *Name and address of consultant*

**Soiltechnics Limited, Cedar Barn, White Lodge, Walgrave, Northampton. NN6 9PY.**
**Tel: (01604) 781877** **E-mail: mail@soiltechnics.net**
**Fax: (01604) 781007** **Website: www.soiltechnics.net**

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signed

Charlotte Murray B.Sc, (Hons) FGS
Geo-environmental Engineer, Soiltechnics Limited

# Basic categorisation schedule for Kempton Park Gravels soils

**Produced following the requirements of The Landfill (England and Wales) (Amendment) Regulations 2004 Part 2 (5)**

(a) *Source and origin of waste*

**Proposed development at Richmond Upon Thames College**

(b) *Process producing the waste*

**Foundation and service trench excavations / general site clearance**

(c) *Statement on waste treatment*

**Refer to pre-treatment confirmation form**

(d) *Composition of the waste*

**Orange and brown sands, gravels and clays. Gravels comprise flint and quartzite**

(e) *Appearance of the waste*

**As above**

(f) *European waste catalogue code*

**17-05-04** (*for non-hazardous waste*)

(g) *Hazardous waste properties*

**None**

(h) *Is the waste prohibited under regulation 9?*

**No**

(i) *Landfill class*

**Inert, by virtue of being natural in origin and unlikely to be affected by anthropogenic contamination**

(j) *Additional precautions required at landfill*

**None**

(k) *Can waste be recycled or recovered?*

**Yes**

(l) *Name and address of waste producer*

**Richmond upon Thames College**

(m) *Name and address of consultant*

**Soiltechnics Limited, Cedar Barn, White Lodge, Walgrave, Northampton. NN6 9PY.**
**Tel: (01604) 781877** **E-mail: mail@soiltechnics.net**
**Fax: (01604) 781007** **Website: www.soiltechnics.net**

**Schedule Date:**

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**Soiltechnics reference:**

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signed

Charlotte Murray B.Sc, (Hons) FGS
Geo-environmental Engineer, Soiltechnics Limited

# Basic categorisation schedule for London Clay soils

**Produced following the requirements of The Landfill (England and Wales) (Amendment) Regulations 2004 Part 2 (5)**

(a) *Source and origin of waste*

**Proposed development at Richmond Upon Thames College**

(b) *Process producing the waste*

**Foundation and service trench excavations / general site clearance**

(c) *Statement on waste treatment*

**Refer to pre-treatment confirmation form**

(d) *Composition of the waste*

**Dark grey and brown silty clay**

(e) *Appearance of the waste*

**As above**

(f) *European waste catalogue code*

**17-05-04** (*for non-hazardous waste*)

(g) *Hazardous waste properties*

**None**

(h) *Is the waste prohibited under regulation 9?*

**No**

(i) *Landfill class*

**Inert, by virtue of being natural in origin and unlikely to be affected by anthropogenic contamination**

(j) *Additional precautions required at landfill*

**None**

(k) *Can waste be recycled or recovered?*

**Yes**

(l) *Name and address of waste producer*

**Richmond upon Thames College**

(m) *Name and address of consultant*

**Soiltechnics Limited, Cedar Barn, White Lodge, Walgrave, Northampton. NN6 9PY.**
**Tel: (01604) 781877** **E-mail: mail@soiltechnics.net**
**Fax: (01604) 781007** **Website: www.soiltechnics.net**

**Schedule Date:**

**18.11.2015**

**Soiltechnics reference:**

**STM3361D**

signed

Charlotte Murray B.Sc, (Hons) FGS
Geo-environmental Engineer, Soiltechnics Limited