# 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 was 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 in 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).

**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 Sections 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, Alluvium, Kempton Park Gravel and London Clay Formation derived from general site clearance and foundation/service trench excavations.

### 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 *'Guidance on the classification and assessment of waste'* (2015), 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).

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 A spreadsheet detailing the hazard assessment following the procedures described in *'framework for the classification of contaminated soils as hazardous wastes'* is presented in Appendix M.

11.4.2.9 The spreadsheet indicates the soils are **hazardous** by virtue of elevated combined metals (primarily due to a high concentration of copper in one of the four samples).

11.4.2.10 It should be noted that the above primary classification relates to Made Ground ***not containing asbestos***; see Section 11.5.6 for the classification of soils containing asbestos.

## 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 **one** sample to measure the parameters listed in table 5.1 (landfill waste acceptance criteria) included in the above publication. A copy of the test result certificate is presented in Appendix H. The source of the composite sample is detailed below:

**Composition of soil samples for classification testing**

| Strata | Source | Soil Type |
|---|---|---|
| Made Ground | BH04 0.4-0.8m<br>BH04 1.4m<br>BH05 0.5-1.0m<br>BH07 0.4-0.6m<br>BH07 1.5m<br>TP01 0.3m<br>TP04 0.3m | Brown, dark brown and orange brown clayey gravelly sand and sandy gravelly clay. Gravel includes flint, brick, clinker, concrete and ash. |

**Table 11.5.1**

11.5.2 The sample was deemed representative of Made Ground soils as described in Section 5. The sample was formed by combining individual samples taken from exploratory excavations within the Made Ground. The combined sample was 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 N 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 soils ***not containing asbestos fibres*** are suitable for disposal as **stable non-reactive hazardous waste in non-hazardous landfill.**

**11.5.5 Classification of soils containing asbestos**

11.5.5.1 Asbestos in the form of chrysotile fibres/clumps was found to be present within the Made Ground in one location (TP02). With reference to the Environment Agency publication '*Guidance on the classification and assessment of waste – WM3 (1st Edition, 2015)*', wastes containing greater than 0.1% free and dispersed asbestos fibres are classified as **hazardous waste** with the code 17 05 03* (soils and stones containing hazardous substances). Where a waste contains identifiable pieces of ACM, then these pieces must be assessed separately. The waste is hazardous if the concentration of asbestos in the ACM exceeds 0.1%. Made Ground containing ACM would be regarded as a mixed waste and classified as follows:

- **17 06 05*** *(Construction material containing asbestos)* – this relates to the individual pieces of asbestos cement within the soil, which are classified as hazardous waste.

- **17 05 04** *(Soil and stones other than those mentioned in 17 05 03)* – this relates to the main body of the soil, which is classified as inert waste.

11.5.5.2 We would recommend additional sampling and testing for asbestos, including quantification if identified, be undertaken within the proposed garden area to further refine the classification of Made Ground for off-site disposal.

11.5.5.3 If Made Ground soils do contain greater than 0.1% free and dispersed asbestos fibres, It may be possible, through additional sampling and analysis, to zone areas of asbestos containing soils. However, due to the density of sampling points required to provide confidence in this approach, this is likely to be a costly exercise with no guaranteed benefit.

11.5.5.4 Due to the high costs associated with disposal of asbestos containing wastes, we recommend that the development is designed with a view to limiting as far as possible the removal from site of asbestos containing soils.

## 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 the Alluvium, Kempton Park Gravel 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 **four** basic categorisation schedules relating to the Made Ground, Alluvium, Kempton Park Gravel and London Clay Formation deposits, which are presented in Appendix O. 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 Alluvium, Kempton Park Gravel and London Clay Formation 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 Treatment of hazardous waste**

11.8.6.1 Made Ground soils at the site have been classified as stable non-reactive hazardous waste due to concentrations of copper. We recommend that a licenced waste carrier who is experienced in handling, treatment and disposal of hazardous waste is consulted to gain their recommendations on the most economical way to dispose of waste at the site.

**11.8.7 Landfill operators**

11.8.7.1 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 At this stage we do not consider further investigations are deemed necessary. Laboratory testing and validation of capping material and thickness will however be required during the construction phase.

12.2 We would be pleased to carry out any of the supplementary investigations described above and provide proposals with costings on further instructions.

# 13 Remediation strategy and specification



## 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 the development will comprise the construction of a 5-6 storey residential care home with access roads and landscaped garden. A plan showing development proposals is presented on 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. |

**Table 13.1.5**

## 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 Lead, mercury and PAHs were measured at concentrations above soil guideline values within the Made Ground. In addition, asbestos fibres/clumps were identified in one sample of Made Ground. These contaminants are considered to pose a risk of causing harm to end-users at the site (particularly the critical human receptor) and thus remediation is considered appropriate.

**13.2.3 Evaluation of contamination - water receptors**

13.2.3.1 Based on the results of investigatory data, we are of the opinion that there is not a significant possibility of significant harm being caused to water resources from ground conditions explored at the site.

**13.2.4 Evaluation of gaseous contamination**

13.2.4.1 Gas monitoring undertaken to date indicates elevated concentrations of landfill gas is present at the site and therefore remediation is required to reduce the risk to end users of the site.

## 13.3 Remediation strategy

**13.3.1 Chemical contamination**

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

13.3.1.2 In proposed garden/landscaped 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 all garden/landscaped areas due to the nature of the contamination.

13.3.1.3 Whilst the capping solution is widely accepted regulating Local Authorities (Environmental Health Departments) have differing views as to the minimum thickness required. On this basis, the recommended thickness needs to be checked with the Local Authority.

13.3.1.4 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.

### 13.3.2 Gaseous contamination

13.3.2.1 Based on monitoring observations to date, development categorisation (section 9.6 above), and the interim site characteristic gas situation (section 9.8 above) and with reference to Table 4 of BS8485:2015, the development requires gas protective measures which would achieve a '*gas protection score'* of 3.5.

13.3.2.2 With the site being classified as Amber 1, then following NHBC report No 10627-R01(04) table 14.2, the following 'low level' gas protection measures are required.

a) Installation of a suitable gas resistant membrane

b) Ventilated subfloor to facilitate a minimum of one complete volume change per 24 hours.

c) Gas protective measures shall be as presented in Building Research Establishment Report 414

13.3.2.3 It should be noted that this is subject to change following completion of ongoing gas monitoring.

## 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 capping 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 | 28 |
| Chromium | - | 910 | 250 |
| Cyanide (total) | - | 34 | 50 |
| Lead | 82 | - | 250 |
| Mercury | - | 1.2 | 1 |
| Nickel | | 180 | 200 |
| Nitrate | - | - | 50000 |
| Selenium | - | 250 | 10 |
| Sulfate | - | - | 400000 |
| Sulfide | - | - | 0.25 |
| Vanadium | - | 410 | 60 |
| | | | |
| **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:

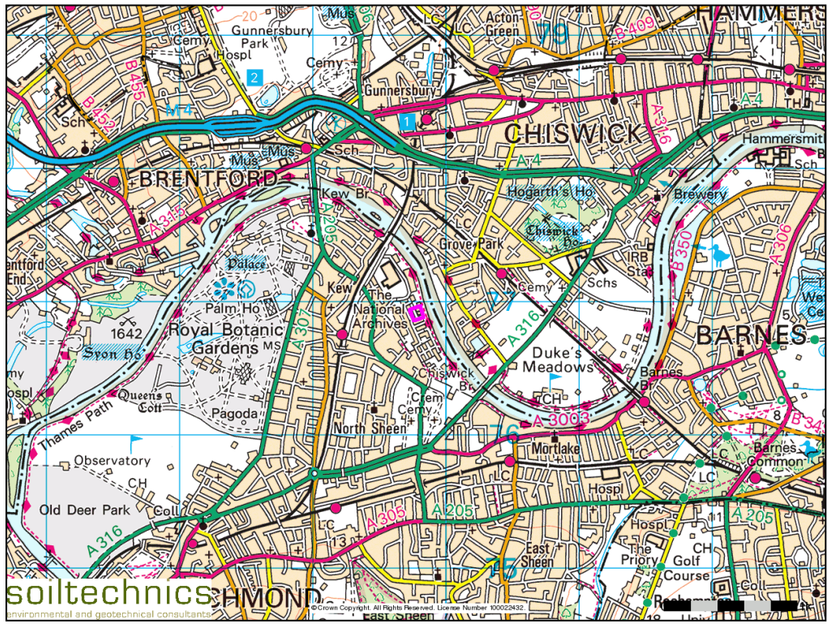
- Copies of test result certificates signed by a MCERTS accredited laboratory which is signed and dated.
- Source and supplier of the capping material.
- Delivery notes confirming the material originates from the stated source (will form part of the subsequent validation reporting).

## 13.5 Verification report

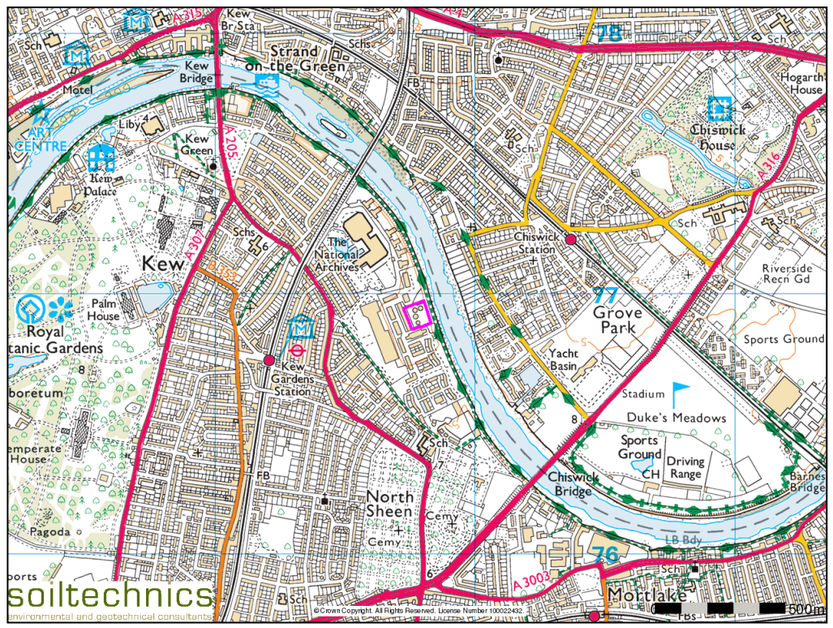
13.5.1 The thickness of the completed cover system will require verification by an independent consultant. We can carry out such investigations on further instructions.

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.

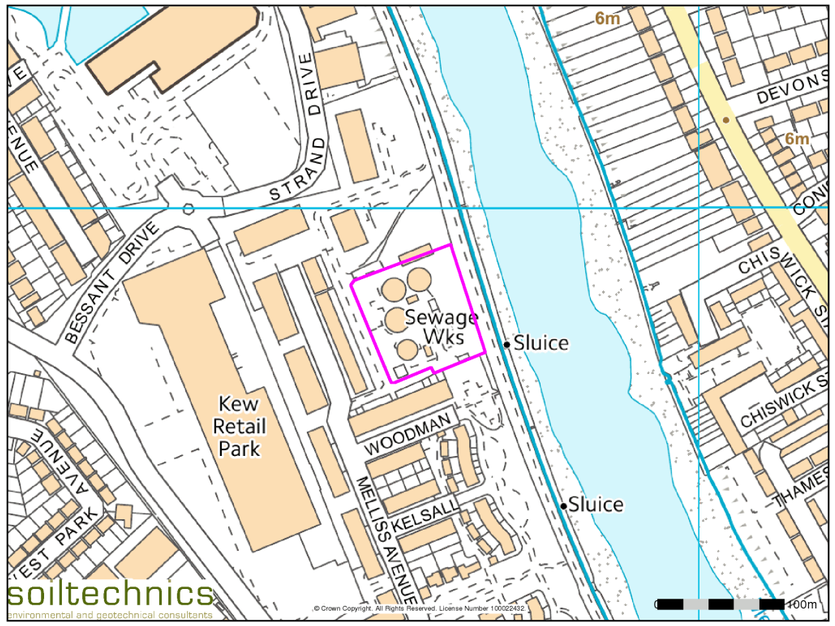
soiltechnics
environmental and geotechnical consultants




**Neighbourhood extract from Ordnance Survey map**




**Town extract from Ordnance Survey map**




**Detail extract from Ordnance Survey map**

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

Proposed redevelopment
Melliss Avenue, Richmond


soiltechnics
environmental and geotechnical consultants

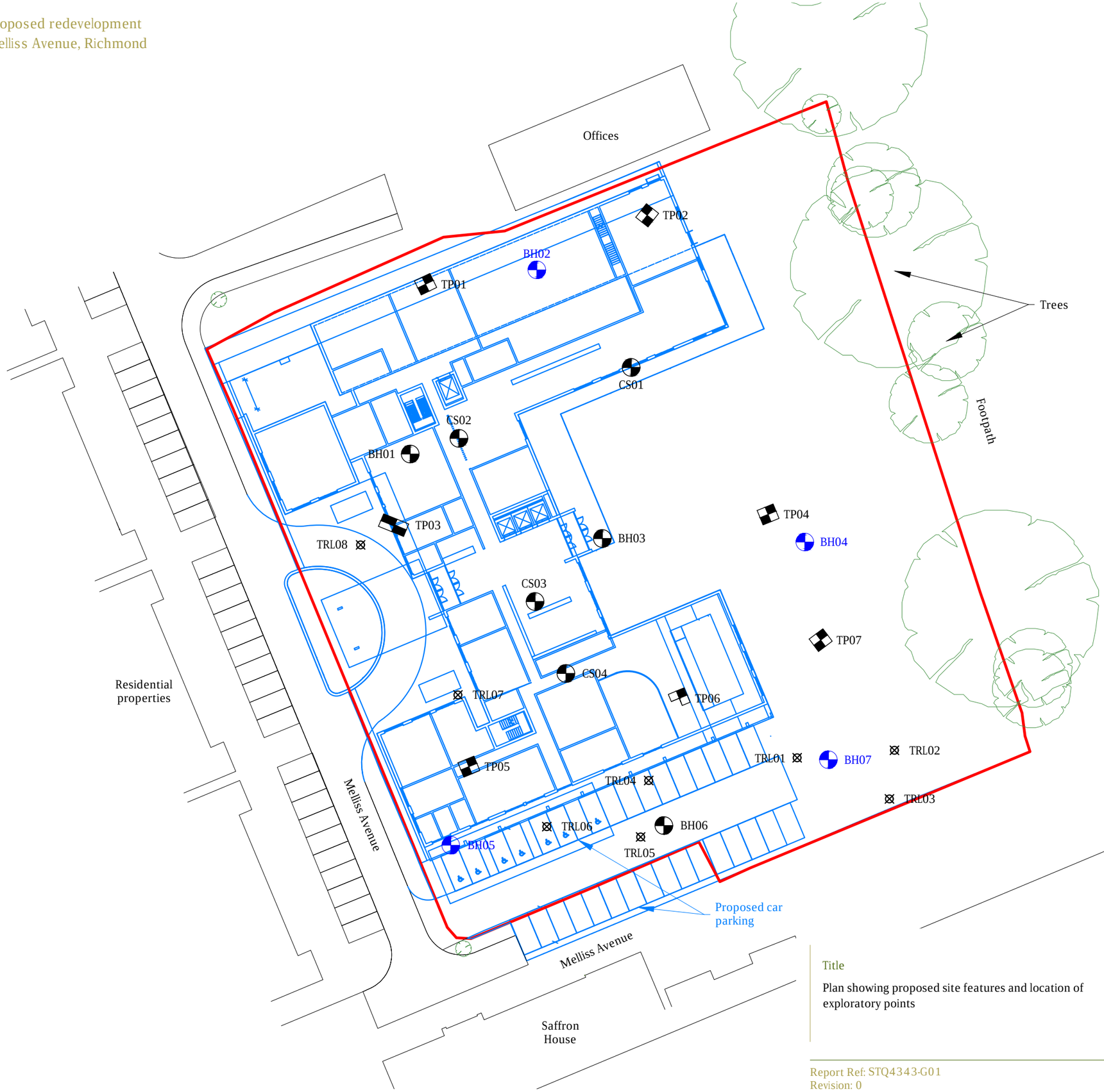
Key

- Approximate site boundary
- BH — Approximate location of borehole formed by Cable and Tool percussive techniques
- BH — Approximate location of borehole formed by Driven Tube Sampling techniques
- TP — Approximate location of trial pit excavation
- CS — Approximate location of corehole
- TRL — Approximate location of TRL testing
- Approximate extent of grass surfacing
- Approximate area inaccessible for rigs

| Title | Scale | Drawing number |
|---|---|---|
| Plan showing existing site features and location of exploratory points | 1:500 at A3 | 02 |

Proposed redevelopment
Melliss Avenue, Richmond

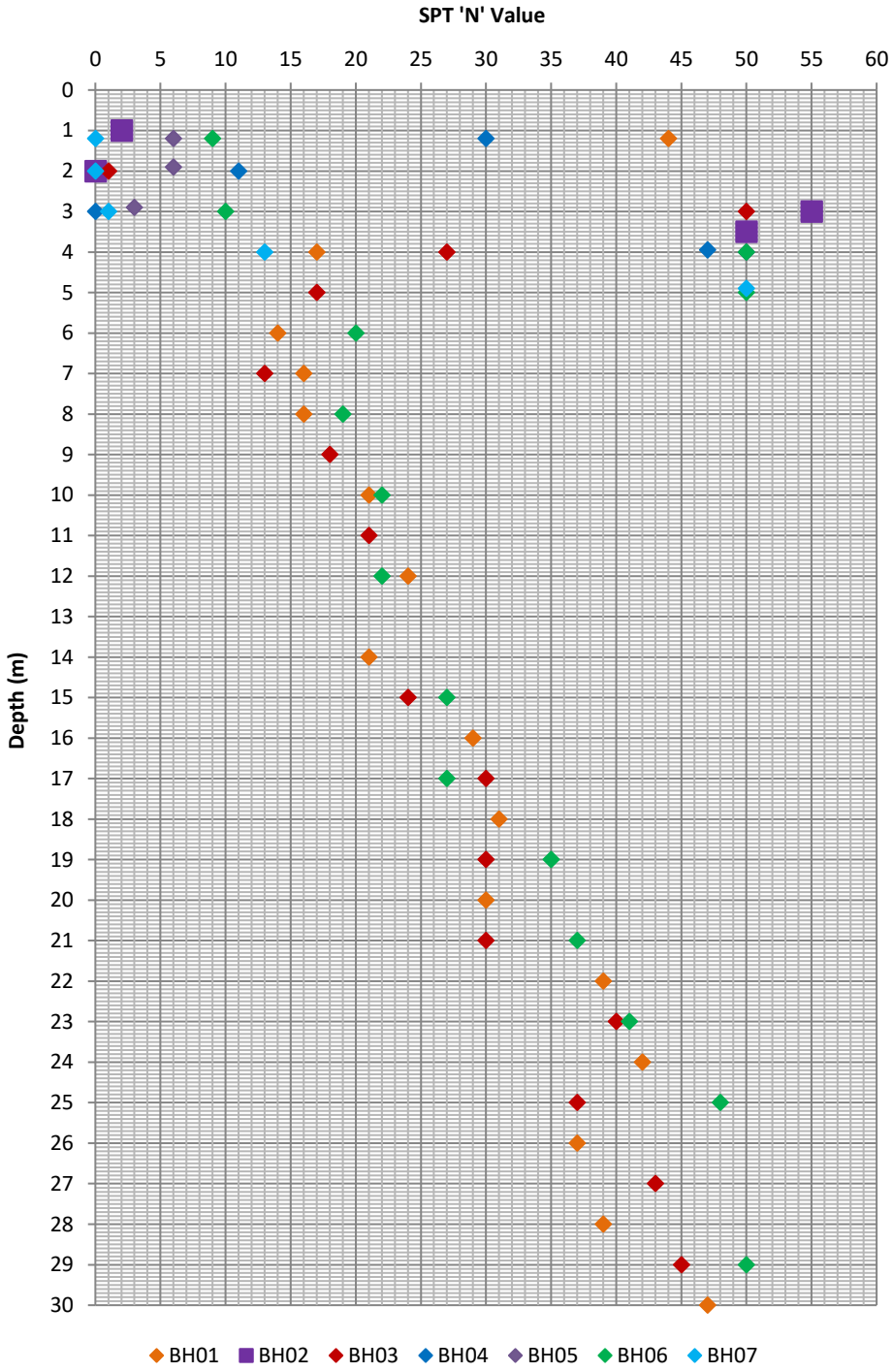
soiltechnics
environmental and geotechnical consultants



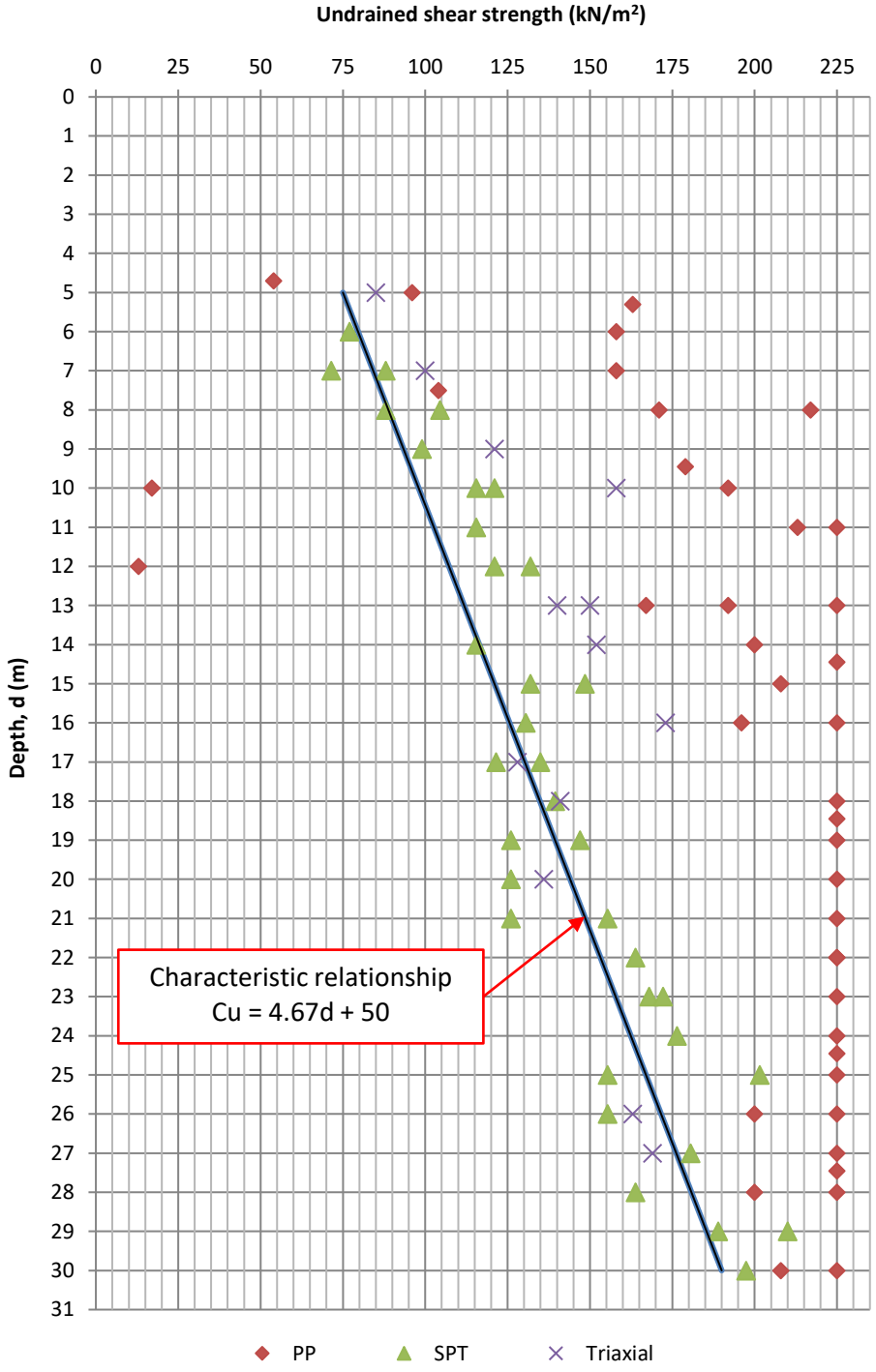

Key

- Approximate site boundary
- Extent of proposed residential property
- BH — Approximate location of borehole formed by Cable and Tool percussive techniques
- BH — Approximate location of borehole formed by Driven Tube Sampling techniques
- TP — Approximate location of trial pit excavation
- CS — Approximate location of corehole
- TRL — Approximate location of TRL testing

| Title | Scale | Drawing number |
|---|---|---|
| Plan showing proposed site features and location of exploratory points | 1:500 at A3 | 03 |




| Title | Scale | Drawing number |
|---|---|---|
| Plot summarising results of standard penetration test results by location | As shown | 04 |

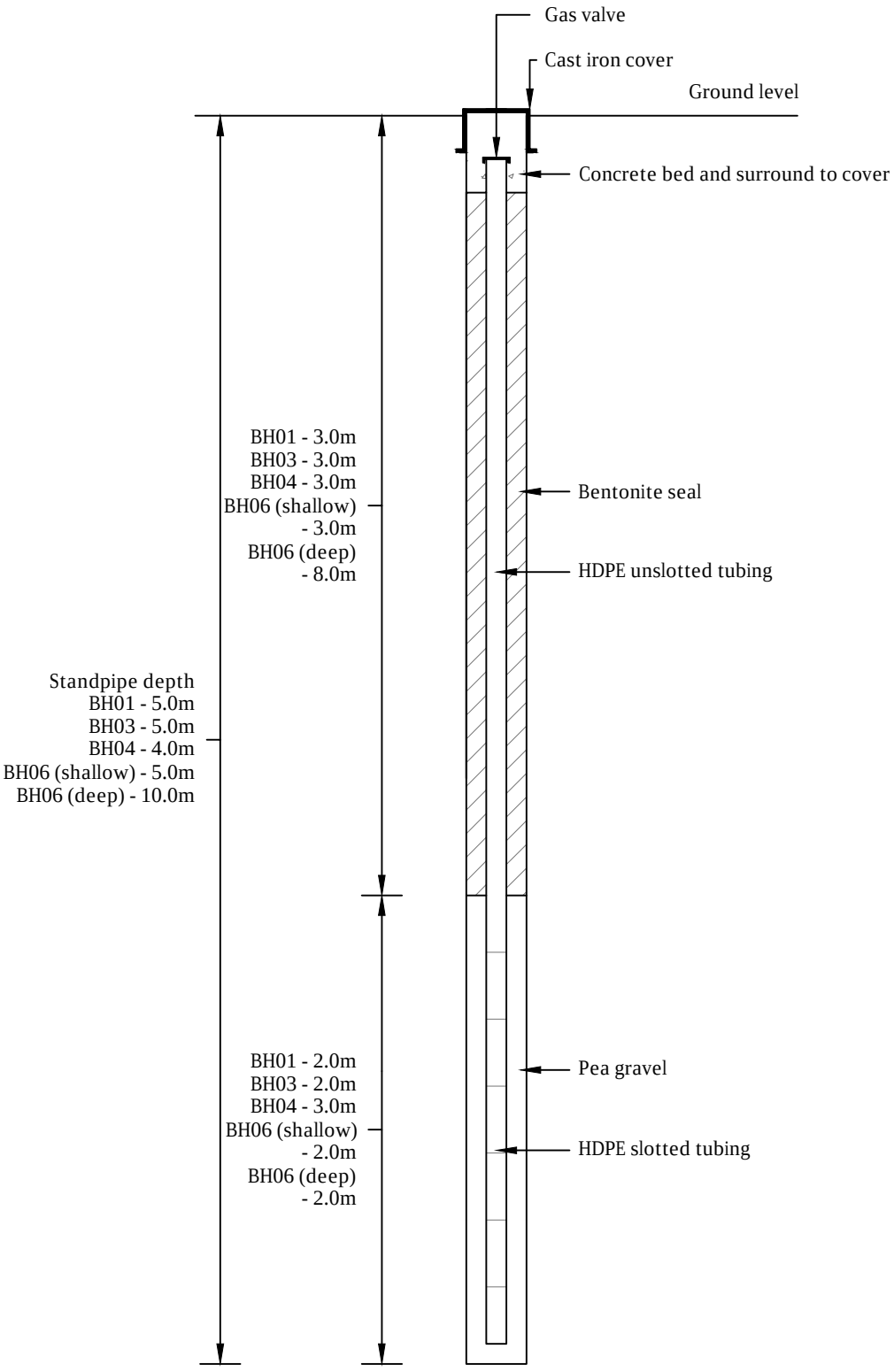



Notes

1) Equivalent undrained shear strength derived by multiplying Pocket Penetrometer (PP) results by 50.
2) SPT 'N' values converted to undrained shear strength by multiplying by a factor of 5.5, 4.5 and 4.2 within 0 to 15m, 16 to 19m and 20 to 30m depth respectively.

| Title | Scale | Drawing number |
|---|---|---|
| Plot summarising undrained shear strength results derived from insitu testing and laboratory test results in the London Clay | As shown | 04 |

soiltechnics
environmental and geotechnical consultants




| Title | Scale | Drawing number |
|---|---|---|
| Section showing construction of gas monitoring standpipes installed in boreholes BH01, BH03, BH04 and BH06 | Not to scale | 05 |

soiltechnics
environmental and geotechnical consultants

# 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.

## 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.

## 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 | The LQM/CIEH S4ULs for Human Health Risk Assessment (2015) | 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 |
| 13 | Atkins ATRISK$^{SOIL}$ (2011) | http://www.atrisksoil.co.uk |
| 14 | Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination (September 2014) | CL:AIRE |

| | |
|---|---|
| CIEH | Chartered institute of Environmental Health |
| LQM | Land Quality Management |
| EA | Environment Agency |
| CL:AIRE | Contaminated Land: Applications in Real Environments |

## Testing suite summary

| Table summarising testing suites | | |
|---|---|---|
| **Suite** | **Parameters** | **Medium** |
| Suite 1 | Arsenic, beryllium, boron, cadmium, chromium (total and VI), copper, lead, mercury, nickel, selenium, vanadium zinc, cyanide (free, total and complex), organic matter content, PAH (16 speciated), pH, phenol (total), TOC | Soil |
| Suite 2 | Arsenic, boron (water soluble), beryllium, cadmium, chromium (total), copper, lead, mercury, nickel, selenium, vanadium, zinc, cyanide (free, total and complex, PAH (16 speciated), pH, phenol (total), sulfate (water soluble), sulfide, nitrate | Leachate |
| Suite 3 | Arsenic, boron (water soluble), beryllium, cadmium, chromium (total), copper, lead, mercury, nickel, selenium, vanadium, zinc, cyanide (free, total and complex, PAH (16 speciated), pH, phenol (total), sulfate (water soluble), sulfide, nitrate | Water |
| Suite 4 | TPH Texas Banding Aliphatic/Aromatic Split, PAH (16 speciated), TOC | Soil |
| Suite 5 | TPH Texas Banding Aliphatic/Aromatic Split, PAH (16 speciated) | Leachate |
| Suite 6 | TPH Texas Banding Aliphatic/Aromatic Split, PAH (16 speciated) | Water |
| Suite 7 | TPH Texas Banding Aliphatic/Aromatic Split, TOC, organic matter | Soil |
| Suite 8 | Sulphur (total), sulphate (water and acid soluble), pH | Soil |
| Suite 9 | Sulphate, ammoniacal nitrogen, dissolved magnesium, pH | Water |
| Suite 10 | VOC, SVOC, TOC, organic matter | Soil |
| Suite 11 | VOC, SVOC | Leachate |
| Suite 12 | VOC, SVOC | Water |
| Suite 13 | Organotins dibutyltin/ tributyl-tin/tetrabutyltin/triphenyl-tin, Tetraethyl-lead/tetramethyl-lead | Soil |
| Suite 14 | Organotin | Leachate |
| Suite 15 | Organotin | Water |
| Suite 16 | TPH Texas Banding Aliphatic/Aromatic Split, BTEX, VOC, SVOC | Soil, water, leachate |
| Suite 17 | TPH Texas Banding Aliphatic/Aromatic Split, BTEX, SVOC, VOC, arsenic, boron (water soluble), beryllium, cadmium, chromium (total), copper, lead, mercury, nickel, selenium, vanadium, zinc, cyanide (free, total and complex, pH, phenol (total), sulfate (water soluble), sulfide, nitrate | Soil, water, leachate |
| Concrete BRE suite | pH, sulphate (water and acid soluble), magnesium (water soluble), ammonia (water soluble), chloride, nitrate | Soil |

## Pocket Penetrometer Results

| Location | Depth (m) | Results | | | | Undrained Shear Strength (kN/m$^2$) | Strength Term | Strata |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Av. | | | |
| BH01 | 1.8 | 0.25 | 0.25 | 0.25 | *0.3* | *13* | Very low | ALLUVIUM |
| | 4.7 | 1 | 1 | 1.25 | *1.1* | *54* | Medium | LONDON CLAY FORMATION |
| | 5 | 1.75 | 2 | 2 | *1.9* | *96* | High | LONDON CLAY FORMATION |
| | 6 | 3 | 3.25 | 3.25 | *3.2* | *158* | Very high | LONDON CLAY FORMATION |
| | 7 | 3.25 | 3.25 | 3 | *3.2* | *158* | Very high | LONDON CLAY FORMATION |
| | 8 | 4 | 4.5 | 4.5 | *4.3* | *217* | Very high | LONDON CLAY FORMATION |
| | 10 | 0.25 | 0.25 | 0.5 | *0.3* | *17* | Very low | LONDON CLAY FORMATION |
| | 11 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 13 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 15 | 4 | 4 | 4.5 | *4.2* | *208* | Very high | LONDON CLAY FORMATION |
| | 19 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 21 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 23 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 25 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 27 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| BH03 | 1.5 | 0.75 | 0.75 | 0.75 | *0.8* | *38* | Low | MADE GROUND |
| | 5.3 | 3.5 | 3.25 | 3 | *3.3* | *163* | Very high | LONDON CLAY FORMATION |
| | 8 | 3.25 | 3.5 | 3.5 | *3.4* | *171* | Very high | LONDON CLAY FORMATION |
| | 10 | 3.5 | 3.5 | 4.5 | *3.8* | *192* | Very high | LONDON CLAY FORMATION |
| | 13 | 3 | 4.25 | 4.25 | *3.8* | *192* | Very high | LONDON CLAY FORMATION |
| | 14 | 3 | 4.5 | 4.5 | *4.0* | *200* | Very high | LONDON CLAY FORMATION |
| | 16 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 18 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 22 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 24 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 26 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 28 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 30 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| BH06 | 1.1 | 2.25 | 2.5 | 2.25 | *2.3* | *117* | High | ALLUVIUM |

Notes

1. Pocket penetrometer determinations converted to undrained shear strength using a factor of 50.

2. Undrained shear strength is based on average pocket penetrometer determination.

3. Strength terms in accordance with BS EN IS0 14688-2 2004.

| Title | Appendix |
|---|---|
| Table summarising results of pocket penetrometer determinations | C |

soiltechnics
environmental and geotechnical consultants

## Pocket Penetrometer Results

| Location | Depth (m) | Results | | | | Undrained Shear Strength (kN/m$^2$) | Strength Term | Strata |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | Av. | | | |
| BH06 | 2.3 | 1.25 | 1 | 1.25 | *1.2* | *58* | Medium | MADE GROUND |
| | 7.5 | 2.25 | 2 | 2 | *2.1* | *104* | High | LONDON CLAY FORMATION |
| | 9.45 | 3.25 | 3.5 | 4 | *3.6* | *179* | Very high | LONDON CLAY FORMATION |
| | 11 | 4.25 | 4.5 | 4 | *4.3* | *213* | Very high | LONDON CLAY FORMATION |
| | 12 | 0.25 | 0.25 | 0.25 | *0.3* | *13* | Very low | LONDON CLAY FORMATION |
| | 13 | 3.25 | 3.25 | 3.5 | *3.3* | *167* | Very high | LONDON CLAY FORMATION |
| | 14.45 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 16 | 3.75 | 4.25 | 3.75 | *3.9* | *196* | Very high | LONDON CLAY FORMATION |
| | 18.45 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 20 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 22 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 24.45 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 26 | 4.25 | 4 | 3.75 | *4.0* | *200* | Very high | LONDON CLAY FORMATION |
| | 27.45 | 4.5 | 4.5 | 4.5 | *4.5* | *225* | Very high | LONDON CLAY FORMATION |
| | 28 | 4 | 3.75 | 4.25 | *4.0* | *200* | Very high | LONDON CLAY FORMATION |
| | 30 | 4 | 4.5 | 4 | *4.2* | *208* | Very high | LONDON CLAY FORMATION |

Notes

1. Pocket penetrometer determinations converted to undrained shear strength using a factor of 50.

2. Undrained shear strength is based on average pocket penetrometer determination.

3. Strength terms in accordance with BS EN IS0 14688-2 2004.

| Title | Appendix |
|---|---|
| Table summarising results of pocket penetrometer determinations | C |

soiltechnics
environmental and geotechnical consultants

## Standard Penetration Test Results

| Location | Depth to top of SPT (m) | Results | | | | | | Penetration (mm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seating 1 | Seating 2 | Main 1 | Main 2 | Main 3 | Main 4 | Total Seating | Total Main | Total Seating | Total Main | Relative Density | Strata |
| BH01 | 1.2 | 7 | 10 | 11 | 11 | 12 | 10 | 17 | 44 | 150 | 300 | Dense | MADE GROUND |
| | 4 | 2 | 3 | 3 | 4 | 5 | 5 | 5 | 17 | 150 | 300 | Medium dense | KEMPTON PARK GRAVEL FORMATION |
| | 6 | 2 | 2 | 2 | 3 | 4 | 5 | 4 | 14 | 150 | 300 | | LONDON CLAY FORMATION |
| | 7 | 2 | 2 | 3 | 3 | 4 | 6 | 4 | 16 | 150 | 300 | | LONDON CLAY FORMATION |
| | 8 | 2 | 2 | 3 | 3 | 4 | 6 | 4 | 16 | 150 | 300 | | LONDON CLAY FORMATION |
| | 10 | 2 | 3 | 5 | 5 | 5 | 6 | 5 | 21 | 150 | 300 | | LONDON CLAY FORMATION |
| | 12 | 2 | 3 | 5 | 5 | 7 | 7 | 5 | 24 | 150 | 300 | | LONDON CLAY FORMATION |
| | 14 | 2 | 3 | 5 | 5 | 5 | 6 | 5 | 21 | 150 | 300 | | LONDON CLAY FORMATION |
| | 16 | 2 | 5 | 8 | 7 | 7 | 7 | 7 | 29 | 150 | 300 | | LONDON CLAY FORMATION |
| | 18 | 4 | 6 | 6 | 8 | 8 | 9 | 10 | 31 | 150 | 300 | | LONDON CLAY FORMATION |
| | 20 | 3 | 5 | 6 | 7 | 8 | 9 | 8 | 30 | 150 | 300 | | LONDON CLAY FORMATION |
| | 22 | 6 | 6 | 8 | 9 | 10 | 12 | 12 | 39 | 150 | 300 | | LONDON CLAY FORMATION |
| | 24 | 4 | 6 | 8 | 10 | 11 | 13 | 10 | 42 | 150 | 300 | | LONDON CLAY FORMATION |
| | 26 | 5 | 7 | 8 | 9 | 10 | 10 | 12 | 37 | 150 | 300 | | LONDON CLAY FORMATION |
| | 28 | 5 | 7 | 9 | 9 | 10 | 11 | 12 | 39 | 150 | 300 | | LONDON CLAY FORMATION |

Notes

1) Relative Density in accordance with BS 5930 2015 - Table 10 for granular soils only.

Title

Table summarising results of standard penetration testing

Appendix

C

soiltechnics
environmental and geotechnical consultants

## Standard Penetration Test Results

| Location | Depth to top of SPT (m) | Results | | | | | | Penetration (mm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seating 1 | Seating 2 | Main 1 | Main 2 | Main 3 | Main 4 | Total Seating | Total Main | Total Seating | Total Main | Relative Density | Strata |
| BH01 | 30 | 7 | 7 | 10 | 11 | 12 | 14 | 14 | 47 | 150 | 300 | | LONDON CLAY FORMATION |
| BH02 | 1 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 150 | 300 | | MADE GROUND |
| | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 150 | 300 | | ALLUVIUM |
| | 3 | 6 | 7 | 8 | 11 | 15 | 21 | 13 | 55 | 150 | 300 | Very dense | KEMPTON PARK GRAVEL FORMATION |
| | 3.5 | 14 | 11 | 19 | 19 | 12 | | 25 | 50 | 125 | 200 | Very dense | KEMPTON PARK GRAVEL FORMATION |
| BH03 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 150 | 300 | | MADE GROUND |
| | 3 | 4 | 8 | 13 | 25 | 12 | | 12 | 50 | 150 | 170 | Very dense | KEMPTON PARK GRAVEL FORMATION |
| | 4 | 4 | 5 | 8 | 6 | 6 | 7 | 9 | 27 | 150 | 300 | Medium dense | KEMPTON PARK GRAVEL FORMATION |
| | 5 | 2 | 3 | 4 | 4 | 4 | 5 | 5 | 17 | 150 | 300 | Medium dense | KEMPTON PARK GRAVEL FORMATION |
| | 7 | 1 | 1 | 3 | 3 | 3 | 4 | 2 | 13 | 150 | 300 | | LONDON CLAY FORMATION |
| | 9 | 1 | 2 | 3 | 5 | 5 | 5 | 3 | 18 | 150 | 300 | | LONDON CLAY FORMATION |
| | 11 | 2 | 4 | 5 | 5 | 5 | 6 | 6 | 21 | 150 | 300 | | LONDON CLAY FORMATION |
| | 15 | 2 | 5 | 5 | 6 | 6 | 7 | 7 | 24 | 150 | 300 | | LONDON CLAY FORMATION |
| | 17 | 5 | 6 | 7 | 7 | 8 | 8 | 11 | 30 | 150 | 300 | | LONDON CLAY FORMATION |
| | 19 | 3 | 6 | 6 | 8 | 8 | 8 | 9 | 30 | 150 | 300 | | LONDON CLAY FORMATION |

Notes

1) Relative Density in accordance with BS 5930 2015 - Table 10 for granular soils only.

Title

Table summarising results of standard penetration testing

Appendix

C

soiltechnics
environmental and geotechnical consultants

## Standard Penetration Test Results

| Location | Depth to top of SPT (m) | Results | | | | | | Penetration (mm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seating 1 | Seating 2 | Main 1 | Main 2 | Main 3 | Main 4 | Total Seating | Total Main | Total Seating | Total Main | Relative Density | Strata |
| BH03 | 21 | 3 | 6 | 6 | 7 | 8 | 9 | 9 | 30 | 150 | 300 | | LONDON CLAY FORMATION |
| | 23 | 5 | 7 | 9 | 9 | 10 | 12 | 12 | 40 | 150 | 300 | | LONDON CLAY FORMATION |
| | 25 | 4 | 6 | 7 | 9 | 10 | 11 | 10 | 37 | 150 | 300 | | LONDON CLAY FORMATION |
| | 27 | 5 | 7 | 9 | 10 | 12 | 12 | 12 | 43 | 150 | 300 | | LONDON CLAY FORMATION |
| | 29 | 8 | 8 | 10 | 11 | 11 | 13 | 16 | 45 | 150 | 300 | | LONDON CLAY FORMATION |
| BH04 | 1.2 | 6 | 6 | 8 | 7 | 8 | 7 | 12 | 30 | 150 | 300 | Dense | MADE GROUND |
| | 2 | 5 | 6 | 5 | 4 | 2 | 0 | 11 | 11 | 150 | 300 | Medium dense | MADE GROUND |
| | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 150 | 300 | | MADE GROUND |
| | 3.95 | 3 | 9 | 9 | 10 | 13 | 15 | 12 | 47 | 150 | 300 | | MADE GROUND |
| BH05 | 1 | 0 | 0 | 0 | 2 | 2 | 2 | 0 | 6 | 150 | 300 | Loose | MADE GROUND |
| | 1.9 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 6 | 150 | 300 | | MADE GROUND |
| | 2.9 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 3 | 150 | 300 | | MADE GROUND |
| | 4 | 7 | 7 | 9 | 11 | 14 | 16 | 14 | 50 | 150 | 295 | Very dense | KEMPTON PARK GRAVEL FORMATION |
| BH06 | 1.2 | 1 | 1 | 2 | 2 | 2 | 3 | 2 | 9 | 150 | 300 | | ALLUVIUM |
| | 3 | 1 | 2 | 2 | 2 | 3 | 3 | 3 | 10 | 150 | 300 | | MADE GROUND |

Notes

1) Relative Density in accordance with BS 5930 2015 - Table 10 for granular soils only.

Title

Table summarising results of standard penetration testing

Appendix

C

soiltechnics
environmental and geotechnical consultants

## Standard Penetration Test Results

| Location | Depth to top of SPT (m) | Results | | | | | | Penetration (mm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seating 1 | Seating 2 | Main 1 | Main 2 | Main 3 | Main 4 | Total Seating | Total Main | Total Seating | Total Main | Relative Density | Strata |
| BH06 | 4 | 3 | 7 | 9 | 13 | 16 | 12 | 10 | 50 | 150 | 265 | Very dense | KEMPTON PARK GRAVEL FORMATION |
| | 5 | 4 | 6 | 9 | 11 | 14 | 16 | 10 | 50 | 150 | 295 | Very dense | KEMPTON PARK GRAVEL FORMATION |
| | 6 | 4 | 4 | 4 | 5 | 5 | 6 | 8 | 20 | 150 | 300 | Medium dense | KEMPTON PARK GRAVEL FORMATION |
| | 8 | 2 | 3 | 3 | 5 | 5 | 6 | 5 | 19 | 150 | 300 | | LONDON CLAY FORMATION |
| | 10 | 2 | 3 | 4 | 5 | 6 | 7 | 5 | 22 | 150 | 300 | | LONDON CLAY FORMATION |
| | 12 | 3 | 3 | 4 | 5 | 6 | 7 | 6 | 22 | 150 | 300 | | LONDON CLAY FORMATION |
| | 15 | 3 | 4 | 5 | 7 | 7 | 8 | 7 | 27 | 150 | 300 | | LONDON CLAY FORMATION |
| | 17 | 3 | 5 | 6 | 6 | 7 | 8 | 8 | 27 | 150 | 300 | | LONDON CLAY FORMATION |
| | 19 | 4 | 6 | 7 | 9 | 9 | 10 | 10 | 35 | 150 | 300 | | LONDON CLAY FORMATION |
| | 21 | 4 | 6 | 8 | 9 | 9 | 11 | 10 | 37 | 150 | 300 | | LONDON CLAY FORMATION |
| | 23 | 5 | 7 | 9 | 10 | 10 | 12 | 12 | 41 | 150 | 300 | | LONDON CLAY FORMATION |
| | 25 | 6 | 8 | 10 | 11 | 12 | 15 | 14 | 48 | 150 | 300 | | LONDON CLAY FORMATION |
| | 29 | 6 | 9 | 10 | 13 | 15 | 12 | 15 | 50 | 150 | 300 | | LONDON CLAY FORMATION |
| BH07 | 1.2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 150 | 300 | | MADE GROUND |
| | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 150 | 300 | | MADE GROUND |

Notes

1) Relative Density in accordance with BS 5930 2015 - Table 10 for granular soils only.

Title

Table summarising results of standard penetration testing

Appendix

C

soiltechnics
environmental and geotechnical consultants

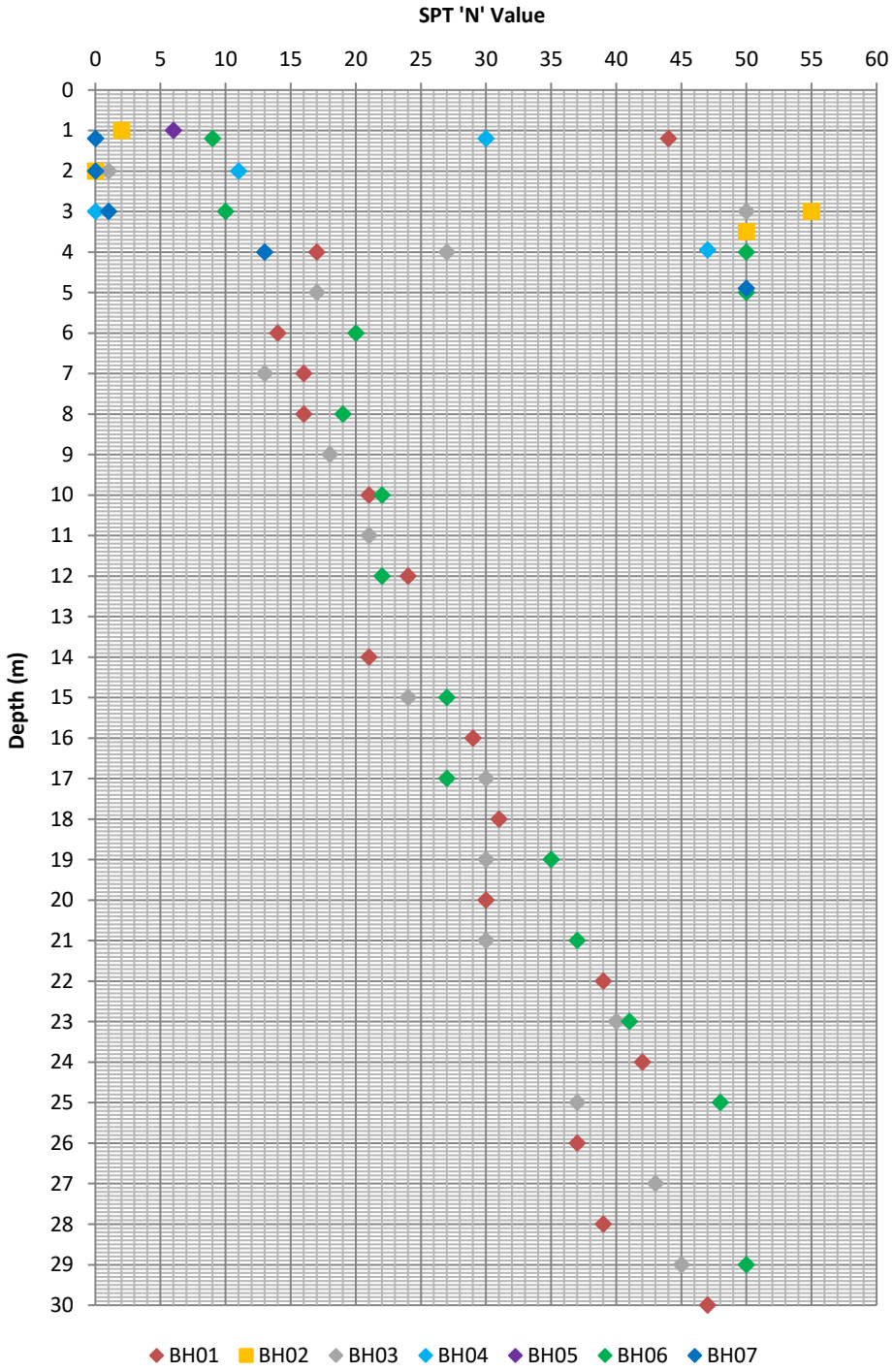
## Standard Penetration Test Results

| Location | Depth to top of SPT (m) | Results | | | | | | Penetration (mm) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Seating 1 | Seating 2 | Main 1 | Main 2 | Main 3 | Main 4 | Total Seating | Total Main | Total Seating | Total Main | Relative Density | Strata |
| BH07 | 3 | 2 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 150 | 300 | | MADE GROUND |
| | 4 | 2 | 3 | 3 | 3 | 3 | 4 | 5 | 13 | 150 | 300 | | MADE GROUND |
| | 4.9 | 10 | 21 | 25 | 25 | | | 31 | 50 | 150 | 140 | Very dense | KEMPTON PARK GRAVEL FORMATION |

Notes

1) Relative Density in accordance with BS 5930 2015 - Table 10 for granular soils only.

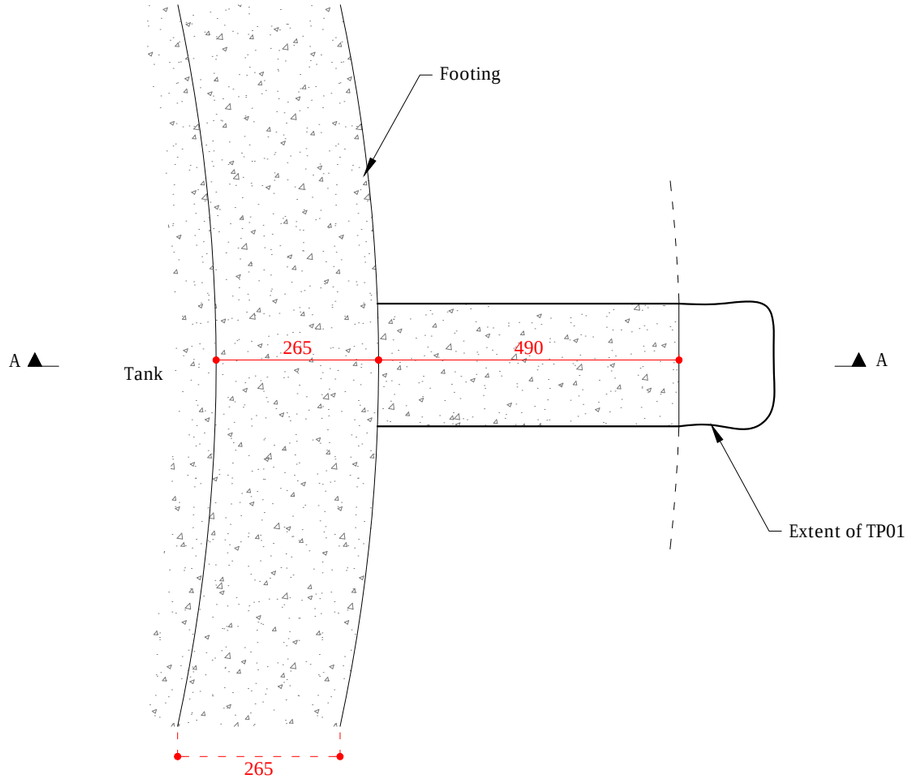
| Title | Appendix |
|---|---|
| Table summarising results of standard penetration testing | C |



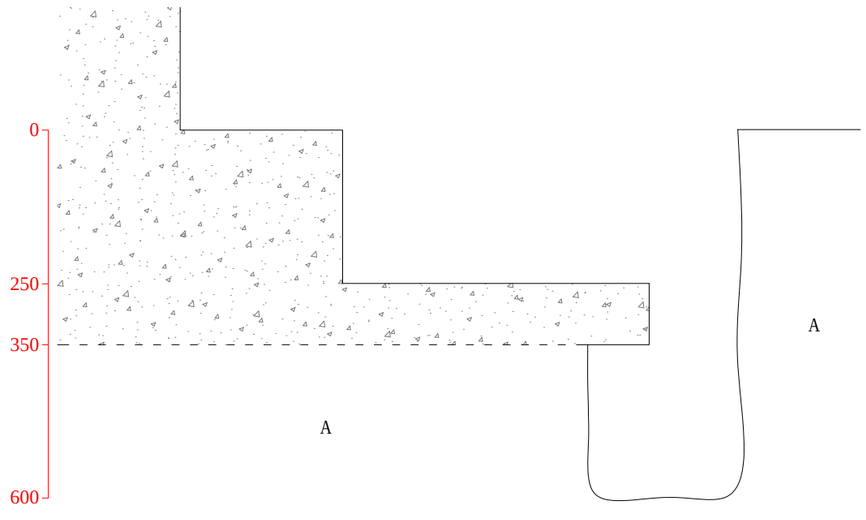

| Title | Scale | Appendix |
|---|---|---|
| Plot summarising results of standard penetration test results by location | As shown | C |

soiltechnics
environmental and geotechnical consultants

Plan




Section A-A




Photographic record

Key

A. Dark brown slightly sandy gravelly CLAY. Gravel consists of flint, brick, concrete, glass and clinker.
(MADE GROUND)

Observed features
Assumed features

Denotes concrete

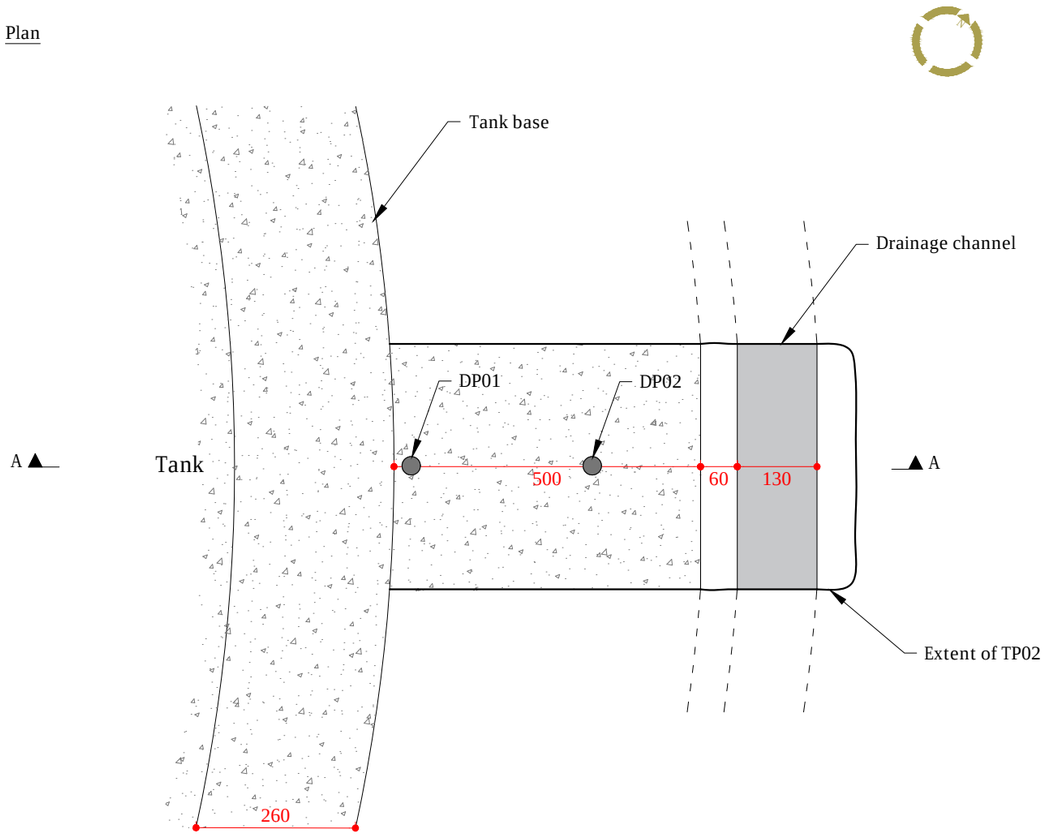
Notes

1. All dimensions shown in millimetres
2. Environmental sample taken from 0.3m depth

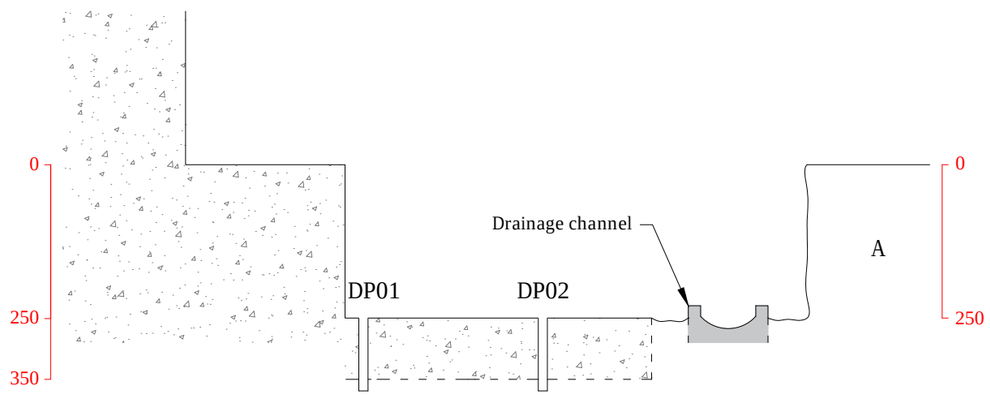
| | | | |
|---|---|---|---|
| Method of excavation | | Title | Location reference |
| Hand tools | | Trial pit record | TP01 |
| Dimensions | | Date of works | Location plan on drawing number |
| As shown | | 12/03/2018 | 02 |
| Groundwater observations | | Scale | Appendix |
| No groundwater encountered | | 1:10 at A3 | D |

soiltechnics
environmental and geotechnical consultants

## Plan




## Section A-A




## Photographic record

## Key

A. Firm brown gravelly very sandy CLAY with occasional cobbles of brick and concrete. Gravel consists of flint, brick, timber, plastic and concrete.

Observed features
Assumed features

Denotes concrete

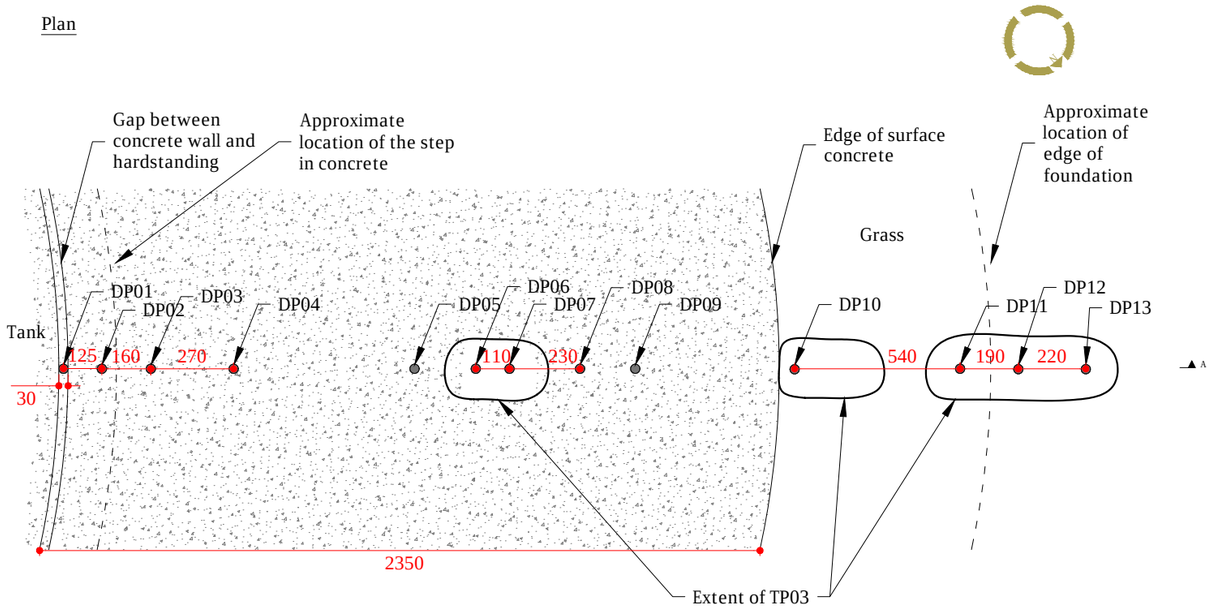
## Notes

1. All dimensions shown in millimetres
2. Environmental sample taken from 0.2m depth

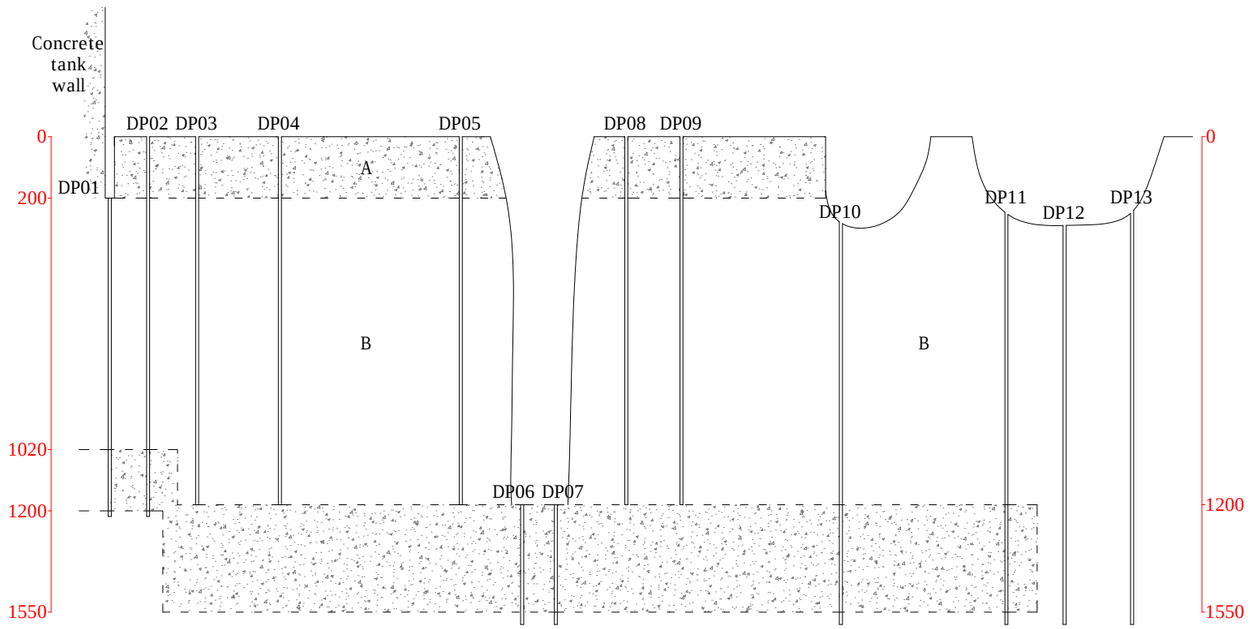
| | | | |
|---|---|---|---|
| Method of excavation | | Title | Location reference |
| Hand tools | | Trial pit record | TP02 |
| Dimensions | | Date of works | Location plan on drawing number |
| As shown | | 12/03/2018 | 02 |
| Groundwater observations | | Scale | Appendix |
| No groundwater encountered | | 1:10 at A3 | D |

soiltechnics
environmental and geotechnical consultants

Plan




Section A-A




Photographic record

Key

A. Light grey reinforced CONCRETE comprised of aggregates of flint up to nominal 30mm. 2% air pores. 9mm plain reinforcement bar located at 150mm depth. Blue plastic membrane at base.
(MADE GROUND)

B. Medium dense brown slightly clayey very gravelly SAND. Gravel consists of flint, brick, sandstone, clinker and concrete.
(MADE GROUND)

Observed features
Assumed features

Denotes concrete

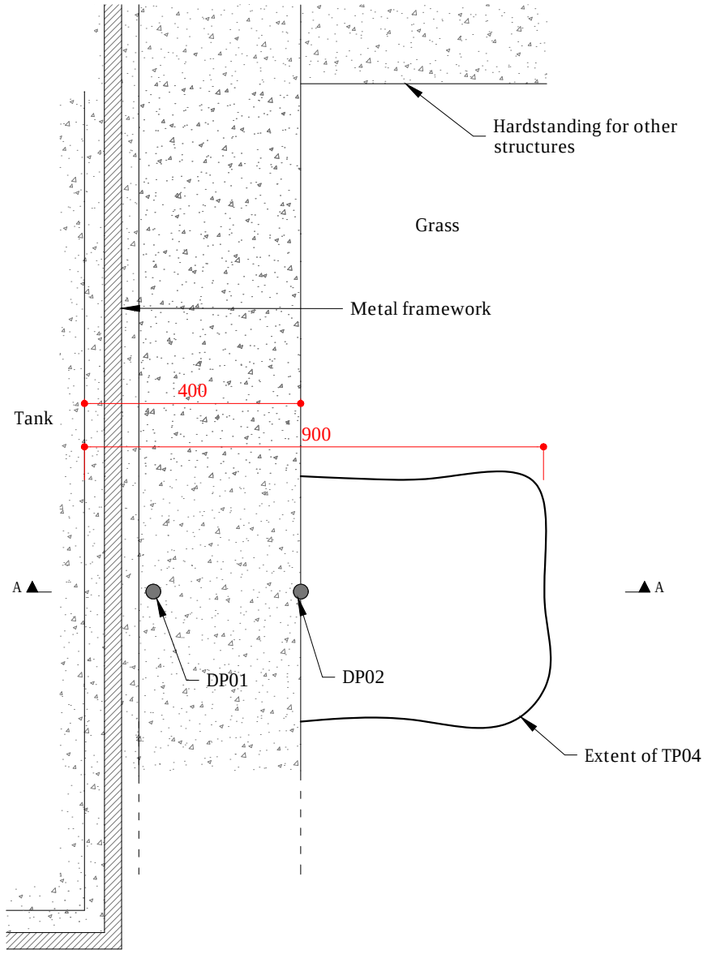
Notes

1. All dimensions shown in millimetres
2. Environmental samples taken from 0.3m and 1.1m depth
3. Disturbed sample taken from 0.4m depth

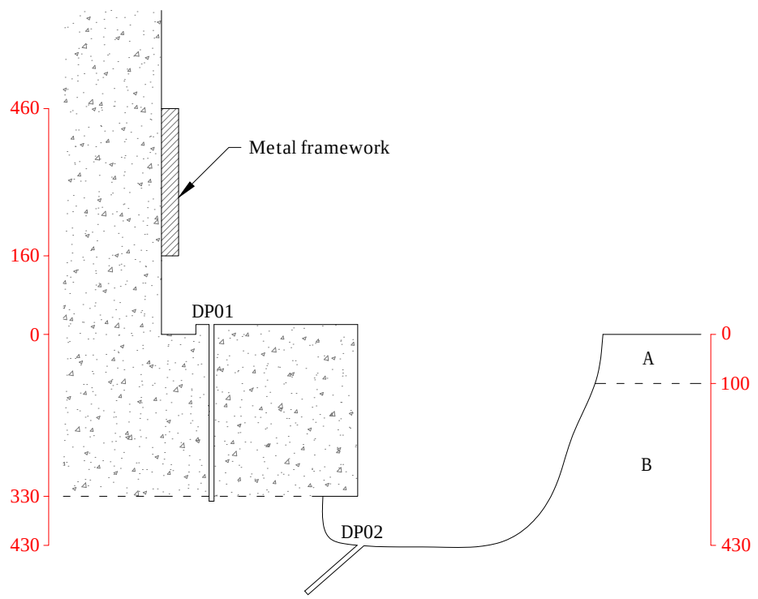
| | | | |
|---|---|---|---|
| Method of excavation | | Title | Location reference |
| Hand tools | | Trial pit record | TP03 |
| Dimensions | | Date of works | Location plan on drawing number |
| As shown | | 12/03/2018 | 02 |
| Groundwater observations | | Scale | Appendix |
| No groundwater encountered | | 1:10 at A3 | D |

soiltechnics
environmental and geotechnical consultants

Plan




Section A-A




Photographic record

Key

A. Brown slightly clayey gravelly SAND. Gravel consists of flint, quartz and brick. (MADE GROUND)

B. Loose brown very gravelly SAND. Gravel consists of sub-angular to sub-rounded flint and brick. (MADE GROUND)

Observed features
Assumed features

Denotes metal
Denotes concrete

Notes

1. All dimensions shown in millimetres
2. Environmental sample taken from 0.05m depth
3. Disturbed sample taken from 0.3m depth

| | | | |
|---|---|---|---|
| Method of excavation | | Title | Location reference |
| Hand tools | | Trial pit record | TP04 |
| Dimensions | | Date of works | Location plan on drawing number |
| As shown | | 12/03/2018 | 02 |
| Groundwater observations | | Scale | Appendix |
| No groundwater encountered | | 1:12.5 at A3 | D |