

P J LIVESEY, BRUNTWOOD & SIEMENS

**SIEMENS DEVELOPMENT PHASE 1 & 2,
PRINCESS ROAD, MANCHESTER, M20 2UR**

GROUND INVESTIGATION REPORT

Contract: 41787

Date: January 2017

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GROUND INVESTIGATION REPORT

carried out at

Siemens Development Phase 1 & 2

Prepared for

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V1	19/01/2016	Complete report on ground investigation pending completion of gas monitoring.	PDF copy to Booth King Partnership Limited
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EXECUTIVE SUMMARY

On the instructions of Booth King Partnership, on behalf of P J Livesey, Bruntwood and Siemens a ground investigation was carried out at a site adjacent to Siemens House, Manchester.

The investigation was carried to determine ground and ground water conditions for the commercial and residential development of the site. A preliminary ground contamination risk assessment was also carried out.

Geological records indicate that the site is underlain by Glaciofluvial Sheet Deposits generally described as sand and gravel. Bedrock beneath the site comprises the Wilmslow Sandstone Formation of Triassic age.

Site work comprised ten cable percussion boreholes, twelve windowless sample boreholes, one trial pit with infiltration testing and in-situ tests to determine CBR values at ten locations.

The ground conditions encountered comprised made ground overlying gravelly sand. Made ground was present as a thin veneer across the site although locally thickening to a maximum of 2.20m. Sand was encountered to depths between 2.80 and 4.70m. Firm and stiff clay was encountered beneath sand and proved to depths up to 10m.

Depending on structural loads consideration may be given to spread foundations bearing in natural sand to support the commercial buildings.

Preliminary design of square pad foundations at nominal depths of 1.00m may be based on allowable bearing capacities about 160kN/m² for pad sizes about 1m by 1m and about 200kN/m² for pad sizes about 2m by 2m. Additional bearing capacity may be gained by increasing the depth of foundations however this should be considered in the context of the groundwater levels recorded at depths between 1.80 and 3.00m.

Additional bearing capacity may also be obtained, if required, by subjecting the natural sand to ground improvement such as vibro-compaction.

It is considered that traditional strip foundations would be suitable to support the residential development. Preliminary design of strip foundations at nominal depths of 0.75m in sand may be based on allowable bearing capacities about 125kN/m² for widths about 1m. Trench fill may locally be required to extend foundations through made ground.

If structural loads imposed by the commercial development exceed the bearing capacity available from spread foundations then consideration should be given to piled foundations.

The majority of the site complies with Design Sulphate Class DS-1 and ACEC-1. Locally elevated sulphate concentrations were recorded that were consistent with DS-2 and ACEC-2. Additional testing would be required to delineate these areas of elevated sulphate content.

The results of contamination testing on soils are all below the relevant guideline values for a residential end use. As the results are below the more sensitive guideline values for a residential end use they are also below the less sensitive guideline values for a commercial end use.

The results of soil analysis indicate that there is only a very low risk to end users of the site from soil contamination.

Asbestos was noted in the laboratory in one soil sample (BH10 at 1.00m) as a small bundle of chrysotile. Quantitative analysis of this sample indicated a total mass of asbestos below the detection limit of <0.001%. There was no visual evidence of bulk asbestos contamination or evidence of ACM's during site work.

The extremely low fibre concentrations indicate that there would not be significant risks to end-users or construction workers from asbestos.

The ground conditions encountered at the site indicate that the risks to ground water would be very low and it is considered unlikely that further assessment of the risks to controlled waters may be required.

Initial gas monitoring determined the presence of methane at a concentration of up to 0.6%v/v and carbon dioxide of up to 15%v/v with a flow rate of up to 4.23litres/hour.

Gas Screening Values (GSV) of 0.03litres/hour may be derived for methane and 0.63l/hr for carbon dioxide. These values indicate that the site is Characteristic Situation 2; low risk.

For residential development with suspended floor slab and ventilated void the NHBC Traffic Light risk classification system puts the maximum carbon dioxide value into Traffic Light Amber 2. The Gas Screening puts it into green. It is likely that the higher classification, based on maximum concentration, would be required.

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1.0 INTRODUCTION

- 1.1 It is understood that it is proposed to develop the site for mixed development, for residential and commercial use.
- 1.2 On the instructions of Booth King Partnership Limited, on behalf of P J Livesey, Bruntwood and Siemens, a ground investigation was undertaken to determine ground conditions for the proposed development. A risk assessment with respect to ground contamination and ground gas was also carried out.
- 1.3 This report should be read in conjunction with the Preliminary Risk Assessment (Desk Study) which was reported under reference 41787 in December 2015.
- 1.4 It is recommended that a copy of this report be submitted to the relevant authorities to enable them to carry out their own site assessments and provide any comments.
- 1.5 This report has been prepared for the sole use of the Client for the purpose described and no extended duty of care to any third party is implied or offered. Third parties using any information contained within this report do so at their own risk.
- 1.6 The comments given in this report and the opinions expressed herein are based on the information received, the conditions encountered during site works, and on the results of tests made in the field and laboratory. However, there may be conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report.
- 1.7 The comments on groundwater conditions are based on observations made at the time the site work was carried out. It should be noted that groundwater levels vary owing to seasonal or other effects.

2.0 SITE SETTING

2.1 Site Location

2.1.1 The site is situated at Siemens House, to the east of Princess Road, approximately 8.5km to the south of the town centre of Manchester and may be located by Grid Reference SJ 834 922.

2.1.2 A site location plan is included as Figure A1.1 in Appendix 1.

2.2 Site Description

2.1.1 The overall site is approximately 8.61ha and is roughly rectangular in shape elongated from north to south. The site is sensibly level.

2.1.2 The site was bound to the north by Nell Lane, to the east by Withington Community Hospital, to the south by Barlow Moor Road and to the west by Princess Road.

2.1.3 At the time of the walkover survey, the site generally comprised several commercial buildings, access roads, hardstanding and grassed areas.

2.1.4 The northern part of the site was dominated by a commercial building, up to five storeys in height; Siemens House. This building was served by access from Nell Lane with car parking on the northeast corner of the site. A further commercial building, two storeys in height, was located to the southeast of Siemens House.

2.1.5 The majority of the western and central part of the site comprised grassed areas with some mature trees to the western boundary.

2.1.6 The southern part of the site comprised an active construction site.

2.1.7 The southeast part of the site comprised car parking area with a further commercial building to the southeast corner.

2.1.8 An access road linked Nell Lane with Barlow Moor Road running along the eastern side of the site.

2.1.9 The site extended to the east of this access road. Disused, brick built, low rise buildings were located to the east of this access road with further car parking to the south of these buildings.

2.2 Geological Setting

- 2.2.1 Details of the geology underlying the site have been obtained from the British Geological Survey map, Sheet No. 85, 'Manchester', Bedrock and Superficial edition, 1:50,000 scale, published 2011.
- 2.2.2 The geological map indicates the site to be underlain by Glaciofluvial Sheet Deposits generally described as sand and gravel.
- 2.2.3 Bedrock beneath the site comprises Wilmslow Sandstone Formation of Triassic Age.
- 2.2.4 The site is within an urban area and, although not indicated as present on the site from the geological maps, the possibility that Made Ground exists on site cannot be discounted.
- 2.2.5 Historical boreholes in the vicinity of the site have been viewed via the British Geological Survey website (contains British Geological Survey materials © NERC 2016).
- 2.2.6 Historical boreholes were located about the northwest corner of the site (SJ89SW700 & 701), about the southwest corner of the site (SJ89SW697) and about the southeast corner of the site (SJ89SW686).
- 2.2.7 The historical boreholes generally recorded a thin veneer of topsoil or made ground overlying medium dense sand to depths about 4 to 5m. These coarse soils may represent the Glacial Sheet Deposits noted on the geological records. Clay was encountered below sand. The clay was typically firm and considered to represent Glacial Till.

3.0 PRELIMINARY DEVELOPMENT PROPOSALS

- 3.1 Proposed development is for mixed residential and commercial use. The proposed development does not extend to the whole of the overall site.
- 3.2 The total site area has been sub-divided into five areas on drawings provided by Booth King Partnership. The areas have been designated A to F on preliminary layout drawings, as listed below:
- A. Northwest: Existing Siemens building and surrounding area to be retained
 - B. Southeast: Existing commercial building and surrounding area to be retained
 - C. Southwest: Hospital (currently under construction)
 - D. Central: Grassed area extending from Princess Road to eastern access road designated for commercial development
 - E. Northeast: Car parks on northeast corner of site and area to east of eastern access road designated for residential development
 - F. Roadway
- 3.3 This ground investigation was carried out on the areas designated for commercial development (Area D) and residential development (Area E) through the central and northeast parts of the site respectively. Area D and Area E are indicated on Figure A1.2.

4.0 SITE WORK

- 4.1 The site work was carried out between the 9th November and 19th November. The site work was carried out on the basis of the practices set out in BS 10175:2011, ref. 10.2, BS 5930:2010 ref. 10.3 and ISO 1997:2007, ref 10.4. The locations of the exploratory holes were agreed with the Engineer with respect to existing buildings and services and the ongoing operational and access requirements of the site.
- 4.2 Ten boreholes, designated BH01 to BH10, were sunk by cable percussion methods, twelve boreholes, designated WS01 to WS12 were undertaken by drive-in window sampler technique and one mechanically excavated trial pit with soakaway testing referenced TP01.
- 4.3 The positions of the exploratory holes are shown on Figure A1.2 in Appendix 1.
- 4.4 The exploratory holes may be related to the proposed development areas as follows:
- Plot D: Commercial: BH06 to BH10, WS08 to WS12, TP01
 - Plot E: Residential: BH01 to BH05 and WS01 to WS07
- 4.5 The depths of exploratory holes, descriptions of strata encountered and comments on groundwater conditions are given in the borehole and trial pit records in Appendix 2.
- 4.6 Representative disturbed and undisturbed samples were taken at the depths shown on the borehole and trial pit records and despatched to the laboratory. Standard penetration tests, ref. 10.4 were carried out in the boreholes in the various strata to assess the relative density or consistency. The values of penetration resistance are given in the borehole records. SPT Hammer Energy Test Certificates are presented in Appendix 2.
- 4.7 Samples were collected for environmental purposes in amber glass jars and kept in a cool box.
- 4.8 Perforated standpipes, surrounded by pea shingle and protected by a stopcock cover were installed in boreholes BH01, BH02, BH03, BH04, BH05, BH07, BH10, WS08, WS09 and WS12, as detailed on the borehole records.
- 4.9 The ground levels at the exploratory hole and in-situ test locations were not determined.
- 4.10 CBR values were determined using a TRL dynamic probe at six location referenced TRL01 to TRL06. CBR values were determined at a further four locations, referenced MP01 to MP04 using a “Mexi Probe”. Locations of the CBR tests are indicated on Figure A1.2. Records of the CBR values obtained are included in Appendix 2.
- 4.11 Monitoring visits to measure groundwater levels and gas concentrations in wells have been carried out on six occasions. The results of monitoring are presented in Appendix 7.

5.0 LABORATORY TESTS

5.1 Geotechnical Testing

5.1.1 Soil samples for testing were prepared in accordance with BS1377: Part One: 1990 ref. 10.8 and representative sub-samples were taken for testing. The following tests were carried out:

- 8 No. Moisture contents
- 8 No. Plasticity indices
- 11 No. Particle size distribution by wet sieving
- 1 No. Bulk & dry density
- 8 No Undrained shear strength
- 1 No. Oedometer consolidation
- 5 No. Dry density moisture content relationship
- 21 No. Water soluble sulphate
- 21 No pH value

5.1.2 The results of the testing are presented in Appendix 3, Test Reports 41487-1, 41787A-1, 41787B-1, 15-51712, 15-51713 and 15-52254.

5.2 Chemical Testing

5.2.1 The chemical analyses were carried out on seven samples of soil. The nature of the analyses is detailed below:

5.2.2 **Metals screen** - arsenic, cadmium, chromium, hexavalent chromium, lead, mercury, selenium, boron (water soluble), copper, nickel and zinc

5.2.3 **Organic Screen** - polycyclic aromatic hydrocarbons (PAH) – USEPA 16 suite, monohydric phenols

5.2.4 **Inorganics Screen** - cyanide (total), sulphate (water soluble)

5.2.5 **Others** - pH, organic matter, asbestos

5.2.6 The results of these tests are presented in Appendix 4, Test Reports 15-50445, 15-50751, 15-51045 and 15-51104-1.

6.0 GROUND CONDITIONS ENCOUNTERED

6.1 Sequence

- 6.1.1 The sequence of the strata encountered during the investigation generally confirms the anticipated geology as interpreted from the geological map.
- 6.1.2 The sequence encountered generally comprised made ground overlying natural sand. The sand in turn overlies firm and stiff clay.
- 6.1.3 The general sequence of strata is shown on the nominal sections; Figures A1.3a to A1.3d.
- 6.1.4 SPT 'N' values are plotted against depth in Figure A1.4.

6.2 Made Ground

- 6.2.1 Made ground was encountered at all exploratory hole locations to depths between 0.30 and 2.20m.
- 6.2.2 A thin veneer of surface coverings were encountered across the site including tarmac, gravel, grass and reinforced concrete.
- 6.2.3 Beneath surface coverings made ground predominantly comprised sand or gravel locally with cobbles. Fragments of brick, concrete, plastic, clinker, ceramic, glass and wood were noted within made ground.
- 6.2.4 The greatest thickness of made ground, 2.20m, was encountered in BH03 towards the southeast corner of the proposed residential area.
- 6.2.5 BH10, WS07, WS08 and WS12 encountered made ground to depths of 1.50m. These boreholes were generally located through the centre of the site.
- 6.2.6 One SPT 'N' value of 20 was obtained in made ground in BH03 indicating medium dense material.

6.3 Sand

- 6.3.1 Sand was encountered at all exploratory hole locations, beneath made ground, at depths between 0.30 and 2.20m.
- 6.3.2 The material was generally described as brown slightly gravelly sand.
- 6.3.3 WS09 was terminated within sand at a depth of 5.45m. TP01 was terminated within sand at a depth of 1.60m.
- 6.3.4 The base of the sand was encountered in all exploratory holes, except WS09 and TP01, at a depths in the range 2.80 to 4.70m.

- 6.3.5 The depth to the base of the sand does not appear to vary systematically across the site.
- 6.3.6 Sixty eight SPT 'N' values were carried out within sand with an overall range from 2 to 39 (uncorrected).
- 6.3.7 The highest value of 39 was obtained in WS04 at 1.20m and appears anomalously high in comparison to the rest of the values. Excluding this highest value a maximum value of 30 was recorded.
- 6.3.8 N_{60} values ranged from 3 to 36 (excluding highest value).
- 6.3.9 The majority of the SPT 'N' values indicate medium dense material. Three values indicate one value was consistent with very loose material (WS01 at 2.00m) and sixteen values indicated loose material.
- 6.3.10 The relative density of the sand does not appear to vary systematically with depth.

6.4 Clay

- 6.4.1 Clay was encountered at all exploratory hole locations, excluding WS09 and TP01, beneath sand, at depths between 2.80 and 4.70m.
- 6.4.2 The depth to the top of the clay does not appear to vary systematically across the site.
- 6.4.3 The material was generally described as brown slightly sandy, slightly gravelly clay. Consistencies were described as firm becoming stiff and very stiff with depths. The upper part of the clay was locally laminated. Sand and silt lenses were locally present.
- 6.4.4 The base of the clay was not proved. All exploratory holes, excluding WS09 and TP01, were terminated within clay. BH01 to BH10 were terminated at depths about 10.00m. WS01 to WS08, WS10 and WS12 were terminated at depths of 5.45m. WS11 was terminated at a depth of 4.45m.
- 6.4.5 Laboratory tests in clay are summarised in the following table:

Parameter	Number of tests	Unit	Minimum	Maximum	Mean
NMC	11	%	18	29	22
LL	8	%	36	49	41
PL	8	%	14	22	18
PI	8	-	19	27	23
Bulk density	8	Mg/m ³	1.91	2.07	2.03
Dry density	8	Mg/m ³	1.5	1.79	1.67
Triaxial Cu	8	kN/m ²	50	131	73

- 6.4.6 On the basis of the Atterberg Limits the clay may be classified as intermediate plasticity.
- 6.4.7 On the basis of the plastic indexes a classification of medium volume change potential is considered appropriate as defined by the National House Building Council, ref 10.13 and other published data, refs 10.14 and 10.15.
- 6.4.8 Strengths determined by triaxial testing indicate firm and stiff clay.
- 6.4.9 One oedometer test recorded coefficients of compressibility about $0.20\text{m}^2/\text{MN}$ for the pressure stage rising from overburden.
- 6.4.10 Forty five SPT 'N' values in clay ranged from 6 to 36. Whilst the higher values were recorded at greater depths there does not appear to be a systematic variation in SPT 'N' value with depth.
- 6.4.11 SPT 'N' values may be used to provide an approximation of C_u values in clay (see Appendix A1.4).
- 6.4.12 On this basis undrained shear strength from 30kN/m^2 to 180kN/m^2 may be derived from SPT 'N' values based on an f_1 value about 5. These strengths derived from SPT 'N' values indicate a wider range than those derived from triaxial testing from soft, through firm and stiff to very stiff. This may be due to the bigger dataset.
- 6.4.13 The lower SPT 'N' values may reflect localised softening due to water bearing sand or silt lenses.

6.5 Groundwater

- 6.5.1 Groundwater was encountered in BH06 and 07 at depths of 3.30 and 2.80m respectively. Small rises in water level were noted during a 20 minute monitoring period.
- 6.5.2 Groundwater was encountered in BH01, WS01 and WS03 to WS11 at depths between 1.70 and 3.00m.
- 6.5.3 Monitoring of wells subsequent to fieldwork has measured standing water levels at depths about 1.80 to 3.00m.

7.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO THE PROPOSED DEVELOPMENT

7.1 General

- 7.1.1 Preliminary development layouts for the commercial area indicate building heights up to 27m suggesting substantial multi-storey units.
- 7.1.2 It is assumed that residential development will be low rise and of traditional brick or block construction.
- 7.1.3 Development layouts and structural loads are not available.
- 7.1.4 The comments and recommendations below do not fall within the requirements of EC7 (refs. 10.4) and should be reviewed as development layout, structural loads and design details become available.

7.2 Foundations

- 7.2.1 Depending on structural loads consideration may be given to spread foundations to support the commercial buildings.
- 7.2.2 Foundations should be extended through any made ground to bear in the underlying natural sand.
- 7.2.3 Preliminary design of square pad foundations at nominal depths of 1.00m may be based on allowable bearing capacities about 160kN/m² for pad sizes about 1m by 1m and about 200kN/m² for pad sizes about 2m by 2m.
- 7.2.4 Additional bearing capacity may be gained by increasing the depth of foundations however this should be considered in the context of the groundwater levels recorded at depths between 1.80 and 3.00m.
- 7.2.5 Additional bearing capacity may also be obtained, if required, by subjecting the natural sand to ground improvement such as vibro-compaction. Specialist ground improvement contractors should be consulted to determine the most appropriate methods in the ground conditions at the site and to provide an estimate of achievable bearing capacity.
- 7.2.6 It is considered that traditional strip foundations would be suitable to support the residential development on the assumption that buildings will be low rise and of traditional brick construction.
- 7.2.7 Preliminary design of strip foundations at nominal depths of 0.75m may be based on allowable bearing capacities about 125kN/m² for widths about 1m. Trench fill may locally be required to extend foundations through made ground.

- 7.2.8 The allowable bearing capacities indicated above would provide an adequate factor of safety against shear failure and limit settlements to the order of 10mm. As the bearing strata are sand settlements would be substantially complete during construction.
- 7.2.9 If structural loads imposed by the commercial development exceed the bearing capacity available from spread foundations then consideration should be given to piled foundations.
- 7.2.10 Guidelines for the design of piles are given in Appendix 5.
- 7.2.11 The carrying capacity of piles depends not only on their size and the ground conditions but also on their method of installation. Pile design and installation are continuously evolving processes and state-of-the-art are often employed before they reach the public domain, perhaps several years down the line. Therefore, it is recommended that specialist Piling Contractors be contacted as to the suitability and carrying capacity of their piles in the ground conditions pertaining to the site.
- 7.2.12 If piled foundations are considered then additional depth of investigation may be required to determine pile design parameters.

7.3 Ground Floor Slabs

- 7.3.1 On the basis of observation on site together with the results of laboratory tests it is recommended that consideration is given to constructing the ground floor slab on formation prepared in the natural sand encountered across the site beneath made ground.
- 7.3.2 Formations should be proof rolled and any loose or deleterious material should be removed and replaced with properly compacted granular fill.
- 7.3.3 If piled foundations are utilised for the commercial development area then consideration should be given to suspended floors to avoid differential settlement between the pile caps and the floor slab.
- 7.3.4 In residential areas where the final levels dictate that the depth of sub floor fill exceeds 600mm, ground floor slabs should be suspended in accordance with NHBC requirements.

7.4 Excavations

- 7.4.1 Shallow excavation for foundations and services will be undertaken through made ground and sand. Beneath surface hardstanding excavation should generally be achievable by standard plant.
- 7.4.2 Previous development has been present on the proposed development areas notably towards the east of the proposed residential area. Localised obstructions from buried structures may therefore require breaking out in some areas.
- 7.4.3 On the basis of observations on site it is considered that excavations to less than 1.00m may not stand unsupported in the short term. Side support for safety purposes should of course be provided to all excavations which appear unstable, and those in excess of 1.20m deep, in accordance with Health and Safety Regulations.
- 7.4.4 Groundwater should not be expected in shallow excavations for foundations or services.
- 7.4.5 Groundwater could be expected in excavations taken to depths in excess of 1.80m.

7.5 Re-use of Materials

- 7.5.1 Particle size distribution tests may be used to provide a provisional classification of the soil materials encountered at shallow depths in accordance with Specification for Highway Works (Earthworks Series 600) Table 6/2 (Ref. 7.7).
- 7.5.2 The sand encountered at shallow depths may be classified as Class 1B on this basis suitable for use as general fill.
- 7.5.3 One sample (WS03 at 0.60m) recorded 16% fines (passing 63µm sieve). This exceeds the 15% fines limit for Class 1B. It is likely that bulk excavation and mixing of soils from shallow depth would reduce the overall fines content to less than 15%. This should be confirmed by testing during earthworks if required.
- 7.5.4 The results of five compaction tests on samples of sand recorded maximum dry densities in the range 1.75 to 1.89Mg/m³ with optimum moisture contents between 12 and 16%.

7.6 Road and Hard Standing

- 7.6.1 California Bearing ratio (CBR) values have been obtained at ten locations by either TRL Dynamic Probe or Mexi-Probe.
- 7.6.2 The values obtained were variable with an overall range from 1.0 to >30%.
- 7.6.3 The lower values were generally obtained at shallow depths with CBR values typically exceeding 5% below about 250mm depth.
- 7.6.4 The design CBR values will depend on depth of formation.
- 7.6.5 A CBR value about 5% is considered appropriate for preliminary design of formations at depths not less than 250mm below existing ground level.
- 7.6.6 Formation should be proof rolled and any areas of soft or deleterious material in should be excavated and replaced with a properly compacted granular fill.

7.7 Soakaways

- 7.7.1 Soakaway testing was carried out at one location on the commercial development area.
- 7.7.2 The results of soakaway tests gave infiltration rates of 3.9×10^{-5} and 4.9×10^{-5} m/s.
- 7.7.3 These indicate the sand to be of good drainage characteristics (Ref. 10.17).
- 7.7.4 Local variations in the grading of the sand, notably silt and clay content, may result in significant variations in infiltration rates. It is recommended that soakaway testing is carried out at proposed soakaway locations to finalise design.

7.8 Chemical Attack on Buried Concrete

- 7.8.1 The site has been classified in accordance with BRE Special Digest 1, ref. 10.18, as greenfield without the presence of pyrite and laboratory testing undertaken accordingly. It is recommended that the guidelines given in BRE Special Digest 1, ref. 10.18, be adopted.
- 7.8.2 The results of ten tests on made ground indicate soluble sulphate concentrations between <10 and 1400mg/l as 2:1 water/soil extract, with pH values between 7.3 and 11.3. On the basis of these results a characteristic soluble sulphate content of 1200mg/l is appropriate for the made ground.
- 7.8.3 The results of fifteen tests on sand indicate soluble sulphate concentrations between <10 and 1300mg/l as 2:1 water/soil extract, with pH values between

6.3 and 8.5. On the basis of these results a characteristic soluble sulphate content of 670mg/l is appropriate for the sand.

- 7.8.4 The results of two tests on clay indicate soluble sulphate concentrations of 15 and 24mg/l as 2:1 water/soil extract, with pH values of 6.6 and 7.6. On the basis of these results a characteristic soluble sulphate content of 24mg/l is appropriate for the clay.
- 7.8.5 It is recommended that for conventional shallow foundations the groundwater should be regarded as mobile.
- 7.8.6 The majority of the results across both the commercial and residential site areas indicate a Design Sulphate Class of DS-1 and an ACEC Class of AC-1. Two results in made ground and one result in sand indicate a design Sulphate Class of DS-2 and an ACEC Class of AC-2.
- 7.8.7 The areas where DS-2 / ACEC-2 may be applicable appear to be limited and may be due to localised soil conditions.
- 7.8.8 It is recommended that further sampling of materials and testing for pH and soluble sulphate is carried out in the vicinity of BH03, BH06 and BH10 to determine site zones for Design Sulphate Class and ACEC Class.

8.0 ENVIRONMENTAL RISK ASSESSMENT IN RELATION TO PROPOSED DEVELOPMENT

8.1 Contaminated Land

- 8.1.1 The definition of ‘contaminated land’, along with the relevant details on legislation and guidance is set out in Appendix 6.

8.2 Risk Assessment – Human Health

- 8.2.1 The proposed development may be sub-divided into commercial to the west and residential to the east.
- 8.2.2 An initial risk assessment has been carried out for both areas based on the more sensitive guideline values for residential end use.
- 8.2.3 The results of the soil chemical analyses have been processed in accordance with recommendations set out in the CIEH and CL:AIRE document ‘Guidance on Comparing Soil Contamination Data with a Critical Concentration’, ref. 10.27. The results have been compared in the first instance to screening levels produced in accordance with current and best practice legislation and guidance, as detailed in Appendix 6.
- 8.2.4 The guidance values used within this contamination assessment have been tabulated and are detailed within Appendix 6.
- 8.2.5 Where the concentrations determined on site are at or below the respective screening level, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated.
- 8.2.6 The results of chemical analyses have been processed in accordance with recommendations set out in the CIEH and CL:AIRE document ‘Guidance on Comparing Soil Contamination Data with a Critical Concentration’, ref 10.27.
- 8.2.7 Where the concentrations determined on site are at or below the respective Guidance Level, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated.
- 8.2.8 The results are all below the relevant guideline values for a residential end use.
- 8.2.9 As the results are below the more sensitive guideline values for a residential end use they are also below the less sensitive guideline values for a commercial end use.
- 8.2.10 As the results are below their respective guideline values further statistical analysis of the results has not been carried out.

- 8.2.11 The results of soil analysis indicate that there is only a very low risk to end users of the site from soil contamination.
- 8.2.12 Asbestos was noted in the laboratory in one soil sample (BH10 at 1.00m) as a small bundle of chrysotile.
- 8.2.13 Quantitative analysis of this sample indicated a total mass of asbestos below the detection limit of <0.001%.
- 8.2.14 There was no visual evidence of bulk asbestos contamination or evidence of ACM's during site work.
- 8.2.15 The extremely low fibre concentrations indicate that there would not be significant risks to end-users or construction workers from asbestos.

8.3 Risk Assessment - Controlled Waters

- 8.3.1 The site is located on a principal aquifer relating to the Wilmslow Sandstone Formation.
- 8.3.2 The site is not located within a groundwater source protection zone.
- 8.3.3 There are no groundwater abstractions within 500m of the site.
- 8.3.4 The nearest surface watercourse is the River Mersey, located approximately 200m to the south of the site.
- 8.3.5 The soils at shallow depth beneath the site are of high leaching potential. This designation of leaching potential relates to the Glaciofluvial Sheet Deposits (sand and gravel) encountered beneath the site to depths between 2.80 and 4.70m.
- 8.3.6 Firm and stiff clay (Glacial Till) was encountered beneath sand and gravel and proved to depths of 10m. These strata are typically of very low permeability and of low leaching potential.
- 8.3.7 The site development history and low concentrations of contaminants in the soil indicate that a significant source of contamination is not present at the site.
- 8.3.8 The ground conditions encountered at the site and the results of this contamination assessment indicate that the risks to ground water would be very low and it is considered unlikely that further assessment of the risks to controlled waters may be required.

8.4 Gas Generation

- 8.4.1 Gas monitoring visits have been undertaken on six occasions since completion of site works. The results of gas monitoring are included within Appendix 7.
- 8.4.2 Gas monitoring has determined the presence of methane at a concentration of up to 0.6%v/v and carbon dioxide up to 15%v/v with a maximum recorded flow rate of 4.23litres/hour.
- 8.4.3 On the basis of these readings, remedial measures may be required, see section 8.0.

8.5 Protection Of Services

- 8.5.1 Guidance from the UKWIR, ref 10.35, sets out the material requirements for newly laid water supply pipes within brownfield sites.
- 8.5.2 The results of contamination testing on soils indicate that there would not be any special requirements with respect to water supply pipes however the exact requirements should be clarified with the relevant local water utility supplier for the site.

8.6 Risk Evaluation

- 8.6.1 The conceptual model formed within the Phase 1 Desk Study has been updated to reflect the findings of the contamination risk assessment and the revised conceptual model, detailing the relevant pollutant linkages, is tabulated below:

Source	Potential Pathways	Receptor Group
Ground gas in soils	• Migration • Ingression	Humans and buildings • Gas ingress into building/s¹ • Site occupants¹
Locally elevated soluble sulphate in soils	• Direct contact of contaminants with building materials.	Building Materials and Services • Concrete
¹ – Assumes no remediation is undertaken		

8.7 Summary of Risk Evaluation

- 8.7.1 The above assessment identifies that the ‘source – pathway – receptor’ linkage potentially occurs with ground gas in soils impacting upon the identified receptors. Therefore, it would be necessary to manage the risk at this location by either eliminating one of the links or by minimising the potential effects.
- 8.7.2 Elevated concentrations of ground gas were noted on both the proposed commercial development area and the proposed residential development area.
- 8.7.3 The presence of high permeability strata at shallow depths and elevated ground gas concentrations across both areas indicate that risks from ground gas would apply across both the commercial and residential development areas.

9.0 MANAGEMENT OF CONTAMINATION

9.1 Remediation and Verification

- 9.1.1 The risk management framework set out in the Model Procedures for the Management of Land Contamination, CLR 11, ref. 10.36, is applicable to the redevelopment of sites that may be affected by contamination.
- 9.1.2 The risk management process set out in the Model Procedures has three main components:
 - Risk assessment
 - Options appraisal
 - Implementation
- 9.1.3 Monitoring has identified the presence of methane and carbon dioxide across the site. Relevant pollutant linkages have been identified, as demonstrated in the updated conceptual model.
- 9.1.4 The remediation strategy will need to review methods of reducing or controlling the identified unacceptable risks. Where gas risks are present this is done by installing gas protection measures to eliminate the pathway between source and receptor and therefore ensure there is no significant risk of significant harm to human health in relation to the proposed end use.
- 9.1.5 An important part of the risk management process is identifying and informing all stakeholders with an interest in the outcome of the risk management project. To this end, if the regulators have not yet been contacted with regard to the redevelopment of this site, it is recommended that they be supplied with a copy of both the Preliminary Risk Assessment (Desk Study) and this Ground Investigation Report in order to enable liaison to be undertaken with them.
- 9.1.6 Following liaison with the relevant regulatory bodies, a remediation strategy, in this case comprising ground gas protection measures, should be formulated,

which should incorporate an options appraisal and summarise in detail the chosen remedial approach, along with the verification proposals. The remediation strategy should then be approved by the relevant regulatory authorities prior to implementation.

- 9.1.7 Where remediation is required, a verification report will need to be formulated following implementation of the remediation strategy, which should provide a complete record of all remedial activities conducted on site and include all the data obtained to support the remedial objectives and demonstrate that the remediation has been effective. Any unexpected conditions encountered during the remedial works should also be detailed within the verification report.
- 9.1.8 The results of gas monitoring recorded the presence of methane at a concentration of up to 0.6%v/v and carbon dioxide up to 15%v/v with a maximum flow rate of 4.23litres/hour.
- 9.1.9 On the basis of the maximum measured concentrations of methane and the maximum flow rate of Gas Screening Value (GSV) of 0.03litres/hour may be derived for methane.
- 9.1.10 On the basis of the maximum measured concentrations of carbon dioxide and the maximum flow rate of Gas Screening Value (GSV) of 0.63litres/hour may be derived for carbon dioxide.
- 9.1.11 The above Gas Screening Values indicate that the site is Characteristic Situation 2; low risk as per Table A7.2 in Appendix 7.
- 9.1.12 For Situation A, being any development other than low rise residential with suspended floor slab and ventilated void, gas protective measures are given in Appendix 7, sections A7.7 and A7.10.
- 9.1.13 For residential development with suspended floor slab and ventilated void the NHBC Traffic Light risk classification system may be considered.
- 9.1.14 On the basis of the maximum levels of carbon dioxide, an initial screening puts the Traffic Light into Amber 2, Table A7.4. The Gas Screening Value determined from the gas monitoring was 0.63litres/hour, putting it into green. It is likely that the higher classification, based on maximum concentration, would be required. Recommended protective measures are given in Appendix 7, section A7.9.

9.2 Management of Unidentified Sources of Contamination

9.2.1 There is the possibility that other sources of contamination may be present on the site, which were not detected during the investigation. Should such contamination be identified or suspected during the site clearance or ground works, these should be dealt with accordingly. A number of options are available for handling this material, which include:

- The removal from site and disposal to a suitably licensed tip of all material suspected of being contaminated. The material would need to be classified prior to disposal.
- Short-term storage of the suspected material while undertaking verification testing for potential contamination. The storage area should be a contained area to ensure that contamination does not migrate and affect other areas of the site. Depending upon the amounts of material under consideration, this could be either a skip or a lined area.
- Having a suitably experienced environmental engineer either on-call or with a watching brief for the visual and olfactory assessment of the material, and sampling for verification purposes.

9.3 Consultation

9.3.1 During the development of a contaminated site, consultation may be required for a number of reasons with a number of regulatory Authorities. The following provides an indication as to the most likely Authorities with which consultation may be required.

- **Local Authority.** There may be a planning condition regarding contamination and consultation will be required with a designated Contaminated Land Officer within the Environmental Health Department. The Local Authority is generally concerned with human health risks. Some Authorities now require 'Completion Certificates' to be signed off following remediation works.
- **Environment Agency.** Where a site is within a groundwater protection zone or has been designated as a special site, the Environment Agency is likely to be involved to ensure that controlled waters are protected.
- **National House Building Council, NHBC.** Section 4.1 of the NHBC Standards requires land management to be addressed. For a new housing development to be approved by the NHBC, any remediation will require a validation report.

9.3.2 Based on the results of any consultation, there may be specific remediation requirements imposed by one or more of the Authorities.

9.4 Risk Management During Site Works

9.4.1 During ground works, some simple measures may have to be put in place to mitigate the risk of contamination affecting the site workers and the environs. The majority of the proposed measures represent good practice for the construction industry and include:

- Informing the site workers of the contamination on site and the potential health effects from exposure.
- Where appropriate, the provision of suitable Personal Protective Equipment (PPE) for workers who may be potentially impacted by working in areas of the contamination.
- Ensuring good hygiene is enforced on site and washing facilities are maintained on the site. Workers are discouraged from smoking, eating or drinking without washing their hands first.
- Dust monitoring, and if necessary, suppression measures should be put into practice where contamination is becoming airborne.

9.4.2 Where contaminated materials are being removed from the site they should be disposed of at a suitably licensed landfill, with a 'duty of care' system in place and maintained throughout the disposal operations.

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For and on behalf of Ian Farmer Associates (1998) Limited

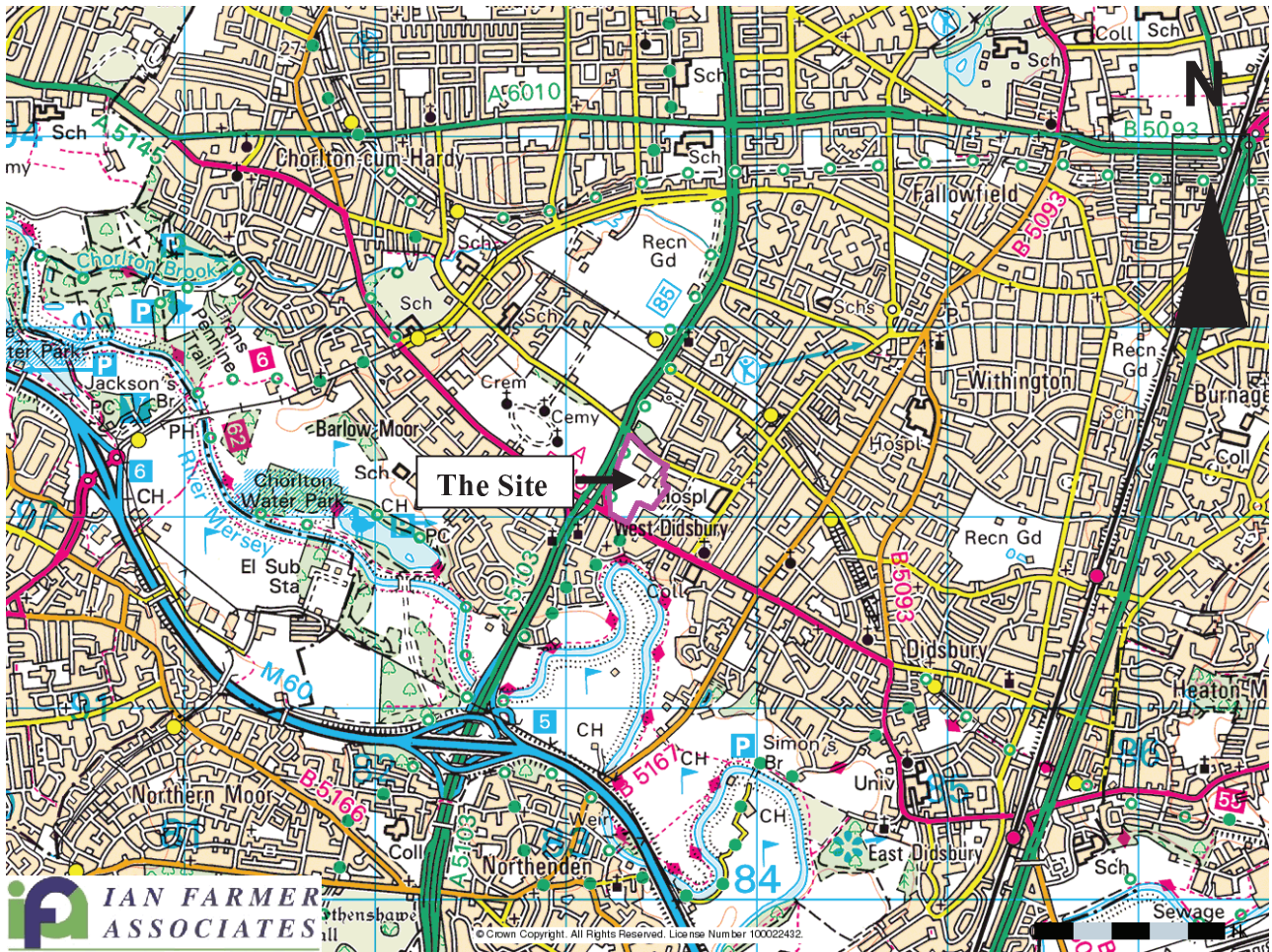
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APPENDIX 1
DRAWINGS



PROJECT: 41787 Siemens Development

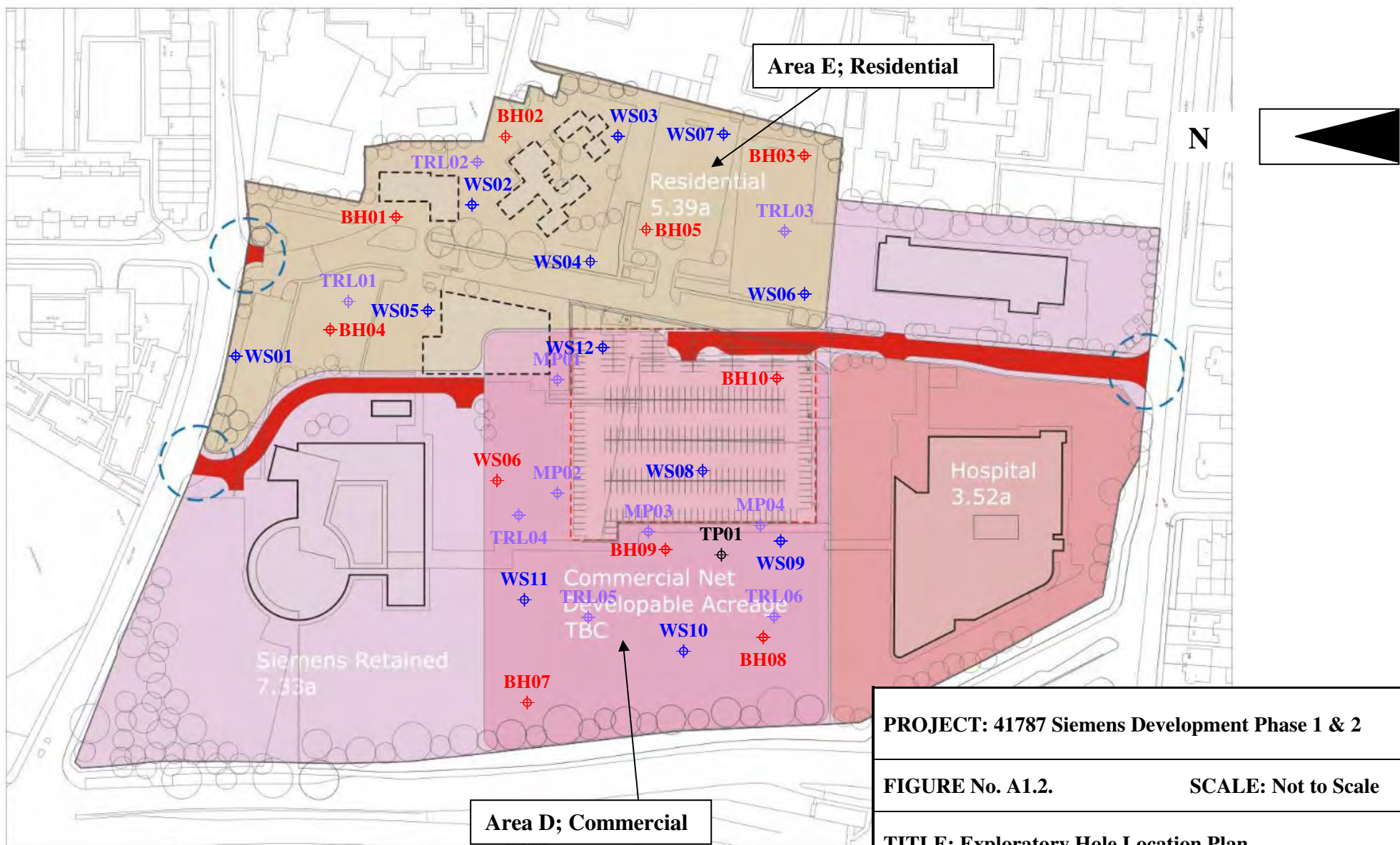
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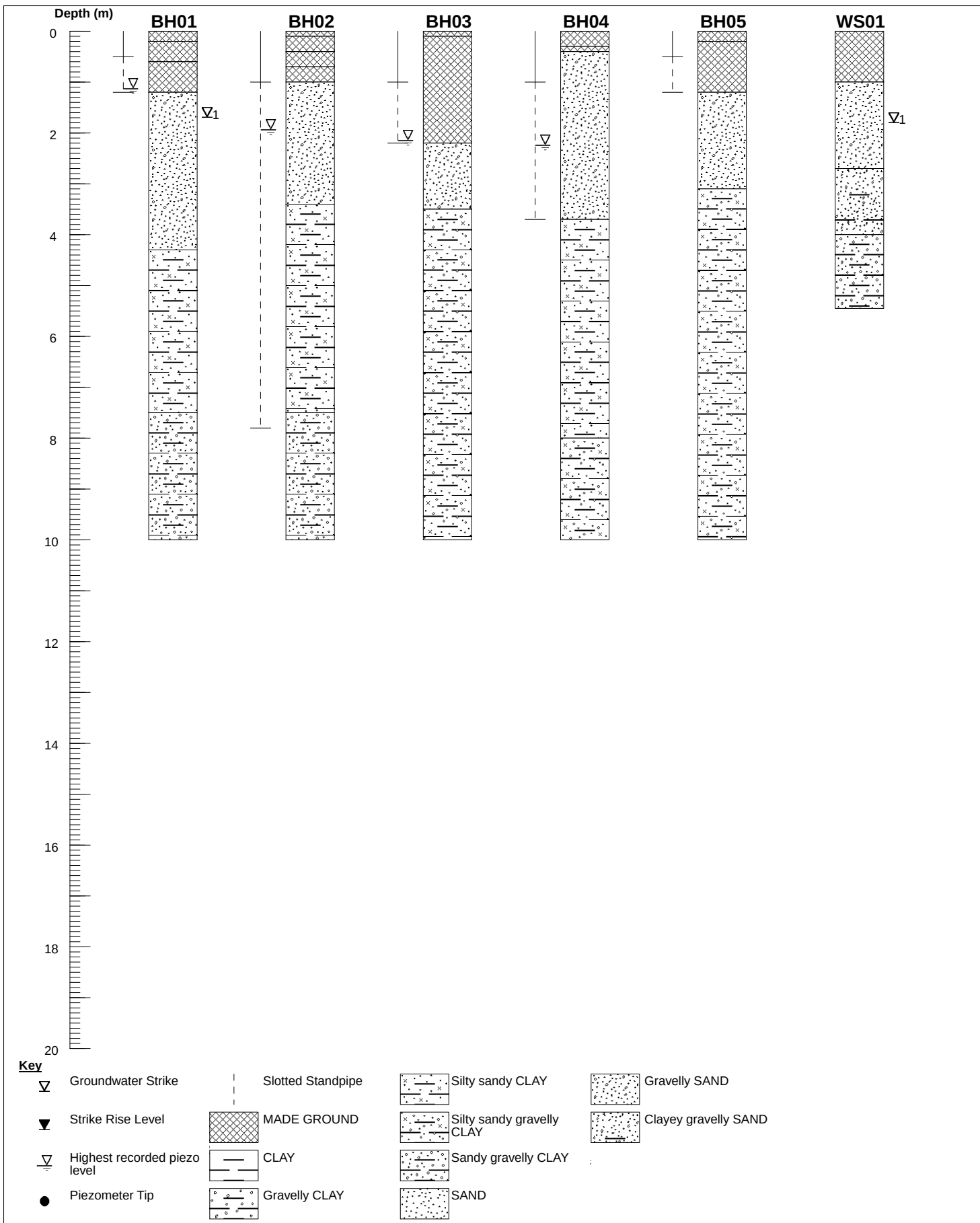
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TITLE: Site Location Plan

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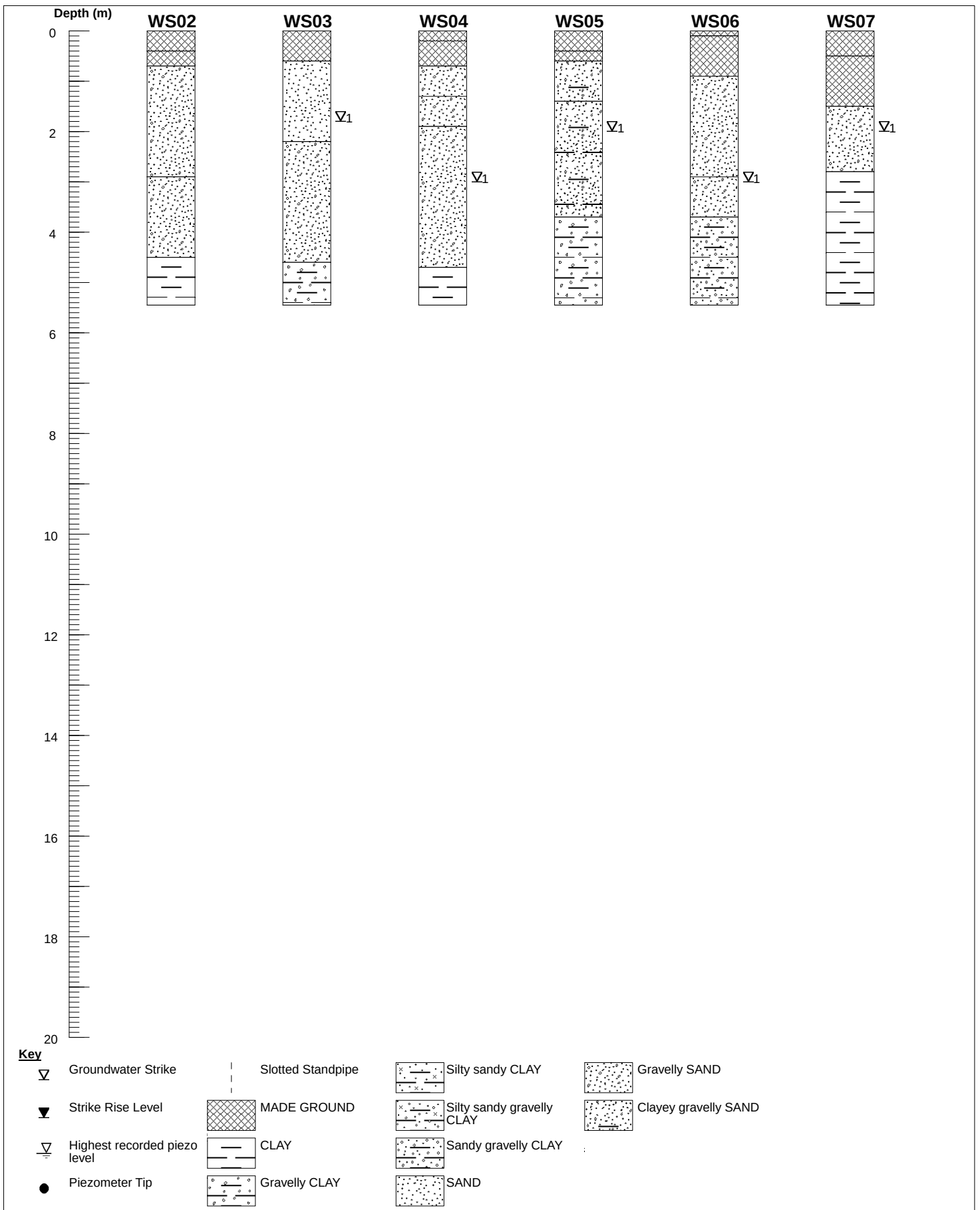
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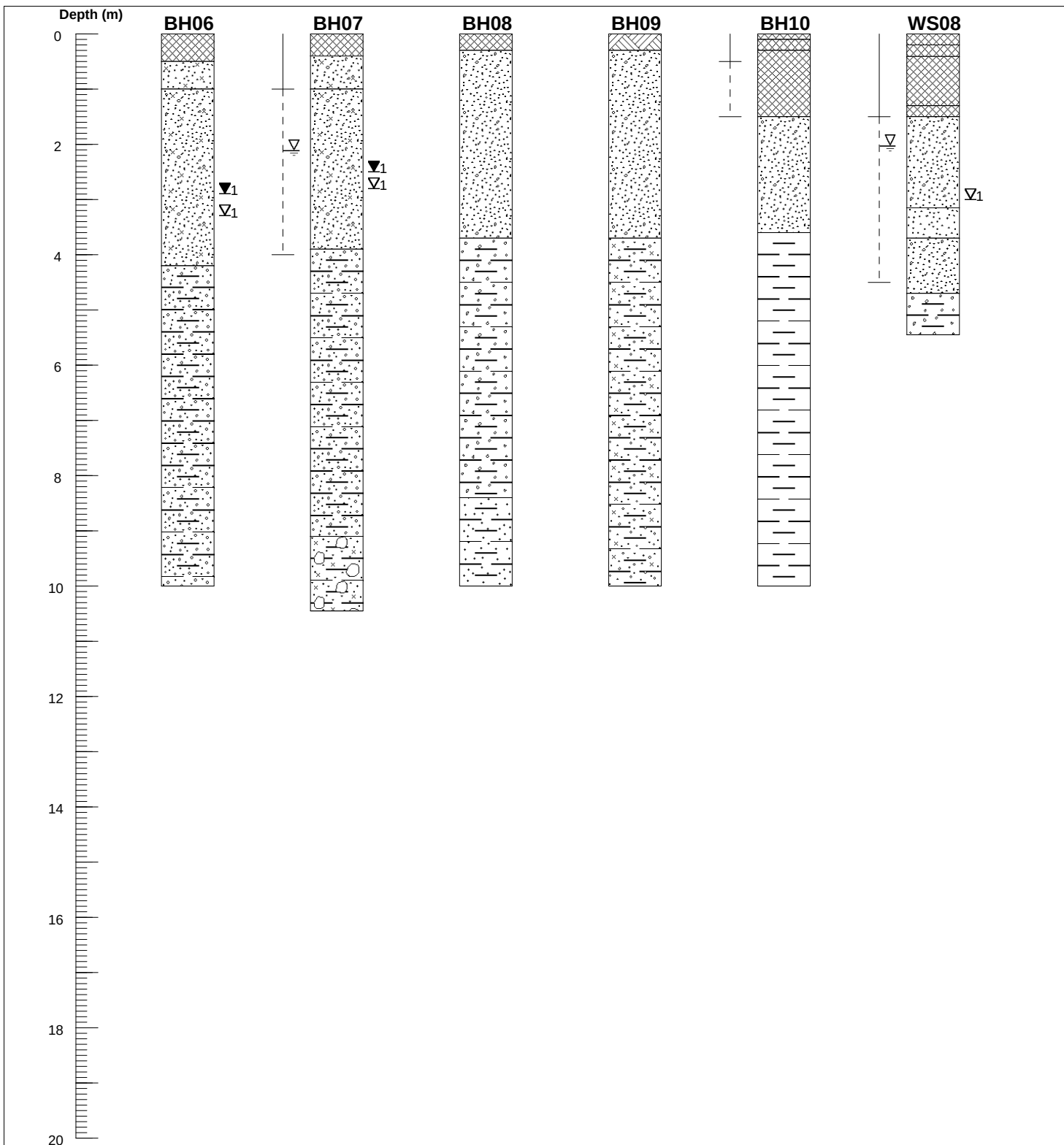


Nominal Section - Residential

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Client Booth King Partnership Ltd	Drawn By	Checked By	Scale 1:100[V]	Figure No. Figure A1.3a

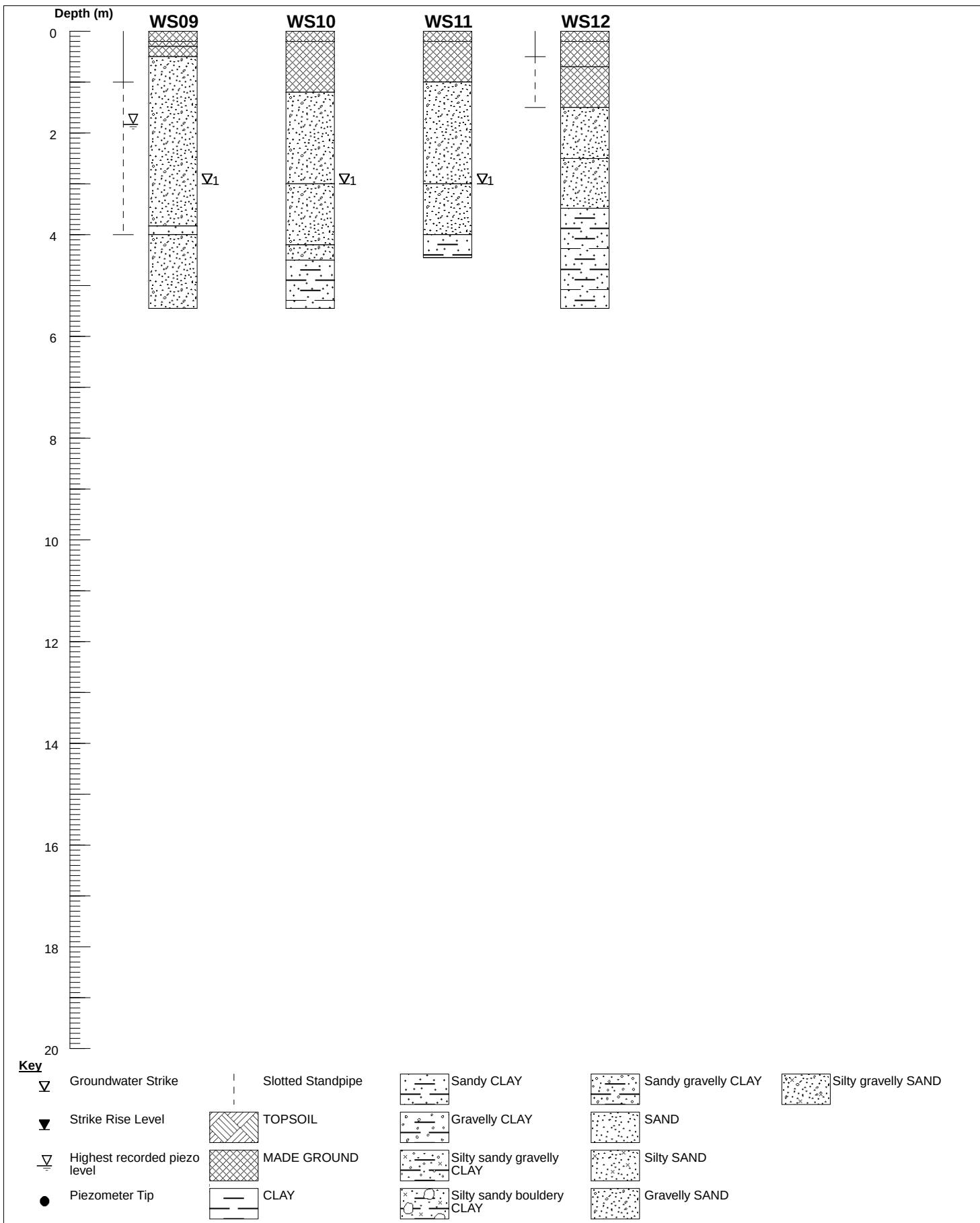


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Client Booth King Partnership Ltd		Drawn By	Checked By	Scale 1:100[V]	Figure No. Figure A1.3b



Key					
▽	Groundwater Strike	Slotted Standpipe			
▼	Strike Rise Level	TOPSOIL			
▽	Highest recorded piezo level	MADE GROUND			
●	Piezometer Tip	CLAY			
			Sandy CLAY	Sandy gravelly CLAY	Silty gravelly SAND
			Gravelly CLAY	SAND	
			Silty sandy gravelly CLAY	Silty SAND	
			Silty sandy bouldery CLAY	Gravelly SAND	

		Nominal Section - Commercial			
Site Siemens Development Phase 1 & 2		Date Drawn 06/01/2016	Date Checked	Sheet 1/2	Job Number 41787
Client Booth King Partnership Ltd		Drawn By	Checked By	Scale 1:100[V]	Figure No. Figure A1.3c

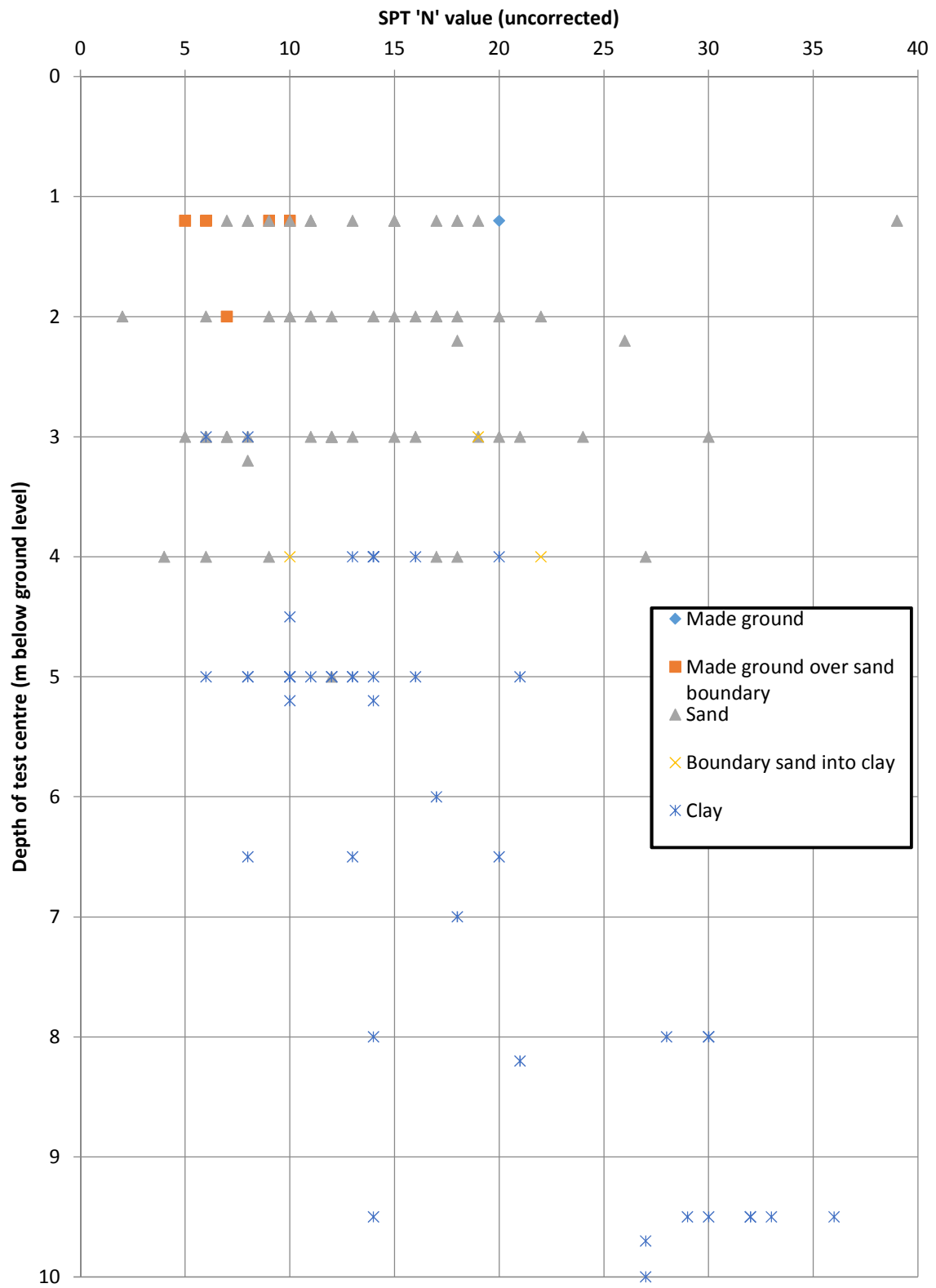


Nominal Section - Commercial

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Client Booth King Partnership Ltd	Drawn By	Checked By	Scale 1:100[V]	Figure No. Figure A1.3d

41787 Siemens development Phase 1 & 2

Figure A1.4; SPT 'N' value versus Depth



APPENDIX 2

SITE WORK

APPENDIX 2

GENERAL NOTES ON SITE WORKS

A2.1 SITE WORK

A2.1.1 General

Site work is carried out in general accordance with the guidelines given in ISO 1997, 10.4 and BS 5930, ref 10.3.

A2.1.2 Trial Pits

Shallow trial pits are generally dug by mechanical excavator, however, in difficult access locations or adjacent to structures, such pits may be hand dug. Pits are best used where the ground will stand unsupported and generally, the maximum depth of machine dug pits is 4m to 5m. Where personnel are required to enter pits, it is essential that side support is provided. Entry by personnel into unsupported pits deeper than 1.2m is not allowed for health and safety reasons.

Trial pits allow the in-situ condition of the ground to be examined both laterally and vertically and also allow discontinuities to be recorded. The field record should give the orientation of the pit with details of which face was logged, assessment of stability of sides of pit and groundwater as well as the strata encountered. Photographs of the pit should also be taken.

In-situ testing, such as hand penetrometer, hand vane, Macintosh probe, or similar, can be undertaken in the sides or base of pits while both disturbed and undisturbed samples recovered.

It is generally advisable to backfill the pits as soon as possible, open pits should not be left unattended.

A2.1.3 Light Cable Percussion Boring

For routine soil exploration to depths in excess of 3m, the light cable percussion rig is generally employed for boring through soils and weak rocks, refs 10.3, 10.4 and 10.5. It consists of a powered winch and tripod frame, with running wheels that are permanently attached so that the rig may be towed behind a suitable vehicle. The rig is towed into position and set up using its own winching system.

The locations of services are checked to make sure the borehole is not situated unacceptably near any services. Regardless of the proximity of services, a CAT scan is undertaken at the borehole location and a trial hole dug to 1.20m by hand.

Boreholes are advanced in soil by the percussive action of the cable tool. The force of the cylindrical tool as it is dropped a short distance cuts a plug of cohesive soil that is removed by the tool.

In non-cohesive soils, the borehole is advanced by a 'shell', otherwise known as a 'bailer' or 'sand pump', which incorporates a clack valve. Material is transferred into the shell and retained by the clack valve. The water level in a borehole is maintained above that in the surrounding granular soil to allow for temporary reductions in the head of water as the shell is withdrawn from the borehole. Water should flow from the borehole into the surrounding soil at all times to prevent 'piping' and loosening the soil at the base of the hole. The casing is always advanced with the borehole in granular soil so that material is drawn from the base rather than the borehole sides.

Obstructions to boring are overcome by fitting a serrated chiselling ring to the base of the percussion tool. For large obstructions, a heavy chisel with a hardened cutting edge may have to be used.

Disturbed samples are taken in polythene bags, jars or tubs that are sealed against air or water loss.

Undisturbed samples are generally taken in cohesive materials at changes in strata and at one metre intervals to 5 metres then at 1.5 metre intervals to the full depths of the borehole. The general purpose open-tube sampler is suitable for firm to stiff clays, but is often used to retrieve disturbed samples of weak rocks, soft or hard clay and also clayey sand or silts. This has been adopted for

routine use, and usually consists of a 100mm internal diameter tube (U100), which is capable of taking soil samples up to 450mm in length. The undisturbed samples are sealed at each end using micro-crystalline wax to prevent drying.

Standard penetration tests are generally carried out in non-cohesive soils but also in stiff clays and soft rocks at frequencies similar to that of undisturbed sampling.

A2.1.4 Drive-in Window Sampler

The drive-in window sampler, ref 10.6, consists generally of a track mounted window sampler and a series of cylindrical sample tubes, generally varying in diameter from 98mm to 35mm. A cutting shoe is fitted to the bottom of each tube, while a window, representing about a quarter of the circumference, is cut along the length of the tube. Soil samples are extracted through the window of the tube.

The borehole is extended by using progressively smaller diameter tubes.

Alternatively, undisturbed samples may be collected in plastic liners, known as *windowless sampling*.

A2.2 IN-SITU TESTS

A2.2.1 Standard Penetration Test

The Standard Penetration Test is carried out in accordance with the proposals recommended by ISO 1997, ref 10.4, BS 1377, Part 9, 1990 ref 10.8 and ISO 22476 ref 10.5.

The standard penetration test, **SPT**, covers the determination of the resistance of soils to the penetration of a split barrel sampler. A 50mm diameter split barrel sampler is driven 450mm into the soil using a 63.5kg hammer with a 760mm drop. The penetration resistance is expressed as the number of blows required to obtain 300mm penetration below an initial seating drive of 150mm through any disturbed ground at the bottom of the borehole. The number of blows to achieve the standard penetration of 300mm is reported as the 'N' value.

The test is generally carried out in fine soils, however, it may also be carried out in coarse granular soils, weak rocks and glacial tills using the same procedure as for the SPT but with a 50mm diameter, 60° apex solid cone replacing the split spoon sampler, **CPT**.

When attempting the standard penetration test in very dense material or weathered rocks it may be necessary to terminate the test before completion to prevent damage to the equipment. In these circumstances it is important to distinguish how the blow count relates to the penetration of the sampler. This may be achieved in the following manner:

- Where the seating drive has been completed, the test drive is terminated if 50 blows are reached before the full penetration of 300mm is achieved. The penetration for 50 blows is recorded and an approximate N value obtained by linear extrapolation of the number of blows for the partial test drive.
- If the seating drive of 150mm is not achieved within the first 25 blows, the penetration after 25 blows is recorded and the test drive then commenced.
- For tests in soft rocks, the test drive should be terminated after 100 blows where the penetration of 300mm has not been achieved.

The N-value obtained from the Standard Penetration Test may be used to assess the relative density of sands and gravels as follows:

Term	SPT N-Value : Blows/300mm Penetration
Very Loose	0 - 4
Loose	4 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Over 50

A2.2.2 California Bearing Ratio, CBR

The California Bearing Ratio test is used to evaluate the strength of subgrade by measuring the load required to cause a plunger of standard size (50mm diameter) into the ground at a standard rate (1.00mm/min) and comparing the result with a standard material, ref 10.8.

The test is arbitrary in that the results cannot be accurately related to any of the fundamental properties governing soil strength. However, in that the deformation is predominantly shear, the CBR can be regarded as an indirect measurement of shear strength and modulus of subgrade reaction.

Alternative methods of determining the equivalent CBR by cone penetrometer can be undertaken. The Mexicone consists of a 30° cone of 129mm² cross-section that is pushed into the ground at a steady rate. The load is determined through a compression spring that deflects under load and is calibrated to give a direct reading of CBR on a dial. The instrument is best suited in cohesive or fine granular soil, but in gravelly soil it should not be used.

A2.2.3 Mackintosh Probe

The mackintosh probe is a lightweight dynamic cone penetrometer consisting of a 12.7mm diameter rod with a 27.94mm diameter, 30° cone of tempered steel at one end. The impact is provided by means of a 4.5kg dead weight with a standard drop height of 300mm. The total weight of the instrument is about 12kg.

The results are recorded as the number of blows of the hammer to drive the cone 100mm, M_{100} .

An approximate correlation between the results of the Standard Penetration Test (N) and the Mackintosh value (M) for soft clays has been derived by Sabtan and Shehata, this including data presented by Chan and Chin (1972) ref **Error! Reference source not found.**, as follows:-

$$\text{'N' value} = 0.15(M_{100})^{0.96}$$

A2.3 SAMPLES

U	represents undisturbed 100mm diameter sample, the number of blows to obtain the sample also recorded.
U fail	indicates undisturbed sample not recovered
HV	represents Hand Vane test with equivalent undrained shear strength in kN/m ² .
PP	represents Pocket Penetrometer test with equivalent undrained shear strength in kN/m ² .
CBR	represents California Bearing Ratio test
B	represents large bulk disturbed samples
D	represents small disturbed sample
A	represents amber jar contamination sample
V	represents vial contamination sample
W	represents water sample
<u>▽</u>	represents water strike
<u>▼</u>	represents level to which water rose

A2.4 DESCRIPTION OF SOILS

A2.4.1 General

The procedures and principles given in ISO 14688 Parts 1 and 2, ref 10.7, supplemented by section 6 of BS 5930, ref. 10.3 have been used in the soil descriptions contained within this report.

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

ARCHWAY ENGINEERING (UK) LTD
AINLEYS INDUSTRIAL ESTATE
ELLAND
WEST YORKSHIRE
HX5 9JP

SPT Hammer Ref: GH01
Test Date: 23/01/2015
Report Date: 1/23/2015
File Name: GH01.spt
Test Operator: SH

Instrumented Rod Data

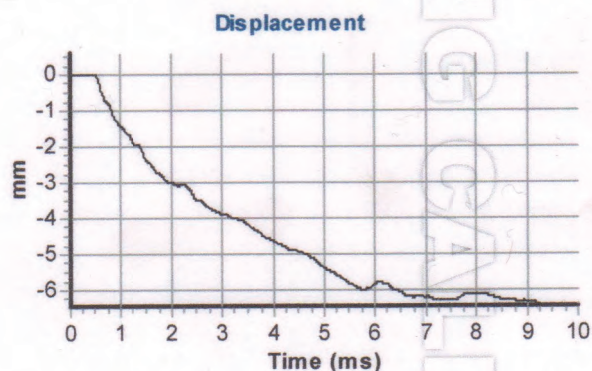
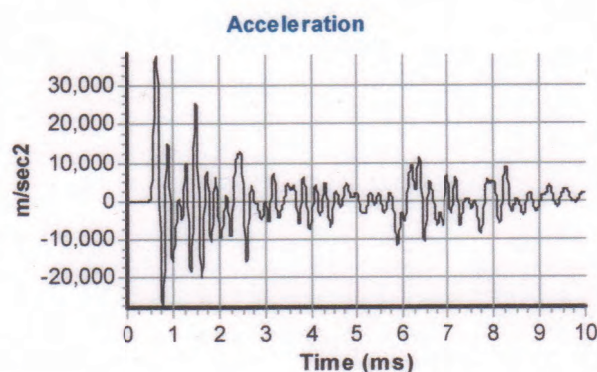
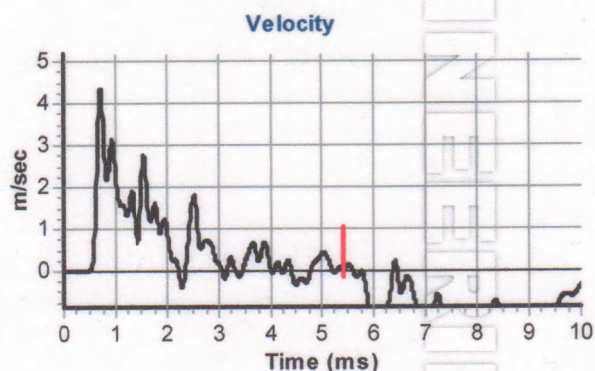
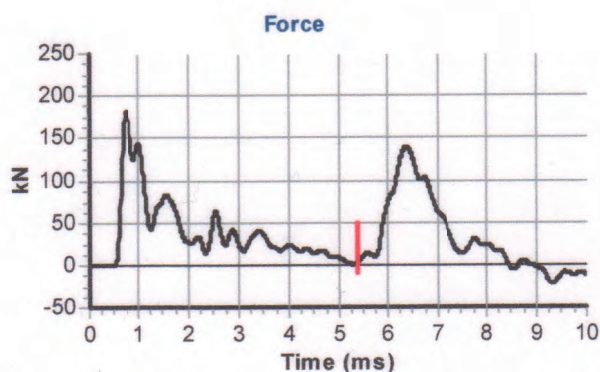
Diameter d_r (mm): 54
Wall Thickness t_r (mm): 6.1
Assumed Modulus E_a (GPa): 200
Accelerometer No.1: 7079
Accelerometer No.2: 7080

SPT Hammer Information

Hammer Mass m (kg): 63.5
Falling Height h (mm): 760
SPT String Length L (m): 13.0

Comments / Location

CALIBRATION



Calculations

Area of Rod A (mm^2): 918
Theoretical Energy E_{theor} (J): 473
Measured Energy E_{meas} (J): 343

Energy Ratio E_r (%):

72

Signed: S. HOWARTH
Title: FITTER

The recommended calibration interval is 12 months

SPT Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

ARCHWAY ENGINEERING (UK) LTD
AINLEYS INDUSTRIAL ESTATE
ELLAND
WEST YORKSHIRE
HX5 9JP

SPT Hammer Ref: DB1
Test Date: 05/12/2014
Report Date: 12/5/2014
File Name: DB1.spt
Test Operator: MG

Instrumented Rod Data

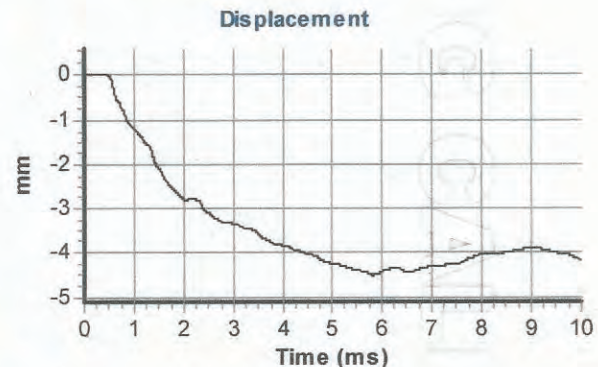
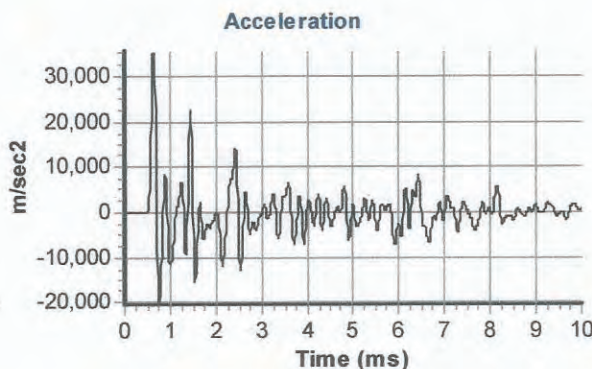
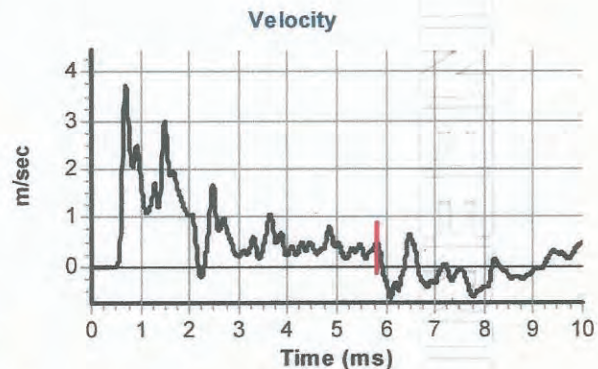
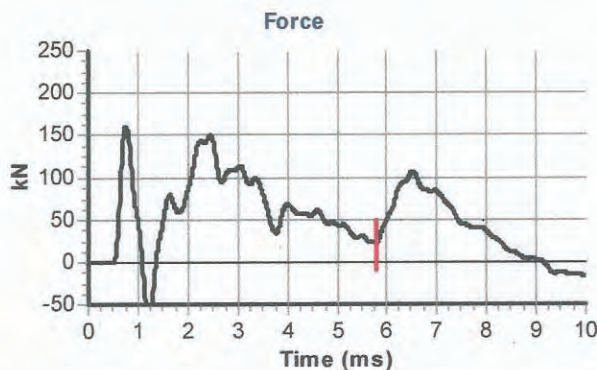
Diameter d_r (mm): 54
Wall Thickness t_r (mm): 6.1
Assumed Modulus E_a (GPa): 200
Accelerometer No.1: 7079
Accelerometer No.2: 7080

SPT Hammer Information

Hammer Mass m (kg): 63.5
Falling Height h (mm): 760
SPT String Length L (m): 13.0

Comments / Location

CALIBRATION



Calculations

Area of Rod A (mm²): 918
Theoretical Energy E_{theor} (J): 473
Measured Energy E_{meas} (J): 355

Energy Ratio E_r (%): **75**

Signed: M.GARDNER

Title: FITTER

The recommended calibration interval is 12 months



Hammer Energy Test Report

in accordance with BSEN ISO 22476-3:2005

Dynamic sampling uk ltd
6-8 victory parkway
victory road
Derby
DE24 8ZF

Hammer Ref: 110.44SM
Test Date: 18/04/2015
Report Date:
File Name: 110.44SM.spt
Test Operator: TP

Instrumented Rod Data

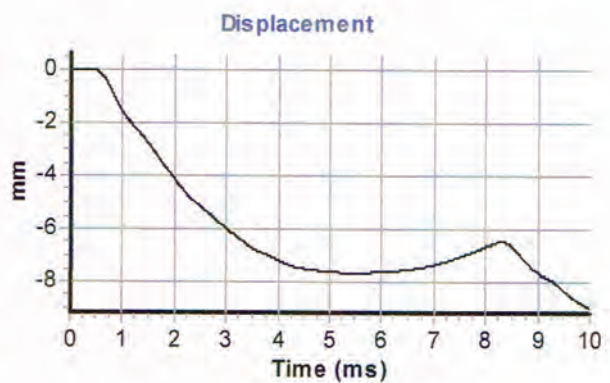
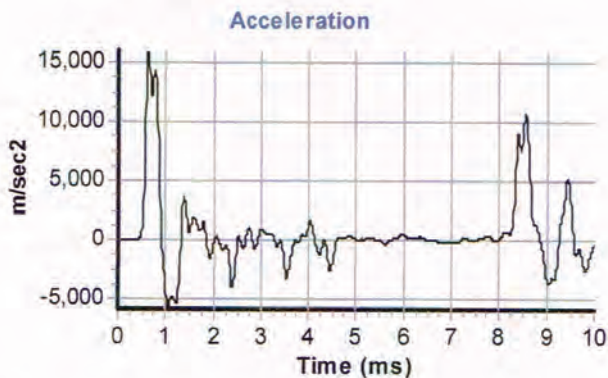
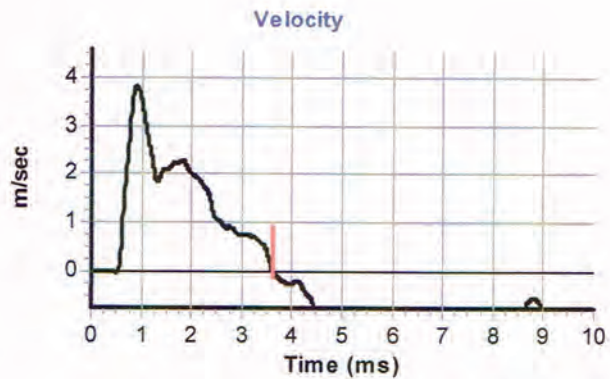
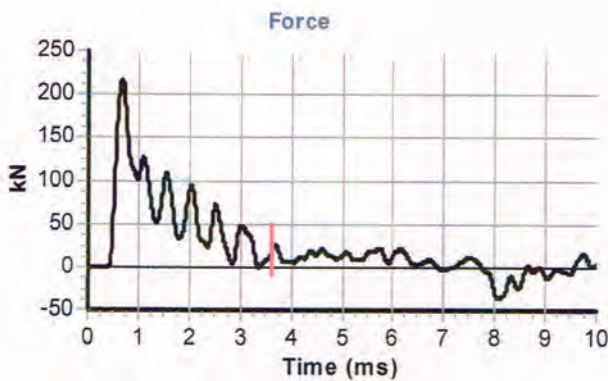
Diameter d_r (mm): 54
Wall Thickness t_r (mm): 6.9
Assumed Modulus E_a (GPa): 208
Accelerometer No.1: 6455
Accelerometer No.2: 6457

Hammer Information

Hammer Mass m (kg): 63.5
Falling Height h (mm): 760
String Length L (m): 15.0

Comments / Location

Hammer tested at Dynamic samplings yard.



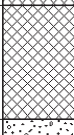
Calculations

Area of Rod A (mm^2): 1021
Theoretical Energy E_{theor} (J): 473
Measured Energy E_{meas} (J): 396

Energy Ratio E_r (%): **84**

Signed: A.parker
Title: Manager

The recommended calibration interval is 12 months

 IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH01																						
Boring Method Cable Percussion		Casing Diameter 150mm cased to 4.70m			Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787																						
		Location			Dates 09/11/2015-10/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/2																						
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr																					
0.20-0.50	B1		DRY	2,2/3,4,5,5		(0.20)	MADE GROUND: Concrete and rebar.																								
0.40	E2					(0.40)	MADE GROUND: Dark brown, gravelly, very clayey, fine and coarse SAND. Gravel is angular to subrounded, fine to coarse including sandstone, mudstone, brick and clinker. Between 0.50m and 0.60m: slightly clayey.																								
0.50	D3					0.60																									
0.60-1.20	B4																														
1.00	E5					(0.60)	MADE GROUND: Black, slightly clayey, very sandy, subangular to subrounded, fine to coarse GRAVEL with low to medium cobble content. Gravel includes sandstone, limestone and clinker. Cobble are subangular to angular including limestone.																								
1.20-1.65	SPT N=17					1.20	Medium dense, light grey brown, slightly gravelly, fine to coarse SAND. Gravel is subrounded to subangular																								
1.20-1.65	D6																														
1.20-1.70	B7																														
2.00-2.45	SPT N=22					1.70	1.50						2,2/5,5,5,7																		
2.00	E10																														
2.00-2.45	D8																														
2.00-2.50	B9																														
2.70	D11				(3.10)																										
3.00-3.45	SPT N=24								3.00	2.50			2,3/5,5,7,7																		
3.00-3.45	D12																														
3.00-3.50	B13																														
4.00-4.45	SPT N=22								4.00	3.00	2,2/4,4,6,8																				
4.00-4.30	B15																			4.30	Stiff, brown/grey, slightly sandy, silty, laminated CLAY with occasional silt dusting on laminae surfaces.										
4.00-4.45	D14																														
4.30-5.00	B16																														
5.00-5.45	U17 (P/0.40)													4.50	DRY	40 blows															
5.50	D18																										(3.20)				
6.00	D19																														
6.50-6.95	D20	09/11/2015:DRY																													
6.50-7.00	B21																														
6.50-6.95	SPT N=8				4.50	DRY	10/11/2015:WET 1,2/2,2,2,2																								
7.50	D22				7.50	Stiff brown/grey, slightly gravelly, very sandy CLAY. Gravel is subrounded to angular, fine to coarse including sandstone and mudstone.																									
Remarks Water added from 1.70m to 4.30m. Excavating from 0.00m to 1.20m for 1.00 hour.									Scale (approx) 1:40	Logged By PMcH																					
Figure No. 41787.BH01																															



**IAN FARMER
ASSOCIATES**

Site

Siemens Development Phase 1 & 2

**Borehole
Number**

BH01

Boring Method

Cable Percussion

Casing Diameter

150mm cased to 4.70m

Ground Level (mOD)

Client

Booth King Partnership Ltd

**Job
Number**

41787

Location

Dates

09/11/2015-
10/11/2015

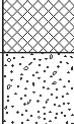
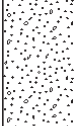
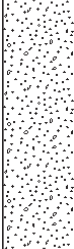
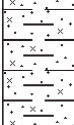
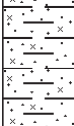
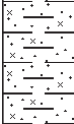
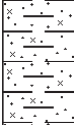
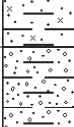
Engineer

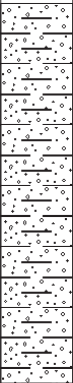
Booth King Partnership Ltd

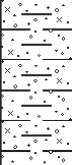
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2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
8.20-8.65	U23 (P/0.45)	4.70	DRY	45 blows						
8.70	D24					(2.65)				
9.00	D25									
9.70-10.15 9.70-10.00 9.70-10.15	SPT N=27 B27 D26	4.70	DRY	4,5/5,6,8,8 10/11/2015:DRY		10.15	Complete at 10.15m			
Remarks								Scale (approx) 1:40	Logged By PMcH	Figure No. 41787.BH01

 IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH02		
Boring Method Cable Percussion		Casing Diameter 1.50mm cased to 4.70m			Ground Level (mOD)		Client Booth King Partnership Ltd			Job Number 41787	
		Location			Dates 10/11/2015		Engineer Booth King Partnership Ltd			Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr	
0.10-0.40 0.20	B1 E2					(0.10) 0.10 (0.30) 0.40	MADE GROUND: Tarmacadam.				
0.70 0.80	E3 E4					(0.30) 0.70 (0.30) 1.00	MADE GROUND: Light grey/brown, slightly clayey, sandy, angular to subangular, fine to coarse GRAVEL with low to medium cobble content. Gravel includes sandstone and limestone. Cobbles are subangular to angular including sandstone and limestone.				
1.20-1.65 1.20-1.65 1.20-1.70	SPT N=15 D6 B5		DRY	2,3/3,4,3,5			MADE GROUND: brick cobbles.				
2.00-2.45 2.00 2.00-2.30 2.00-2.45 2.40	SPT N=20 E9 D8 D7 D10	1.70	DRY	2,3/2,5,6,7		(2.40)	MADE GROUND: Brown, slightly clayey, very gravelly, fine to coarse SAND with medium to high cobble content. Gravel is angular to subrounded, fine to coarse including sandstone, limestone, brick and concrete. Cobbles are subangular to angular including brick and concrete.				
3.00-3.45 3.00-3.45 3.00-3.50	SPT N=19 D12 B11	3.00	2.50	2,2/2,5,6,6		3.40	Medium dense, light brown/grey, slightly gravelly, fine to coarse SAND. Gravel is subangular, coarse including sandstone, mudstone and limestone.				
3.40-4.00	B13						Firm brown/grey, slightly sandy, silty, laminated CLAY.				
4.00-4.45	U14 (P/0.36)	4.00	WET	32 blows							
4.50	D15										
4.80	D16										
5.00-5.45 5.00-5.45 5.00-5.50	SPT N=11 D18 B17	4.70	WET	1,2/3,2,3,3		(4.10)					
6.00	D19										
6.50-6.95	U20 (P/0.32)	4.70	WET	34 blows							
7.00	D21										
7.50	D22					7.50	Stiff, brown/grey, slightly gravelly, very sandy CLAY. Gravel is angular to subrounded, fine to coarse including sandstone and mudstone.				
8.00-8.45	SPT N=28	4.70	WET	3,3/6,7,7,8							
Remarks Water added from 2.00m to 3.40m. Excavating from 0.00m to 1.20m for 1.50 hours.								Scale (approx)	Logged By		
								1:40	PMcH		
								Figure No. 41787.BH02			

 IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH02	
Boring Method Cable Percussion		Casing Diameter 1.50mm cased to 4.70m		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787		
		Location				Dates 10/11/2015		Engineer Booth King Partnership Ltd		Sheet 2/2
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
8.00-8.45	D23	4.70	WET	120 blows 10/11/2015:WET						
9.00	D24									
9.50-9.95 9.50-10.00	U (P/0.0) B25									
10.00	D26									
							Complete at 10.00m			
Remarks								Scale (approx)	Logged By	
								1:40	PMcH	
								Figure No. 41787.BH02		

							Site Siemens Development Phase 1 & 2		Borehole Number BH03	
Boring Method Cable Percussion		Casing Diameter 150mm cased to 4.50m			Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787	
		Location			Dates 12/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.50	B1					(0.10)	MADE GROUND: Tarmacadam.			
0.50 0.50-1.20	E3 B2						MADE GROUND: Medium dense, dark brown/grey, slightly clayey, sandy, angular to subrounded, fine to coarse GRAVEL with medium cobble content including sandstone, brick, concrete and limestone, plastic fragments, tile/ceramic, glass and wood fragments. Cobbels are subangular to angular including brick and concrete.			
1.00	E4					(2.10)				
1.20-1.65 1.20-1.65 1.20-1.70	SPT(C) N=20 D6 B5		DRY	1,2/3,5,5,7						
2.00-2.45 2.00 2.00-2.45 2.00-2.50	SPT(C) N=7 E9 D8 B7	1.70	DRY	1,2/2,1,2,2		2.20				
2.70	D10					(1.30)	Medium dense, light brown/grey, slightly gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and limestone.			
3.00-3.45 3.00 3.00-3.45 3.00-3.50	SPT N=16 E13 D12 B11	3.00	2.50	1,2/2,3,5,6		3.50	Stiff, brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is subangular to subrounded, fine and medium including sandstone, mudstone and coal. Between 3.50m and 5.50m: closely fissured.			
4.20-4.65	U14 (P/0.32)	4.20	DRY	30 blows						
4.70	D15									
5.00-5.45 5.00-5.45 5.00-5.50	SPT N=12 D17 B16	4.50	DRY	2,1/2,3,3,4						
6.00	D18						At 6.50m: firm.			
6.50-6.95 6.50-7.00	U20 (P/0.0) B19	4.50	DRY	41 blows		(6.50)				
7.00-7.45 7.00-7.45 7.00-7.50	SPT N=18 D22 B21	4.50	DRY	2,2/3,4,5,6						
Remarks Water added from 2.20m to 3.50m. Excavating from 0.00m to 1.20m for 1.00 hour.								Scale (approx)	Logged By	
								1:40	P McH	
								Figure No. 41787.BH03		



Siemens Development Phase 1 & 2

**Borehole
Number
BH03**

Boring Method
Cable Percussion

Casing Diameter	150mm cased to 4.50m
------------------------	----------------------

Ground Level (mOD)

Client	Booth King Partnership Ltd
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**Job
Number**
41787

Location

Dates	12/11/2015
--------------	------------

Engineer
Booth King Partnership Ltd

Sheet
2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
8.00-8.45	U23 (P/0.23)	4.50	DRY	50 blows						
8.50	D24									
9.00	D25									
9.50-9.95 9.50-9.95 9.50-10.00	SPT N=32 D27 B26	4.50	DRY	2,5/6,7,9,10		10.00	Complete at 10.00m			

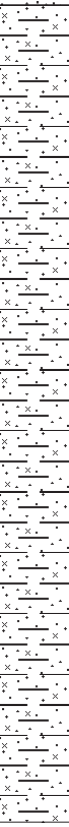
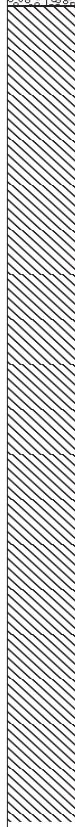
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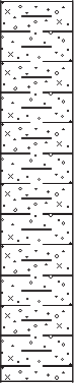
Scale (approx)
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Logged
By

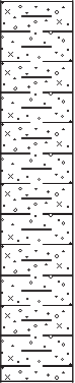
P MCH

Figure No.
41787.BH03

IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH04		
Boring Method Cable Percussion		Casing Diameter 150mm cased to 4.70m			Ground Level (mOD)		Client Booth King Partnership Ltd			Job Number 41787	
		Location			Dates 13/11/2015		Engineer Booth King Partnership Ltd			Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr	
0.20 0.30 0.40-1.20 0.50	D1 D2 B3 E4					(0.30) (0.30) (0.40)	MADE GROUND: Grass over dark brown, clayey, sandy Topsoil. MADE GROUND: Light brown/grey, sandy, clayey GRAVEL. Gravel is subangular to angular, fine to coarse including limestone chippings. Medium dense, light brown/grey, very gravelly, fine to coarse, silty SAND. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and limestone.	 			
1.00 1.20-1.65 1.20-1.65 1.20-1.70	E5 SPT N=10 D7 B6		DRY	2,2/2,2,3,3							
2.00-2.45 2.00 2.00-2.45 2.00-2.50	SPT N=14 E10 D9 B8	1.70	DRY	2,2/3,3,4,4		(3.30)					
2.70	D11										
3.00-3.45 3.00-3.45 3.00-3.50	SPT N=21 D12 D13	3.00	2.50	2,3/4,5,5,7							
3.80	D14					3.70	Firm, closely fissured, brown/grey, slightly sandy, silty CLAY.				
4.20-4.65	U15 (P/0.14)	4.20	DRY	34 blows							
4.70 4.90	D16 D17										
5.20-5.65 5.20-5.65 5.20-5.70	SPT N=14 D19 B18	4.70	DRY	2,2/3,3,4,4							
6.00	D20					(4.30)					
6.50-6.95	U21 (P/0.27)	4.70	DRY	40 blows			Below 6.50m: stiff.				
7.00	D22										
7.50	D23										
8.00-8.45	SPT N=30	4.70	DRY	4,5/7,7,8,8							
Remarks Water added from 2.00m to 3.70m. Excavating from 0.00m to 1.20m for 1.00 hour.								Scale (approx) 1:40	Logged By P.McH		
								Figure No. 41787.BH04			

 IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH04	
Boring Method Cable Percussion		Casing Diameter 150mm cased to 4.70m		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787		
		Location				Dates 13/11/2015		Engineer Booth King Partnership Ltd		Sheet 2/2
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
8.00-8.45 8.00-8.50	D25 B24					8.00	Stiff, brown/grey, slightly gravelly, very sandy, silty CLAY. Gravel is subangular to subrounded, including sandstone, mudstone and coal.			
9.00	D26					(2.00)				
9.50-9.95 9.50-9.95	SPT N=33 D27	4.70	DRY	4,6/7,8,8,10		10.00				
							Complete at 10.00m			
Remarks								Scale (approx) 1:40	Logged By P.McH	
								Figure No. 41787.BH04		

IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH05	
Boring Method Cable Percussion		Casing Diameter 150mm cased to 3.20m			Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787	
		Location			Dates 13/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.20 0.20-0.60	D2 B1		DRY	1,0/1,2,2,2		(0.20) 0.20	MADE GROUND: Grey, slightly sandy, angular to subangular, coarse GRAVEL including limestone chippings.			
0.60-1.20	B3					(1.00)	MADE GROUND: Dark brown slightly clayey, gravelly, fine to coarse grained SAND with medium cobble content. Gravel is subrounded to angular, fine to coarse including sandstone, brick, concrete and limestone chippings. Cobble are subangular to angular including brick ad ballast.			
1.00	E4					1.20	Loose, light brown/grey, very gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and limestone.			
1.20-1.65 1.20-1.65 1.20-1.70	SPT N=7 D6 B5									
2.00	E7	1.70	DRY	1,2/2,4,6,6		(1.90)	Below 2.20m: medium dense.			
2.20-2.65 2.20-2.65 2.20-2.70	SPT N=18 D9 B8									
2.80	D10	3.00	2.50	1,2/2,2,2,2		3.10	Firm, brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is subangular to subrounded, fine and medium including sandstone, mudstone and coal.			
3.00-3.45 3.00-3.45 3.10-3.30	SPT N=8 D11 B12									
4.20-4.65	U13 (P/0.45)					3.20	WET			
4.70	D14	3.20	DRY	1,2/2,2,3,3						
4.90	D15									
5.20-5.65 5.20-5.65 5.20-5.70	SPT N=10 D17 B16									
6.00	D18	3.20	DRY	40 blows		(6.90)	Below 6.50m: stiff to very stiff, very sandy.			
6.50-6.95	U19 (P/0.23)									
7.00	D20									
8.00-8.45	SPT N=30	3.20	DRY	4,4/5,6,9,10						
Remarks Water added from 2.00m to 3.10m. Excavating from 0.00m to 1.20m for 1.00 hour.								Scale (approx) 1:40	Logged By PMcH	
								Figure No. 41787.BH05		

 IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH05	
Boring Method Cable Percussion		Casing Diameter 150mm cased to 3.20m		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787		
		Location				Dates 13/11/2015		Engineer Booth King Partnership Ltd		Sheet 2/2
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
8.00-8.45 8.00-8.50	D22 B21									
9.00	D23									
9.50-9.95 9.50-9.95 9.50-10.00	SPT N=36 D25 B24	3.20	DRY	4,5/7,8,10,11 11/11/2015:DRY		10.00	Complete at 10.00m			
Remarks								Scale (approx) 1:40	Logged By PMcH	
								Figure No. 41787.BH05		

 IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH06	
Boring Method Cable Percussion		Casing Diameter 150mm cased to 7.70m			Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787	
		Location			Dates 13/11/2015-16/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
0.50 0.50 0.50-1.00	D2 E3 B1	1.20	DRY	2,3/3,4,4,4		(0.50)	MADE GROUND: Topsoil (driller's description).		 	
1.00 1.00 1.20-1.65 1.20-1.65 1.20-1.65	D4 E5 SPT N=15 B6 D7					0.50 (0.50)	Medium dense, orange brown, very clayey, silty, fine to coarse SAND with occasional clay lenses.			
2.00 2.00 2.00-2.45 2.00-2.45 2.00-2.45	D10 E11 B8 SPT N=16 D9					1.00	Medium dense, grey brown, silty, slightly gravelly, fine and medium SAND. Gravel is subangular to rounded, fine to coarse including quartzite, siltstone, mudstone and sandstone.			
2.00 2.00 2.00-2.45 2.00-2.45 2.00-2.45	D10 E11 B8 SPT N=16 D9	1.70	DRY	13/10/2015:0.00m 16/10/2015:0.00m 2,3/3,4,4,5		(3.20)	Below 2.00m: occasional silt lenses.			
3.00-3.45 3.00-3.45 3.00-3.45	SPT N=19 B12 D13			4.00		ADDED	2,3/4,4,5,6 Water strike(1) at 3.30m, rose to 2.90m in 20 mins, sealed at 4.20m.			
4.00-4.45 4.00-4.45 4.00-4.45	SPT N=10 B14 D15	4.00	3.90	2,2/3,3,4		4.20	Firm, grey brown, slightly sandy, slightly gravelly CLAY with occasional sand lenses. Gravel is angular to subrounded, fine to coarse including sandstone, siltstone, mudstone and occasional coal.			
5.00-5.45	U16 (P/0.45)	4.70	DRY	81 blows						
5.50	D17									
6.00-6.45 6.00-6.45 6.00-6.45	SPT N=17 B18 D19	6.00	DRY	3,3/3,4,5,5						
7.50	D20					(5.80)	Below 6.50m: stiff.			
Remarks Water added from 2.50m to 3.00m. Excavating from 0.00m to 1.20m for 1.00 hour.								Scale (approx) 1:40	Logged By CH	
								Figure No. 41787.BH06		



**IAN FARMER
ASSOCIATES**

Site

Siemens Development Phase 1 & 2

**Borehole
Number**

BH06

Boring Method

Cable Percussion

Casing Diameter

150mm cased to 7.70m

Ground Level (mOD)

Client

Booth King Partnership Ltd

**Job
Number**

41787

Location

Dates

13/11/2015-
16/11/2015

Engineer

Booth King Partnership Ltd

Sheet

2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
8.00-8.45	U21 (P/0.45)	7.70	DRY	63 blows			At 8.00m: medium strength.		
8.50	D22								
9.50-9.95 9.50-9.95 9.50-9.95	SPT N=14 B23 D24	9.50	DRY	2,2/3,3,4,4 16/10/2015:0.00m		10.00	Complete at 10.00m		

Remarks

**Scale
(approx)**

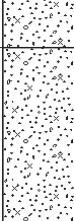
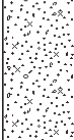
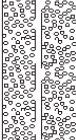
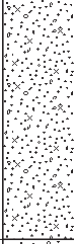
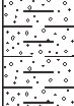
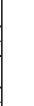
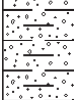
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By**

CH

Figure No.

41787.BH06

IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH07	
Boring Method Cable Percussion		Casing Diameter 150mm cased to 7.70m		Ground Level (mOD)		Client Booth King Partnership Ltd			Job Number 41787	
		Location		Dates 16/11/2015-17/11/2015		Engineer Booth King Partnership Ltd			Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.50 0.50-1.00	E2 B1	1.20	DRY	2,3/3,3,3,4		(0.40)	MADE GROUND: Topsoil (driller's description).			
						0.40	Medium dense, dark brown, very silty, slightly gravelly, fine and medium SAND. Gravel is subangular to subrounded, fine to coarse including siltstone.			
1.00 1.20-1.65 1.20-1.65 1.20-1.65	E3 SPT N=13 B4 D5					1.00	Medium dense, grey, brown, slightly silty, slightly gravelly, fine to coarse SAND. Gravel is subangular to rounded including quartzite and siltstone, sandstone and mudstone.			
2.00-2.45 2.00 2.00-2.45 2.00-2.45	SPT N=15 E6 B7 D8	1.70	DRY	2,3/3,4,4,4		(2.90)	Below 2.00m: gravelly.			
3.00-3.45 3.00-3.45 3.00-3.45	B9 SPT N=15 D10	3.00	2.60	Water strike(1) at 2.80m, rose to 2.50m in 20 mins. 2,2/3,3,4,5						
4.00 4.00-4.45 4.50	D11 U12 (P/0.41) D13	4.00	DRY	16/10/2015:2.60m 17/10/2015:0.00m 56 blows		3.90	Firm, grey brown, slightly sandy, slightly gravelly CLAY with occasional sand lenses. Gravel is subangular to rounded, fine to coarse including sandstone, siltstone, mudstone and occasional coal.			
						Below 4.50m: sand lenses absent.				
5.00-5.45 5.00-5.45 5.00-5.45	SPT N=13 B14 D15	4.70	DRY	2,2/3,3,3,4						
6.00	D16						Below 6.00m: occasional gravels.			
6.50-6.95	U17 (P/0.41)	6.20	DRY	55 blows		(5.20)				
7.00	D18									
7.50	D19									
8.00-8.45	SPT N=14	7.70	DRY	2,3/3,3,4,4						
Remarks								Scale (approx) 1:40	Logged By CH	
								Figure No. 41787.BH07		



**IAN FARMER
ASSOCIATES**

Site

Siemens Development Phase 1 & 2

**Borehole
Number
BH07**

Boring Method

Cable Percussion

Casing Diameter

150mm cased to 7.70m

Ground Level (mOD)

Client

Booth King Partnership Ltd

**Job
Number
41787**

Location

Dates

16/11/2015-
17/11/2015

Engineer

Booth King Partnership Ltd

**Sheet
2/2**

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
8.00-8.45 8.00-8.45	B20 D21						Below 8.00m: occasional silt lenses.			
9.10	D22			17/10/2015:MOIST		9.10	Stiff grey brown, slightly sandy, slightly gravelly CLAY with occasional sand lenses. Gravel is subangular to subrounded, fine and medium including sandstone, siltstone, mudstone, occasional coal and quartzite.			
9.50-9.95	U	7.70	WET	98 blows		(1.35)				
10.00-10.45 10.00-10.45	SPT N=27 D23	7.70	WET	3,5/5,7,7,8		10.45	Complete at 10.45m			

Remarks

**Scale
(approx)**

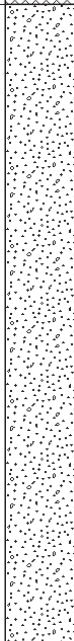
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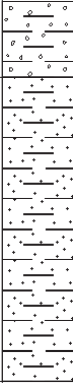
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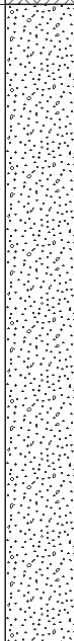
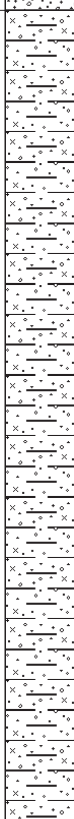
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Figure No.

41787.BH07

IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH08		
Boring Method Cable Percussion		Casing Diameter 150mm cased to 4.50m			Ground Level (mOD)		Client Booth King Partnership Ltd			Job Number 41787	
		Location			Dates 17/11/2015		Engineer Booth King Partnership Ltd			Sheet 1/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description			Legend	Water
0.10-0.30	B1					(0.30)	MADE GROUND: Grass over black, clayey, fine and medium SAND (Topsoil).				
0.30-1.20	B2					0.30	Medium dense, brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to rounded, fine to coarse including sandstone.				
0.50	E3										
1.00	E4										
1.20-1.65	SPT N=19		DRY	1,2/3,5,6,5			(3.40)				
1.20-1.65	D5										
1.20-1.70	B6										
2.00-2.45	SPT N=11	1.70	DRY	2,3/3,3,2,3			3.70				
2.00	E7										
2.00-2.45	D8										
2.00-2.50	B9						3.70				
3.20-3.65	SPT N=8	3.20	7.50	3,3/1,2,2,3							
3.20-3.65	D10										
3.20-3.70	B11						3.70				
3.30-4.20	B12										
4.20-4.65	U	4.20	DRY	35 blows			(4.70)				
4.20-4.80	B13										
5.00-5.45	SPT N=10	4.50	DRY	2,2/2,2,3,3							
5.00-5.45	D14						(4.70)				
5.00-5.50	B15										
6.00	D16										
6.50-6.95	U17 (P/0.45)	4.50	DRY	45 blows			(4.70)				
7.00	D18										
7.50	D19										
Remarks Water added from 2.00m to 3.70m.										Scale (approx) 1:40	Logged By JC
										Figure No. 41787.BH08	

 IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH08
Boring Method Cable Percussion		Casing Diameter 150mm cased to 4.50m		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787	
		Location		Dates 17/11/2015		Engineer Booth King Partnership Ltd		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
8.20-8.65 8.20-8.65 8.20-8.70	SPT N=21 D20 B21	4.50	DRY	3,4/4,6,5,6		8.40	Stiff, brown, slightly sandy CLAY with occasional gravel. Gravel is angular to subrounded, fine to coarse including mudstone, sandstone, siltstone and coal.		
9.00	D22					(1.60)			
9.50-9.95 9.50-9.95 9.50-10.00	SPT N=29 D23 B24	4.50	DRY	2,3/5,6,9,9		10.00			
				17/11/2015:DRY			Complete at 10.00m		
Remarks								Scale (approx) 1:40	Logged By JC
								Figure No. 41787.BH08	

 IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2		Borehole Number BH09			
Boring Method Cable Percussion		Casing Diameter 150mm cased to 4.70m			Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787			
		Location			Dates 16/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/2			
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water			
0.10-0.30	B1		DRY	1,2/3,2,3,3		(0.30) 0.30	Grass over, dark brown, clayey, sandy TOPSOIL. (made ground).					
0.50 0.50-1.20	E3 B2						DRY	2,3/4,6,8,8			(3.40)	Medium dense, light brown/grey, slightly gravelly, fine SAND. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and limestone.
1.00 1.20-1.65 1.20-1.65 1.20-1.70	E4 SPT N=11 D6 B5											
2.00 2.20-2.65 2.20-2.65 2.20-2.70	E7 SPT N=26 D9 B8	1.70	2.50	2,2/3,4,6,7	3.70				Firm, brown, slightly sandy, slightly gravelly, silty CLAY. Gravel is subangular to subrounded, fine and medium including sandstone, mudstone and coal. Below 4.00m: stiff.			
3.00-3.45 3.00-3.45 3.00-3.50	SPT N=20 D11 B10	3.00	2.50	2,2/3,4,6,7								
3.70	D12	4.00	DRY	2,2/3,4,6,7								
4.00-4.45 4.00-4.45 4.00-4.50	SPT N=20 D14 B13	4.70	DRY	40 blows								
4.70	D15											
5.20-5.65	U16 (P/0.36)											
5.70	D17	4.70	DRY	2,3/4,5,5,6		(6.30)						
6.00	D18											
6.50-6.95 6.50-6.95 6.50-7.00	SPT N=20 D20 B19											
7.00	D21											
Remarks Water added from 2.00m to 3.70m. Excavating from 0.00m to 1.20m for 1.00 hour.								Scale (approx)	Logged By			
								1:40	P.McH			
								Figure No. 41787.BH09				



Siemens Development Phase 1 & 2

**Borehole
Number**
BH09

Casing Diameter	150mm cased to 4.70m
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Client	Booth King Partnership Ltd
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**Job
Number**
41787

Dates	16/11/2015
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Engineer
Booth King Partnership Ltd

Sheet
2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
8.00-8.45	U22 (P/0.45)	4.70	DRY	46 blows					
8.50	D23								
9.00	D24						Below 9.00m: very stiff and very sandy.		
9.50-9.95 9.50-9.95 9.50-10.00	SPT N=30 D26 B25	4.70	DRY	5,5/6,7,8,9		10.00	Complete at 10.00m		

Remarks

Scale (approx)

1:40

Logged
By

P.McH

Figure No.
41787.BH09

 IAN FARMER ASSOCIATES							Site Siemens Development Phase 1 & 2			Borehole Number BH10	
Boring Method Cable Percussion		Casing Diameter 150mm cased to 45.00m		Ground Level (mOD)		Client Booth King Partnership Ltd			Job Number 41787		
		Location		Dates 18/11/2015		Engineer Booth King Partnership Ltd			Sheet 1/2		
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr	
0.20 0.30-0.60	D1 B2		DRY	1,2/3,3,2,1		(0.10) 0.10 (0.20) 0.30	MADE GROUND: Tarmacadam. MADE GROUND: Black, angular to subrounded, fine to coarse GRAVEL including ash.				
0.50 0.60-1.20	E3 B4					MADE GROUND: Black, slightly gravelly, clayey, fine to coarse SAND. Gravel is subangular to rounded, fine to coarse including sandstone.					
1.00	E5										
1.20-1.65 1.20-1.65 1.20-1.80	SPT N=9 D6 B7										
2.00-2.45 2.00 2.00-2.45 2.00-2.50	SPT N=12 E8 D9 B10	1.70	DRY	1,3/3,2,3,4		1.50	Medium dense, brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to rounded, fine to coarse including sandstone.				
2.70	D11	3.00	2.50	3,2/6,6,8,10		(2.10)	Below 2.70m: grey/brown, fine and medium. Below 3.00m: dense.				
3.00-3.45 3.00-3.45 3.00-3.50 3.10-3.40	SPT N=30 D12 B13 B14										
4.00-4.45 4.00-4.50	U15 NR B16										
4.50-4.95 4.50-4.95 4.50-5.00	SPT N=10 D17 B18										
5.20-5.65	U19 (P/0.32)	4.50	DRY	42 blows							
5.70	D20	4.50	DRY	2,2/3,3,3,4		(6.40)					
6.00	D21										
6.50-6.95 6.50-6.95 6.50-7.00	SPT N=13 D22 B23										
7.50	D24										
Remarks Water added from 2.50m to 3.60m. Excavating from 0.00m to 1.20m for 1.00 hour.								Scale (approx) 1:40	Logged By JC	Figure No. 41787.BH10	



**IAN FARMER
ASSOCIATES**

Site

Siemens Development Phase 1 & 2

**Borehole
Number**

BH10

Boring Method

Cable Percussion

Casing Diameter

150mm cased to 45.00m

Ground Level (mOD)

Client

Booth King Partnership Ltd

**Job
Number**

41787

Location

Dates

18/11/2015

Engineer

Booth King Partnership Ltd

Sheet

2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
8.20-8.65	U25 (P/0.23)	4.50	DRY	51 blows						
8.70	D26									
9.00	D27									
9.50-9.95 9.50-10.00	SPT N=32 B29	4.50	DRY	4,4/6,8,8,10		10.00	Below 9.50m: stiff.			
							Complete at 10.00m			

Remarks

**Scale
(approx)**

1:40

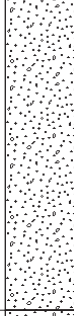
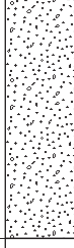
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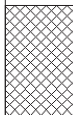
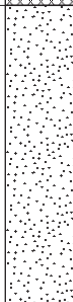
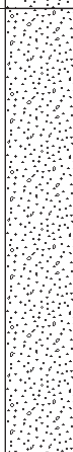
JC

Figure No.

41787.BH10

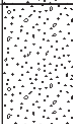
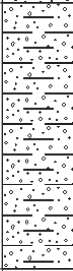
 IAN FARMER ASSOCIATES						Site Siemens Development Phase 1 & 2		Number WS01	
Excavation Method Drive-in Window Sampler		Dimensions		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787	
		Location		Dates 13/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
0.30	D1		2,2/2,2,2,2						

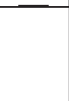
 IAN FARMER ASSOCIATES						Site Siemens Development Phase 1 & 2		Number WS02			
Excavation Method Hnad excavated		Dimensions		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787			
		Location		Dates 13/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/1			
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water			
0.30	D1		2,2/3,3,2,3		(0.40)	MADE GROUND: Grass over brown, slightly clayey, slightly gravelly, fine to coarse SAND (Topsoil). Gravel is angular to subrounded, fine to coarse including sandstone, brick and mudstone.					
0.50	E2				0.40 (0.30)				MADE GROUND: Dark, brown, clayey, gravelly SAND. Gravel is angular to subrounded, fine to coarse including sandstone, brick and mudstone.		
0.70-2.00 0.80 1.00	B3 D4 E5				0.70						
1.20-1.65 1.30	SPT(C) N=11 D6				(2.20)	Medium dense, grey, slightly gravelly, coarse SAND. Gravel is angular, fine and medium including sandstone and siltstone.					
1.80	D7										
2.00-2.45 2.30	SPT(C) N=10 D8				2,2/2,2,3,3						
2.80	D9										
3.00-3.45	SPT(C) N=8				1,1/1,1,3,3	2.90	Loose, brown, slightly gravelly, medium and coarse SAND. Gravel is angular, fine and medium including sandstone and siltstone.				
3.50	D10					(1.60)					
4.00-4.45 4.30	SPT(C) N=18 D11				2,3/3,4,5,6	4.50	Firm, brown, slightly gravelly CLAY. Gravel is angular to subrounded, fie and medium including sandstone and siltstone.				
4.80	D12		(0.95)								
5.00-5.45	SPT(C) N=16	2,2/2,4,5,5	5.45	Complete at 5.45m							
Remarks Between 1.20m and 2.00m: recovery = 100%. Between 2.00m and 3.00m: recovery = 100%. Between 3.00m and 4.00m: recovery = 80%. Between 4.00m and 5.00m: recovery = 100%. Excavating from 0.00m to 1.20m for .50 hours.							Scale (approx)	Logged By			
							1:50	JC			
							Figure No. 41787.WS02				

 IAN FARMER ASSOCIATES						Site Siemens Development Phase 1 & 2		Number WS03	
Excavation Method Drive-in Window Sampler		Dimensions		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787	
		Location		Dates 13/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
0.00-0.60	B1		2,2/2,2,2,2		(0.60) 0.60 (1.60) 2.20 (2.40) 4.60 (0.85) 5.45	MADE GROUND: Grass over brown, slightly clayey, slightly gravelly, fine to coarse SAND (Topsoil). Gravel is angular to subrounded, fine to case including sandstone, brick and mudstone.		▽1	
0.30	D2					Loose, grey, slightly gravelly, fine SAND.			
0.50	E3								
0.60-1.20	B4								
0.80	D5								
1.00	E6								
1.20-1.65	SPT(C) N=8								
1.30	D7								
1.80	D8					Water strike(1) at 1.80m.			
2.00-2.45	SPT(C) N=11					2,2/2,3,3,3			
2.30	D9					Medium dense, grey brown, slightly gravelly, medium and coarse SAND. Gravel is angular to subrounded, fine and medium including sandstone.			
2.80	D10								
3.00-3.45	SPT(C) N=6					2,1/1,1,2,2	Below 3.00m: loose		
3.30	D11								
3.80	D12	1,1/1,3,2,3	4.60	Firm, brown, slightly gravelly CLAY. Gravel is subangular to subrounded, fine to coarse including sandstone, siltstone and mudstone.					
4.00-4.45	SPT(C) N=9								
4.30	D13	8,6/6,5,5,5	(0.85)	Below 5.00m: stiff					
4.80	D14								
5.00-5.45	SPT N=21			5.45	Complete at 5.45m				
Remarks Between 1.20m and 2.00m: recovery = 100%. Between 2.00m and 3.00m: recovery = 100%. Between 3.00m and 4.00m: recovery = 100%. Between 4.00m and 5.00m: recovery = 100%. Excavating from 0.00m to 1.20m for 0.50 hours.							Scale (approx)	Logged By	
							1:40	JC	
							Figure No. 41787.WS03		

 IAN FARMER ASSOCIATES						Site Siemens Development Phase 1 & 2		Number WS04
Excavation Method Drive-in Window Sampler		Dimensions		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787
		Location		Dates 16/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/1
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50	D1				(0.20)	MADE GROUND: Black grass over topsoil, gravelly SAND.		
0.50	E2				0.20	MADE GROUND: Black, slightly gravelly, organic SAND. Gravel is subangular to rounded, fine to coarse including limestone, sandstone and occasional brick.		
1.00	D3				(0.50)			
1.00	E4				0.70	Grey, slightly gravelly, fine and medium SAND. Gravel is subangular to subrounded, fine and medium including sandstone.		
1.20-1.65	SPT(C) N=39		5,8/10,10,10,9		(0.60)			
1.50	D5				1.30	Dense dark brown, slightly gravelly, medium and coarse SAND. Gravel is subangular to rounded, fine to coarse including sandstone and quartzite.		
1.50	E6				(0.60)			
2.00-2.45	SPT(C) N=17		3,4/4,4,5,4		1.90	Medium dense, dark brown, occasionally gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine and medium including sandstone.		
2.50	D7							
3.00-3.45	SPT(C) N=7		Water strike(1) at 3.00m. 2,2/2,1,2,2		(2.80)	Below 3.00m: loose.		
3.50	D8							
4.00-4.45	SPT(C) N=6		2,1/2,1,2,1					
4.50	D9				4.70	At 4.50m: clayey.		
4.90	D10					Firm, locally stiff, brown, sandy CLAY.		
5.00-5.45	SPT(C) N=13		2,2/3,3,3,4		(0.75)			
					5.45	Complete at 5.45m		
Remarks Excavating from 0.00m to 1.20m for 0.50 hours.							Scale (approx) 1:40	Logged By BL
							Figure No. 41787.WS04	

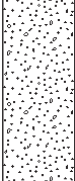
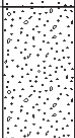
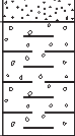
IAN FARMER ASSOCIATES						Site Siemens Development Phase 1 & 2		Number WS05		
Excavation Method Drive-in Window Sampler		Dimensions		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787		
		Location		Dates 13/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/1		
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water		
0.50 0.60-1.20	E1 B2	2,2/2,2,2,3	Water strike(1) at 2.00m. 2,2/2,2,2,3		(0.40)	MADE GROUND: Concrete with rebar.		V1		
0.80	D3				0.40 (0.20) 0.60	MADE GROUND: Grey brown, sandy, angular to subangular, medium and coarse GRAVEL including limestone.				
1.00	E4				(0.80)	Brown, slightly clayey, slightly gravelly, fine and medium SAND. Gravel is subangular to subrounded, fine and medium including sandstone and siltstone.				
1.20-1.65 1.30 1.40-3.70	SPT(C) N=9 D5 B6				1.40	Loose, red brown, slightly clayey, slightly gravelly SAND. Gravel is subangular to subrounded, medium and coarse of sandstone and siltstone.				
1.80	D7				(2.30)					
2.00-2.45	SPT(C) N=9									
2.30	D8									
2.80	D9									
3.00-3.45	SPT(C) N=6				1,1/1,1,2,2					
3.30	D10									
3.80	D11									
4.00-4.45	SPT(C) N=13	1,1/2,3,4,4								
4.30	D12									
4.80	D13									
5.00-5.45 5.00-5.45	SPT N=10 D14	3,3/3,3,2,2								
					3.70	Below 3.60m: very gravelly.				
					(1.75)	Firm, brown slightly gravelly CLAY. Gravel is angular to subrounded, fine and medium including sandstone, siltstone and mudstone.				
					5.45	Complete at 5.45m				
Remarks Between 1.20m and 2.00m: recovery = 100%. Between 2.00m and 3.00m: recovery = 100%. Between 3.00m and 4.00m: recovery = 80%. Between 4.00m and 5.00m: recovery = 100%. Excavating from 0.00m to 1.20m for 0.50 hours.							Scale (approx) 1:40	Logged By JC		
							Figure No. 41787.WS05			

 IAN FARMER ASSOCIATES						Site Siemens Development Phase 1 & 2		Number WS06
Excavation Method Drive-in Window Sampler		Dimensions		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787
		Location		Dates 16/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/1
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50 0.50	D1 E2				0.10 (0.80)	MADE GROUND: Tarmacadam. MADE GROUND: Brown, sandy, angular to subangular, fine to coarse GRAVEL including brick, limestone and sandstone.		
1.00 1.00 1.20-1.65 1.20-1.65 1.50	D3 E4 SPT N=11 D5 D6		2,2/2,3,3,3		0.90 (2.00)	Medium dense, light brown/grey, slightly gravelly, fine to coarse SAND. Gravel is subangular to subrounded, fine to coarse includes sandstone and limestone.		
2.00-2.45 2.00 2.00-2.45 2.50	SPT N=14 E8 E9 D7 D10		3,3/3,3,4,4		2.90 (0.80)	Loose, orange brown, slightly gravelly, fine to coarse SAND. Gravel is subangular to rounded, fine and medium including sandstone.		V1
3.00-3.45 3.50	SPT N=5 D11		Water strike(1) at 3.00m. 1,1/1,1,2,1		3.70 (1.75)	Firm, brown, slightly gravelly, sandy CLAY. Gravel is subangular to subrounded, fine and medium including mudstone and sandstone.		
4.00-4.45 4.00-4.45 4.50	SPT N=14 D12 D13		1,2/3,3,4,4		5.45	Complete at 5.45m		
5.00-5.45 5.00-5.45	SPT N=10 D14		1,1/2,2,3,3					
Remarks Excavating from 0.00m to 1.20m for 0.50 hours.							Scale (approx) 1:50	Logged By BL
							Figure No. 41787.WS06	

 IAN FARMER ASSOCIATES						Site Siemens Development Phase 1 & 2		Number WS07	
Excavation Method Drive-in Window Sampler		Dimensions		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787	
		Location		Dates 16/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description		Legend	Water
0.50 0.50	D1 E2		1,2/2,2,3,3		(0.50) 0.50	MADE GROUND: Grey brown, sandy, angular to subangular, fine to coarse GRAVEL including limestone and sandstone.			
1.00 1.00 1.20-1.65	D3 E4 SPT(C) N=10				(1.00)	MADE GROUND: Medium dense, grey/brown, gravelly SAND. Gravel is angular to subrounded, fine to coarse including limestone and sandstone.			
1.50	D5				1.50	Loose, brown, gravelly, fine to coarse SAND. Gravel is subangular to rounded, fine and medium including quartzite and sandstone.			V ₁
2.00 2.00-2.45 2.00	D6 SPT(C) N=6 E7		Water strike(1) at 2.00m. 1,2/1,2,1,2		(1.30)	Below 2.4m: orange brown.			
2.60	D8				2.80	Firm, brown CLAY. At 3.00m: soft.			
3.00-3.45 3.00	SPT N=6 D9		1,1/1,1,2,2						
3.50	D10								
4.00-4.45 4.00-4.45	SPT N=14 D11		1,2/3,3,4,4		(2.65)				
5.00-5.45	SPT N=8		2,2/2,2,2,2		5.45	Complete at 5.45m			
Remarks Excavating from 0.00m to 1.20m for 0.50 hours.								Scale (approx) 1:40	Logged By BL
								Figure No. 41787.WS07	



**IAN FARMER
ASSOCIATES**

Site		Number WS08		
Client Booth King Partnership Ltd		Job Number 41787		
Engineer Booth King Partnership Ltd		Sheet 1/1		
Description	Legend	Water	Instr	
MADE GROUND: Tarmacadam.				
MADE GROUND: Brown grey, sandy, angular to subangular, fine to coarse GRAVEL including brick, limestone and sandstone.				
MADE GROUND: Loose, light brown, slightly gravelly, clayey SAND. Gravel is angular to subrounded, fine to coarse including limestone and sandstone.				
MADE GROUND: Light grey and black, coarse SAND.				
Medium dense, brown, occasionally gravelly SAND. Gravel is subangular to rounded, fine and medium including sandstone and quartzite.				
Orange brown, fine to coarse SAND.				
Very loose, brown/grey, very gravelly SAND. Gravel is subangular to rounded, fine including quartzite and sandstone.				
Firm, brown, occasionally gravelly CLAY. Gravel is rounded, fine including sandstone.				
Complete at 5.45m				
Scale (approx)			Logged By	
1:50				
Figure No.				
41787.WS08				



Site

Siemens Development Phase 1 & 2

**Number
WS09**

Excavation Method

Drive-in Window Sampler

Dimensions

Ground Level (mOD)

Client

Booth King Partnership Ltd

**Job
Number
41787**

Location

Dates

13/11/2015

Engineer

Booth King Partnership Ltd

**Sheet
1/1**

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.50	D1				(0.20)	MADE GROUND: Grass over topsoil.			
0.50	E2				(0.20)	MADE GROUND: Dark brown, slightly clayey, slightly gravelly, medium and coarse SAND. Gravel is angular, coarse including brick.			
1.00	D3		4,4/4,4,5,5		(0.30)	MADE GROUND: Brown, slightly clayey, medium and coarse SAND.			
1.00	E4				(0.20)	Medium dense, brown, slightly gravelly, medium and coarse SAND. Gravel us subangular to rounded, fine and medium sandstone.			
1.20-1.65	SPT N=18				0.50				
1.50	B5								
2.00-2.45	SPT N=17		3,3/4,4,4,5						
2.00	D7				(3.33)				
2.00	E8								
2.00-2.45	D6								
3.00-3.45	D9		Water strike(1) at 3.00m.						
3.00-3.45	SPT N=12		3,3/5,3,2,2						
3.50	D10								
4.00-4.45	SPT N=27		3,3/5,6,8,8		3.83	Firm, brown, sandy CLAY.			
4.00-4.45	D11				(0.17)	Medium dense, brown, very gravelly SAND. Gravel is subanglar to rounded, fine including sandstone and quartzite.			
4.30	D12				4.00				
4.50	D13				(1.45)				
5.00-5.45	SPT N=12		4,3/3,3,3,3						
					5.45	Complete at 5.45m			

Remarks

Excavating from 0.00m to 1.20m for 0.50 hours.

**Scale
(approx)**

1:40

**Logged
By**

BL

Figure No.

41787.WS09

IAN FARMER ASSOCIATES						Site Siemens Development Phase 1 & 2		Number WS10	
Excavation Method Drive-in Window Sampler		Dimensions		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787	
		Location		Dates 13/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
0.50 0.50	D1 E2				(0.20) 0.20	MADE GROUND: Grass over black, slightly gravelly SAND. Gravel is rounded, medium including sandstone (Topsoil).			
1.00 1.00 1.20-1.65 1.20-1.65	D3 E4 SPT N=18 D5		5,5/4,5,4,5		(1.00) 1.20	MADE GROUND: Brown, slightly gravelly SAND. Gravel is subangular to subrounded, fine to coarse including sandstone and quartzite.			
1.70 1.75-2.00	D6 B7					Medium dense, brown, gravelly, medium and coarse SAND. Gravel is subangular to rounded, fine to coarse including sandstone and quartzite.			
2.00-2.45 2.00 2.00	SPT N=18 D8 E9		4,4/4,4,5,5		(1.80)				
3.00 3.00-3.45	D10 SPT N=7		Water strike(1) at 3.00m. 1,2/1,2,2,2		3.00	Loose, light brown, slightly gravelly, medium and coarse SAND. Gravel is subrounded to rounded, fine and medium including sandstone and quartzite.		▽1	
3.50	D11				(1.20)				
4.00-4.45 4.20	SPT N=17 D12		4,4/4,4,4,5		4.20 (0.30) 4.50	Brown, very gravelly, angular SAND. Gravel is rounded, fine and medium including sandstone and quartzite.			
4.80 5.00-5.45 5.00-5.45	D13 SPT N=12 D14		3,2/2,3,4,3		(0.95) 5.45	Firm, brown, slightly sandy CLAY.			
						Complete at 5.45m			
Remarks Excavating from 0.00m to 1.20m for 0.50 hours.							Scale (approx) 1:40	Logged By BL	
							Figure No. 41787.WS10		

 IAN FARMER ASSOCIATES						Site Siemens Development Phase 1 & 2		Number WS11
Excavation Method Drive-in Window Sampler		Dimensions		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787
		Location		Dates 13/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/1
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30 0.30	D1 E2				(0.20) 0.20	MADE GROUND: Grass over dark brown, slightly organic, medium and coarse SAND (Topsoil).		
					(0.80)	MADE GROUND: Orange/brown, slightly clayey, slightly gravelly, medium and coarse SAND. Gravel is subangular to rounded, fine to coarse including sandstone.		
1.00 1.00 1.20-1.65 1.20-1.65	D3 E4 SPT N=15 D5		2,3/4,3,4,4		1.00	Medium dense, grey brown, slightly gravelly, medium and coarse SAND. Gravel is subrounded to rounded, fine to coarse including sandstone and quartzite.		
1.80	D6							
2.00-2.45 2.00 2.00 2.00-2.45	SPT N=17 D7 E8 D9		4,3/4,5,4,4		(2.00)			
2.50	D10							
3.00-3.45 3.00-3.45 3.20	D11 SPT N=12 D12		Water strike(1) at 3.00m. 1,1/2,2,3,5		3.00	Medium dense, brown, gravelly, coarse SAND. Gravel is fine and medium including sandstone and quartzite.		V1
					(1.00)			
3.80	D13							
4.00-4.45 4.00-4.45	SPT N=16 D14		3,3/3,4,4,5		4.00	Stiff, brown, slightly sandy CLAY.		
					(0.45) 4.45	Complete at 4.45m		
Remarks Window sample hole collapsed upon completion to 3.00m. Excavating from 0.00m to 1.20m for 0.50 hours.							Scale (approx) 1:40	Logged By BL
							Figure No. 41787.WS11	



Site Siemens Development Phase 1 & 2						Number WS12			
Excavation Method Drive-in Window Sampler		Dimensions		Ground Level (mOD)		Client Booth King Partnership Ltd		Job Number 41787	
		Location		Dates 13/11/2015		Engineer Booth King Partnership Ltd		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.50 0.50	D1 E2		2,1/1,1,2,1		(0.20) 0.20 (0.50) 0.70	MADE GROUND: Tarmacadam. MADE GROUND: Brown, very sandy, angular to subangular, fine to coarse GRAVEL including limestone and sandstone. At 0.50m: engineer notes plastic membrane.			
1.00 1.00 1.20-1.65 1.20-1.65	D3 E4 SPT N=5 D5		2,1/1,1,2,1		(0.80) 1.50	MADE GROUND: Loose, dark brown, slightly gravelly SAND. Gravel is angular to subangular, fine to coarse including sandstone and limestone.			
2.00-2.45 2.00 2.00 2.00-2.45	SPT N=10 D6 E7 D8		2,2/2,2,3,3		(1.00) 2.50	Medium dense, brown, slightly gravelly SAND. Gravel is, subangular, fine and medium including sandstone.			
3.00-3.45 3.00-3.45 3.30	SPT N=12 D9 D10		2,2/3,3,3,3		(0.98) 3.48	Medium dense, brown, gravelly, coarse SAND. Gravel is subrounded to rounded, fine and medium including sandstone.			
3.80 4.00-4.45 4.00-4.45	D11 SPT N=14 D12		2,2/3,3,4,4		(1.97)	Firm, brown, slightly sandy CLAY.			
5.00-5.45	SPT N=6		2,1/2,1,2,1		5.45	At 5.00m:soft.			
						Complete at 5.45m			
Remarks Excavating from 0.00m to 1.20m for 0.50 hours.							Scale (approx)	Logged By	
							1:40	BL	
							Figure No. 41787.WS12		



Excavation Method JCB 3CX	Dimensions 2.10m x 0.70m x 1.60m	Ground Level (mOD)	Client Booth King Partnership Ltd	Job Number 41787
	Location	Dates 18/11/2015	Engineer Booth King Partnership Ltd	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20	B1				(0.30) 0.30	Grass over dark brown, clayey, sandy TOPSOIL (possible made ground).		
1.00	B2				(1.30) 1.60	Light brown grey, slightly gravelly, fine to coarse grained SAND. Gravel is subangular to subrounded, fine to coarse including sandstone, mudstone and limestone.		
						Complete at 1.60m		

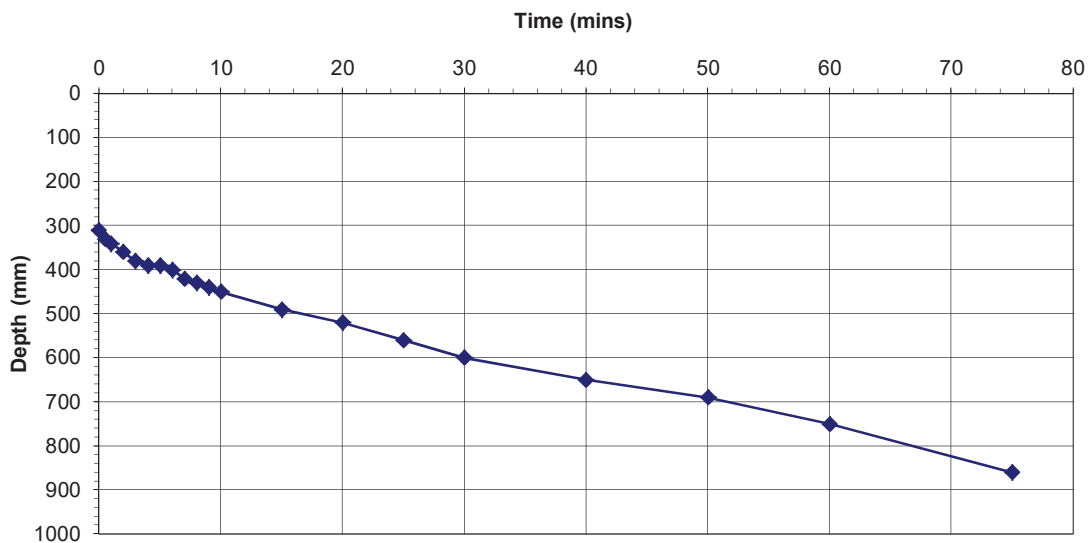
Plan	Remarks									
	Trial pit remained dry during excavation. Slight spalling of trial pit sides between 0.30m and 1.60m. Soakaway undertaken within trial pit.									
	Scale (approx)				Logged By			Figure No.		
	1:40				PMcH			41787.TP01		

**SOAKAWAY DESIGN IN ACCORDANCE WITH BRE DIGEST 365: 2007
BRE Digest 365, Figure 2, Page 5**

Client:	Booth King Partnership		
Site:	Siemens Development Phase 1 & 2		
Job No:	41787	Test No:	TP01 Test 2
Date	18.11.2015	Weather:	Cloudy, heavy showers

CALCULATION OF SOIL INFILTRATION RATE

Time (min)	Depth (mm)	Size of Soakaway	Length (m) =	2.10
0	310		Width (m) =	0.70
0.5	330		Depth (m) =	1.60
1	340			
2	360			
3	380	Depth to water at start of test =		
4	390	Depth to water at end of test =		
5	390	Depth to water at 75% level =		
6	400	Depth to water at 50% level =		
7	420	Depth to water at 25% level =		
8	430			
9	440	Base area of pit (m ²) =		
10	450	Eff area of loss 75 - 25% (m ²) =		
15	490	Volume outflow 75 - 25% (m ³) =		
20	520			
25	560	From the graph:		
30	600	tp 75 (min) =		
40	650	tp 25 (min) =		
50	690			
60	750			
75	860	Soil infiltration rate, f, (m/s) =		4.87E-05 normal test
				n/a pit with stone
		Tested by:	PMcH	Date: 18/11/2015
		Checked by:	HH	Date: 04/01/2016



Notes

TRL Dynamic Cone Penetrometer Test

Project: Siemens Development

Project No: 41787

Client: Booth King Partnership

Date: 19/11/2015

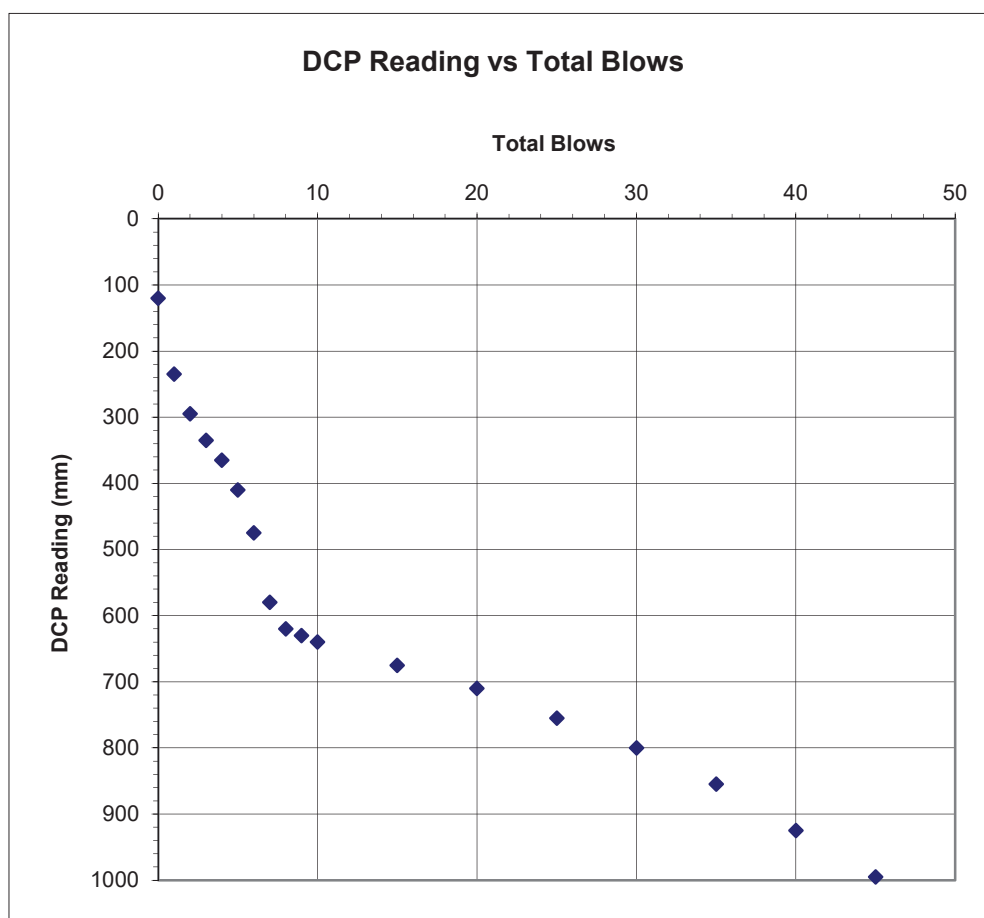
Engineer: Booth King Partnership

Location: TRL 01 **Test:** 1

DCP zero reading: 120

Layer	Depth below g.l.(mm)		Layer Thickness	Total Blows at Base of Layer	DCP value (mm/blow)	Equivalent CBR (%)
	Top	Base				
1	120	295	175	2	87.5	2.7
2	295	475	180	6	45.0	5.4
3	475	995	520	45	13.3	19.5

Derivation of CBR value from DCP based on TRRL Road Note 8 (60 degree cone)



TRL Dynamic Cone Penetrometer Test

Project: Siemens Development

Project No: 41787

Client: Booth King Partnership

Date: 19/11/2015

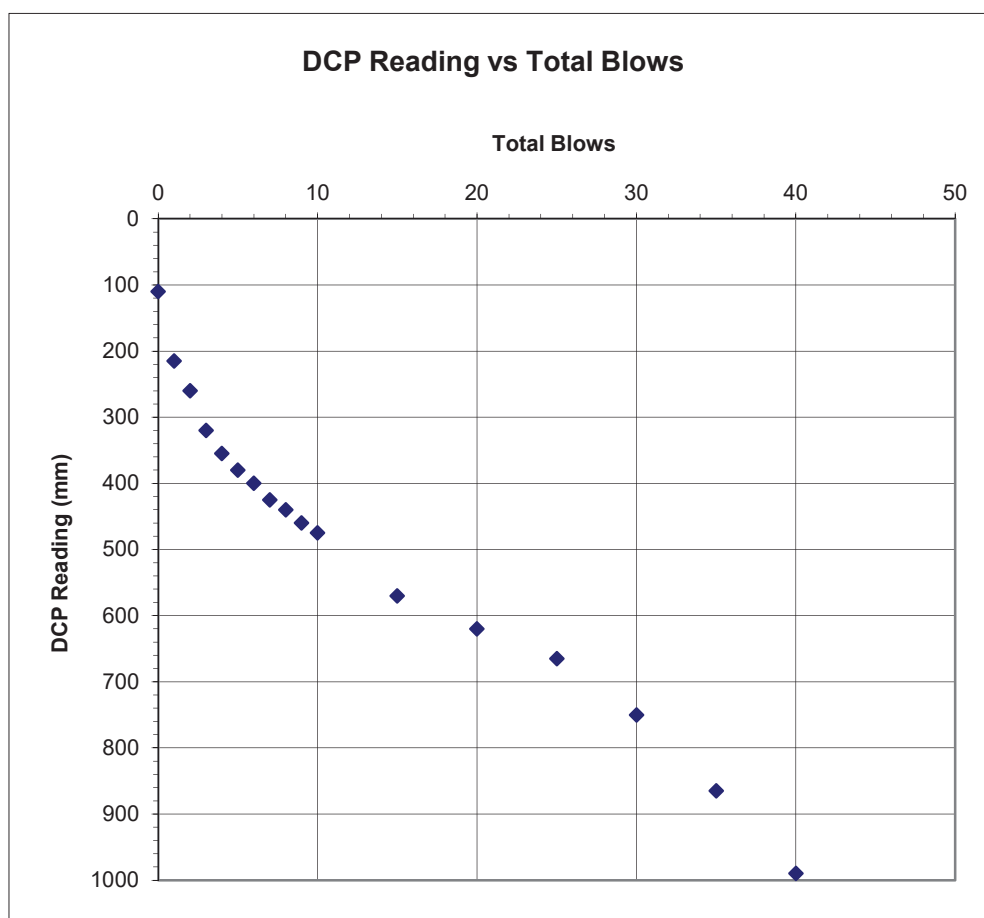
Engineer: Booth King Partnership

Location: TRL 02 **Test:** 1

DCP zero reading: 110

Layer	Depth below g.l.(mm)		Layer Thickness	Total Blows at Base of Layer	DCP value (mm/blow)	Equivalent CBR (%)
	Top	Base				
1	110	355	245	4	61.3	3.9
2	355	665	310	25	14.8	17.5
3	665	990	325	40	21.7	11.7

Derivation of CBR value from DCP based on TRRL Road Note 8 (60 degree cone)



TRL Dynamic Cone Penetrometer Test

Project: Siemens Development

Project No: 41787

Client: Booth King Partnership

Date: 19/11/2015

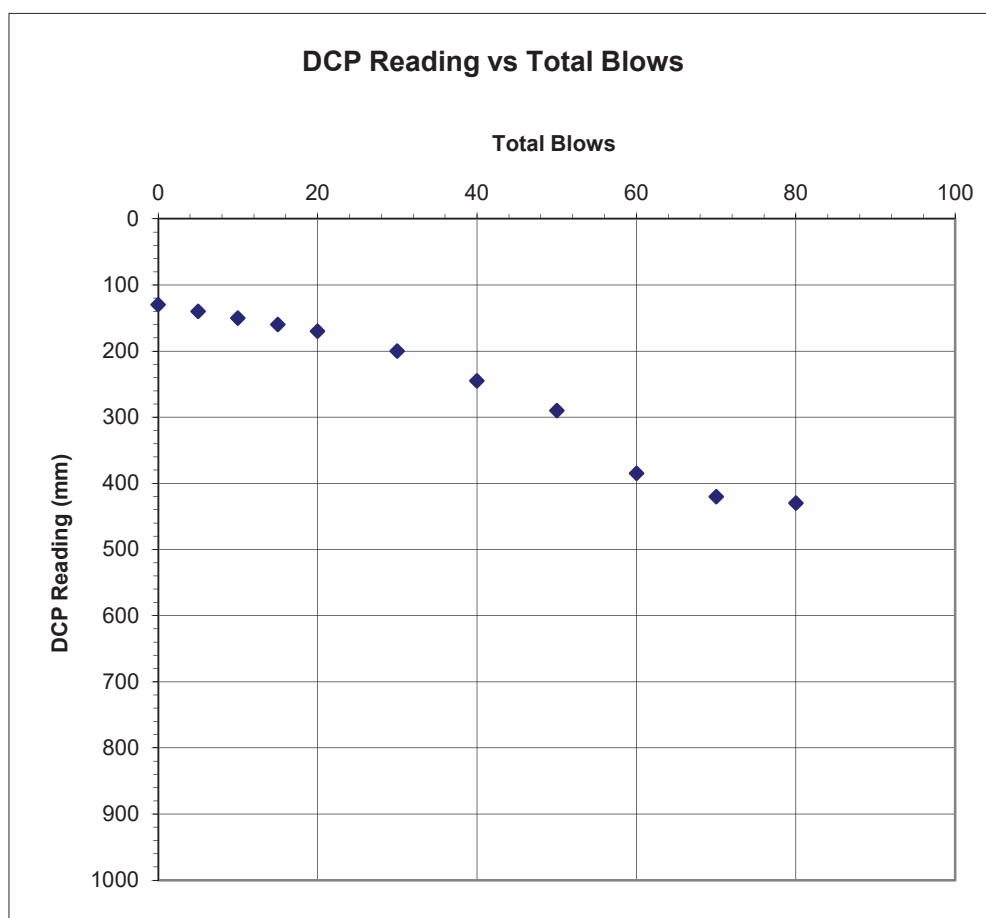
Engineer: Booth King Partnership

Location: TRL 03 **Test:** 1

DCP zero reading: 130

Layer	Depth below g.l.(mm)		Layer Thickness	Total Blows at Base of Layer	DCP value (mm/blow)	Equivalent CBR (%)
	Top	Base				
1	130	245	115	40	2.9	98.9
2	245	385	140	60	7.0	38.6
3	385	430	45	80	2.3	128.2

Derivation of CBR value from DCP based on TRRL Road Note 8 (60 degree cone)



TRL Dynamic Cone Penetrometer Test

Project: Siemens Development

Project No: 41787

Client: Booth King Partnership

Date: 19/11/2015

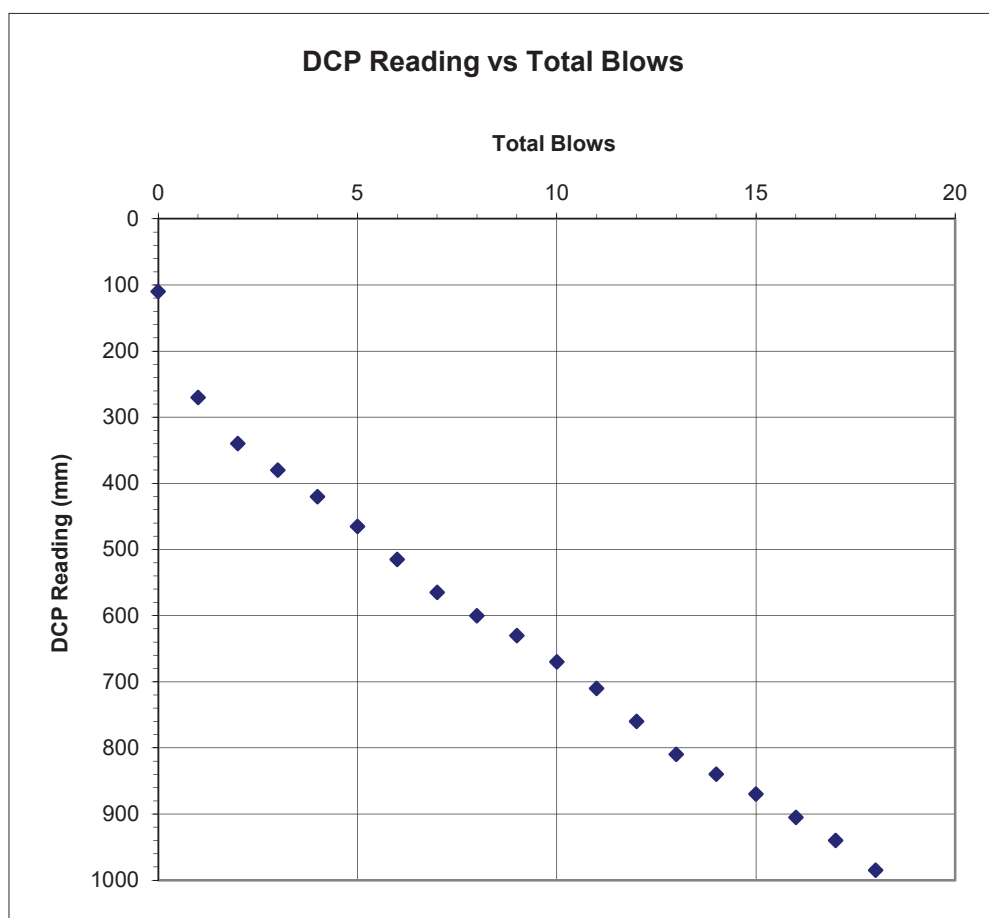
Engineer: Booth King Partnership

Location: TRL04 **Test:** 1

DCP zero reading: 110

Layer	Depth below g.l.(mm)		Layer Thickness	Total Blows at Base of Layer	DCP value (mm/blow)	Equivalent CBR (%)
	Top	Base				
1	110	270	160	1	160.0	1.4
2	270	985	715	18	42.1	5.8

Derivation of CBR value from DCP based on TRRL Road Note 8 (60 degree cone)



TRL Dynamic Cone Penetrometer Test

Project: Siemens Development

Project No: 41787

Client: Booth King Partnership

Date: 19/11/2015

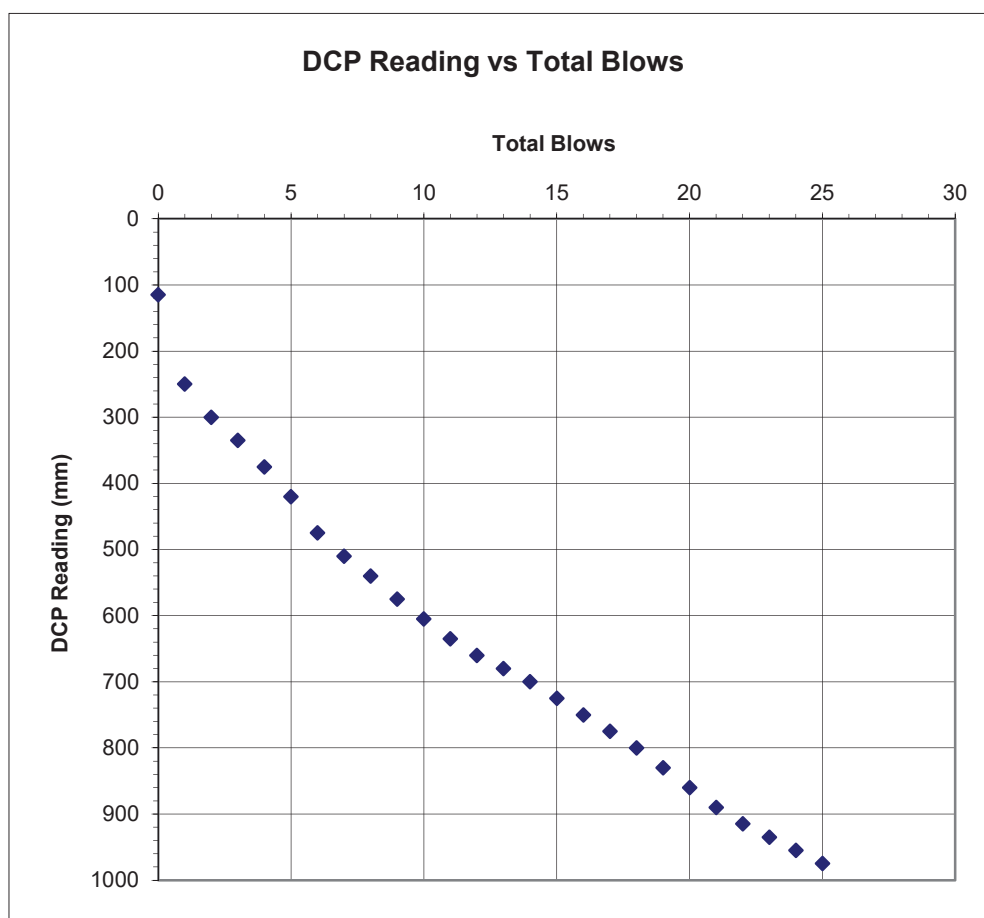
Engineer: Booth King Partnership

Location: TRL05 **Test:** 1

DCP zero reading: 115

Layer	Depth below g.l.(mm)		Layer Thickness	Total Blows at Base of Layer	DCP value (mm/blow)	Equivalent CBR (%)
	Top	Base				
1	115	250	135	1	135.0	1.7
2	250	975	725	25	30.2	8.2

Derivation of CBR value from DCP based on TRRL Road Note 8 (60 degree cone)



TRL Dynamic Cone Penetrometer Test

Project: Siemens Development

Project No: 41787

Client: Booth King Partnership

Date: 19/11/2015

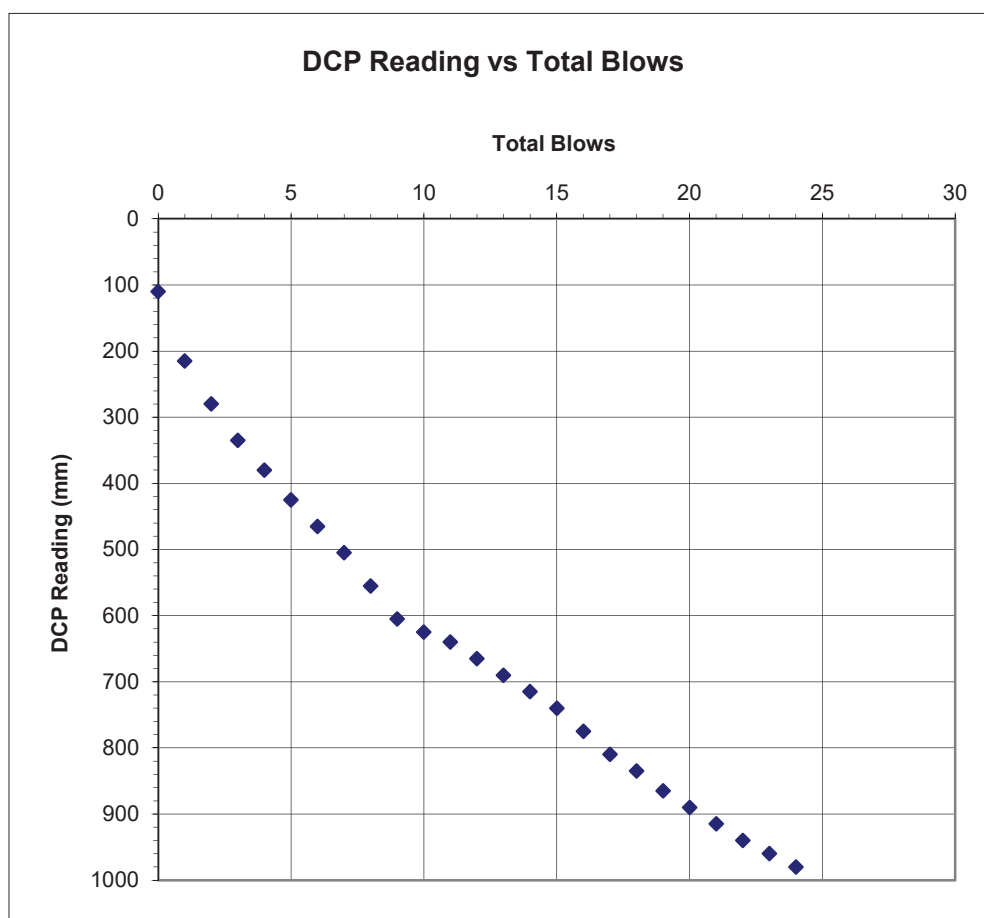
Engineer: Booth King Partnership

Location: TRL 06 **Test:** 1

DCP zero reading: 110

Layer	Depth below g.l.(mm)		Layer Thickness	Total Blows at Base of Layer	DCP value (mm/blow)	Equivalent CBR (%)
	Top	Base				
1	110	215	105	1	105.0	2.2
2	215	605	390	9	48.8	5.0
3	605	980	375	24	25.0	10.1

Derivation of CBR value from DCP based on TRRL Road Note 8 (60 degree cone)



CBR Mexi Probe Test

Project: Siemens Development

Project No: 41787

Client: Booth King Partnership

Date: 19/11/2015

Engineer: Booth King Partnership

Location: MP01		Depth: GL	
Depth mm	CBR Value (%)		
	Test 1	Test 2	Test 3
0	0.0	0.0	0.0
75	1.5	1.5	2.0
150	8.5	2.5	5.0
225	13.0	7.0	5.5
300	13.0	12.0	13.0
375	11.5	8.0	13.0
450	11.0	10.0	
525	13.0		
600			

Location: MP02		Depth: GL	
Depth mm	CBR Value (%)		
	Test 1	Test 2	Test 3
0	0.0	0.0	0.0
75	1.0	0.5	0.5
150	2.0	1.0	1.0
225	5.0	4.0	5.0
300	8.0	9.0	5.5
375	4.0	5.4	3.0
450	2.0	2.0	3.0
525	2.5	3.5	4.0
600	2.5	6.0	4.5

Location: MP03		Depth: GL	
Depth mm	CBR Value (%)		
	Test 1	Test 2	Test 3
0	0.0	0.0	0.0
75	1.0	1.0	1.0
150	2.5	3.0	2.0
225	3.0	3.0	2.5
300			
375			
450			
525			
600			

Location: MP04		Depth: GL	
Depth mm	CBR Value (%)		
	Test 1	Test 2	Test 3
0	0.0	0.0	0.0
75	1.0	2.0	1.5
150	3.0	8.0	2.0
225	6.0	7.0	3.0
300	3.5	5.0	3.0
375	4.0	7.0	4.5
450	5.0	5.0	5.0
525	6.0	3.5	5.5
600	12.0	4.5	6.5

Location:		Depth:		
Depth mm	CBR Value (%)			
	Test 1	Test 2	Test 3	
0				
75				
150				
225				
300				
375				
450				
525				
600				

Location:		Depth:		
Depth mm	CBR Value (%)			
	Test 1	Test 2	Test 3	
0				
75				
150				
225				
300				
375				
450				
525				
600				

APPENDIX 3
LABORATORY TESTS

APPENDIX 3

GENERAL NOTES ON LABORATORY TESTS ON SOILS

A3.1 GENERAL

- A3.1.1 Where applicable all tests are carried out in accordance with the relevant British Standard. The laboratory test procedures are as below:

Test Name	Procedures BS1377:1990 Part:Clause
Moisture Content	2:3
Liquid Limit	2:4
Plastic Limit and Plastic Index	2:5
Particle Size Distribution	9:2
Sedimentation	9:4
Mass Loss on Ignition	3:4
Sulphate content	3:5
pH Value	3:9
Compaction Test	4:3
California Bearing Ratio	4:7
Consolidation	5:3
Bulk Density	7:2*
Laboratory Vane Tests	7:3*
Triaxial Compression	
Total Stress Single-Stage	7:8
Total Stress Multi-Stage	7:9
Desiccation	Note 1*

Note 1 - BRE Information paper IP4 issued February 1993

* Tests are not included in UKAS accreditation

- A3.1.2 Where an external laboratory carried out testing, their report, including test methods is included in this Appendix.
- A3.1.3 A summary sheet of laboratory test results undertaken by Ian Farmer Laboratories is included, however where copies of the individual test results are required these will be provided on request.
- A3.1.4 Any discussion in this report is based on the values and results obtained from the appropriate tests. Due allowance should be made, when considering any result in isolation, of the possible inaccuracy of any such individual result. Details of the accuracy of results are included in this section, where applicable.

A3.2 MOISTURE CONTENT

- A3.2.1 Unless stated to the contrary, the moisture content of a soil sample was determined by the standard oven drying method, BS 1377, Part 1, Test 3. The result is reported to an accuracy of $\pm 0.5\%$

A3.3 ATTERBERG LIMITS

- A3.3.1 The Liquid Limit, **LL**, is the moisture content at which the soil passes from the liquid to plastic state. Unless stated to the contrary, the Liquid Limit was determined using the four point, cone penetrometer method, Test 4. The value is reported to the nearest whole number, to an accuracy of $\pm 0.5\%$.
- A3.3.2 The Plastic Limit, **PL**, is the moisture content at which soil passes from the plastic to solid state and becomes too dry to remain in a plastic condition. The Plastic Limit was determined using the method described in Test 5. The value is reported to the nearest whole number, to an accuracy of $\pm 0.5\%$.

- A3.3.3 The Plasticity Index, **PI**, is the numerical difference between the liquid and plastic limits, corresponding to the range of moisture contents over which a soil is in a plastic state. The determination of the Plasticity Index is covered by Test 5.

A3.4 SOIL CLASSIFICATION

- A3.4.1 Classification of soils is usually undertaken by means of the Plasticity Classification Chart, sometimes called the A-Line Chart. This is graphical plot of PI against LL with the A-Line defined as $PI = 0.73(LL - 20)$.
- A3.4.2 This line is defined from experimental evidence and does not represent a well defined boundary between soil types, but forms a useful reference datum. When the values of LL and PI for inorganic clays are plotted on the chart they generally lie just above the A-Line in a narrow band parallel to it, while silts and organic clays plot below this line.
- A3.4.3 Clays and silts are divided into five zones of plasticity:
- | | |
|-------------------------------|----------------------|
| Low Plasticity (L) | LL less than 35 |
| Intermediate Plasticity (I) | LL between 35 and 50 |
| High Plasticity (H) | LL between 50 and 70 |
| Very High Plasticity (V) | LL between 70 and 90 |
| Extremely High Plasticity (E) | LL greater than 90 |
- A3.4.4 In general, clays of high plasticity are likely to have a lower permeability, are more compressible and consolidate over a longer period of time under load than clays of low plasticity. Clays of high plasticity are more difficult to compact as fill material.

A3.5 SHEAR STRENGTH TESTS

- A3.5.1 The shear strength tests have been carried out in accordance with the procedures given in BS1377, Part 7.
- The type of test referred to is:
- A3.5.2 U1(100) - Undrained triaxial compression test on single specimen of 100mm diameter at a lateral pressure approximately equal to overburden pressure.
- A3.5.3 UM(100) - Multi-stage undrained triaxial compression test on a specimen of 100mm diameter. An initial low cell pressure is applied and the deviator stress increased until failure is imminent. The cell pressure is then increased and the procedure repeated until the failure stress at three different cell pressures have been determined.
- A3.5.4 U1(38) - Undrained triaxial compression test on a single specimen of 38mm diameter at a lateral pressure approximately equal to overburden pressure.
- A3.5.5 U(38) - Undrained triaxial compression test on set of three specimens of 38mm diameter at three differential lateral pressures.
- A3.5.6 Consolidated undrained triaxial – The Effective Stress Parameters were determined in accordance with the procedure detailed in BS1377: Part 8:1990 Clause 7 and the samples were prepared in accordance with clause 4.
- A3.5.7 Small shearbox – The peak, and in some cases residual, shear stress parameters were determined in accordance with the procedure detailed in BS1377: Part 7: 1990 Clause 4 and the samples were prepared in accordance with clause 4.

A3.6 COMPACTION TESTS

- A3.6.1 Whenever soil is placed as fill, it is generally necessary to compact it into a dense state. Laboratory compaction tests are carried out to provide the basis for control procedures. Compaction tests provide the following information.
- A3.6.2 The relationship between the dry density and moisture content for a given degree of compactive effort.
- A3.6.3 The moisture content for the most efficient compaction. This is defined as the **Optimum Moisture Content, OMC**, being the moisture content of the soil at which a specified amount of compaction will produce the maximum dry density.
- A3.6.4 The **Maximum Dry Density**, being the dry density obtained using a specified amount of compaction at the optimum moisture content.
- A3.6.5 There are three basic laboratory compaction tests, these being as follows:

Type of test (BS1377:1990 Part 4)	Container	Rammer			
		mass (kg)	drop (mm)	No of Layers	Blows Per Layer
Light compaction	BS mould (1l) CBR mould	2.5	300	3	27
		2.5	300	3	62
Heavy compaction	BS mould (1l) CBR mould	4.5	450	5	27
		4.5	450	5	62
Vibrating hammer	CBR mould	32 to	vibro	3	(1 min)

Unit 4 Faraday Close, Pattinson North Industrial Estate, Washington, Tyne & Wear, NE38 8QJ.
Tel. 0191 4828500 Fax. 0191 4828520 Email. washington@ianfarmer.co.uk Internet. www.ianfarmer.co.uk

Ian Farmer Associates (1998) Ltd
17 Rivington Court
Warrington
Cheshire
WA1 4RT

F.A.O. Mr A Latimer

TEST REPORT - 41787A/1

Site : Siemens Development Phase 1 & 2

Job Number : 41787A

Originating Client : Booth King Partnership Ltd

Originating Reference : 41787A

Date Sampled : Not given

Date Scheduled : 24/11/2015

Date Testing Started : 30/11/2015

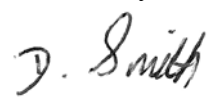
Date Testing Finished : 21/12/2015

Remarks :

- First Report for above Job Number
- Samples will be disposed of 28 days after the report is issued unless otherwise agreed
- This report may contain results from tests which are not included within the scope of the UKAS accreditation. Please see final sheet for details.

Data Input By:  Jemma Clark

Position : Laboratory Administrator Date : 21/12/2015

Authorised By:  Daniel Smith

Position : Laboratory Supervisor Date : 21/12/2015

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Job Number
41787A

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DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY AND LIQUIDITY INDEX

Borehole/ Trial Pit	Depth (m)	Sample	Natural / Sieved	Natural Moisture Content %	Sample Passing 425µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
					Percentage %	Moisture Content %						
BH01	5.00	U17	Natural	25	94	26	41	20	21	0.29	CI	Brown gravelly sandy CLAY
BH02	4.00	U14	Natural	22	96	23	43	20	23	0.13	CI	Brown gravelly CLAY
BH03	4.20	U14	Natural	20	99	21	36	16	20	0.25	CI	Brown gravelly CLAY
BH04	4.20	U15	Natural	19	97	20	36	14	22	0.27	CI	Brown sandy silty CLAY
BH06	5.00	U16	Natural	19	99	19	46	20	26	-0.04	CI	Brown CLAY
BH09	3.70	D12	Natural	74	93	79	41	19	22	2.73	CI	Brown sandy CLAY

Method of Preparation : BS 1377:PART 1:1990:7.4 Preparation of samples for classification tests BS 1377:PART 2:1990:4.2 & 5.2 Sample preparations

Method of Test : BS 1377:PART 2:1990:3.2 Determination of moisture content 4.3 Determination of the liquid limit 5.3 Determination of the plastic limit and plasticity index



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

Job Number
41787A

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DETERMINATION OF MOISTURE CONTENT / BULK DENSITY / DRY DENSITY

Borehole/ Trial Pit	Depth (m)	Sample	Moisture Content %	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Description / Remarks
BH04	4.20	U15	19	2.14	1.79	Brown sandy silty CLAY

Method of Preparation : BS 1377:PART 1:1990:8.2,8.3,8.4

Method of Test : BS 1377:PART 2:1990:7 Determination of Density

Site : Siemens Development Phase 1 & 2

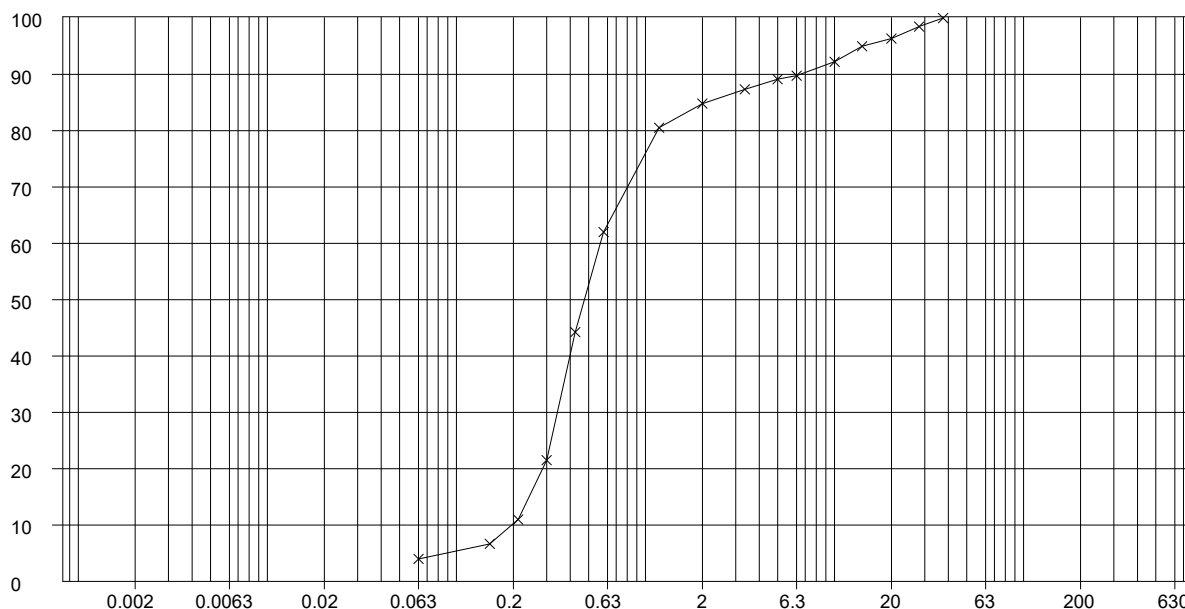
Client : Booth King Partnership Ltd

Job Number
41787A

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH01	2.00	B9	N/A	Brown silty clayey gravelly SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	99
20 mm	96
14 mm	95
10 mm	92
6.3 mm	90
5 mm	89
3.35 mm	87
2 mm	85
1.18 mm	81
600 µm	62
425 µm	44
300 µm	22
212 µm	11
150 µm	7
63 µm	4

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

Grading Analysis	
D85	2.1 mm
D60	580.1 µm
D10	198.0 µm
Uniformity Coefficient	2.9

Particle Proportions	
Cobbles + Boulders	0%
Gravel	15%
Sand	81%
Silt/Clay	4%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with no dispersant used, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

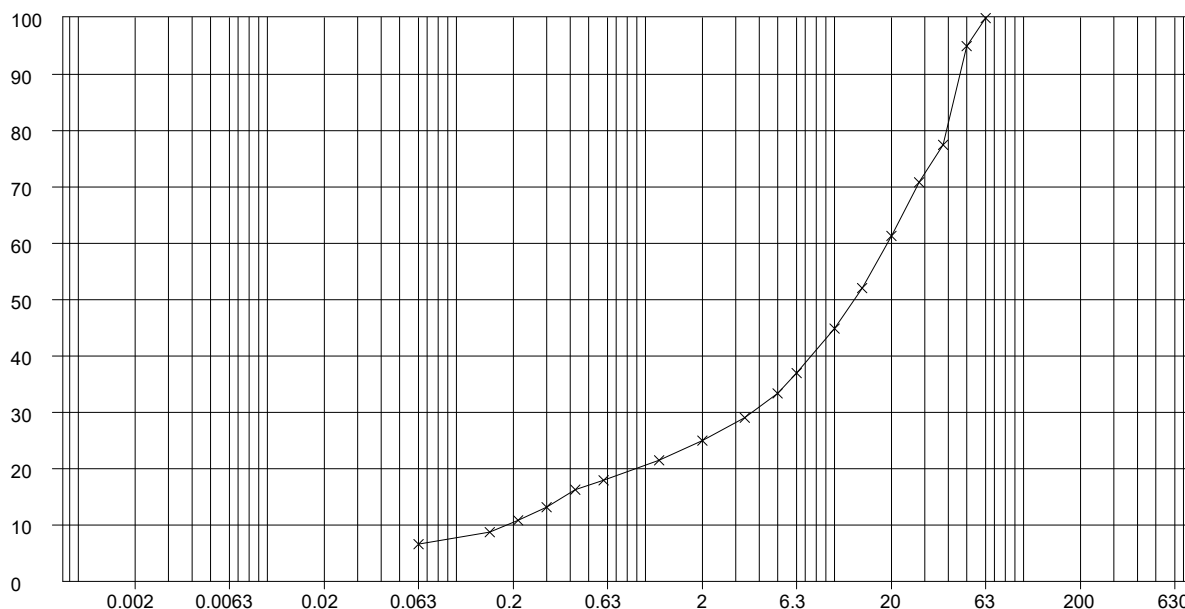
Client : Booth King Partnership Ltd

Job Number
41787A

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH03	0.50	B2	N/A	Brown silty clayey sandy GRAVEL includes cobbles



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	95
37.5 mm	77
28 mm	71
20 mm	61
14 mm	52
10 mm	45
6.3 mm	37
5 mm	33
3.35 mm	29
2 mm	25
1.18 mm	22
600 µm	18
425 µm	16
300 µm	13
212 µm	11
150 µm	9
63 µm	7

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

Grading Analysis	
D85	42.9 mm
D60	19.1 mm
D10	187.0 µm
Uniformity Coefficient	102.4

Particle Proportions	
Cobbles + Boulders	1%
Gravel	74%
Sand	18%
Silt/Clay	7%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with no dispersant used, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

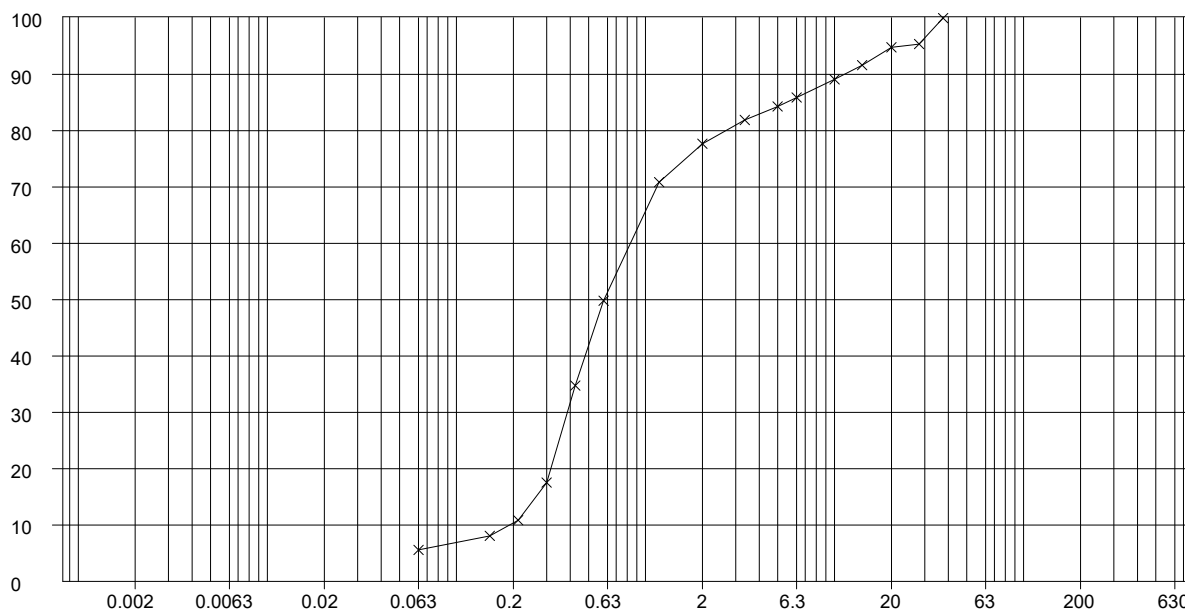
Client : Booth King Partnership Ltd

Job Number
41787A

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH04	1.20	B6	N/A	Brown silty clayey gravelly SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	95
20 mm	95
14 mm	92
10 mm	89
6.3 mm	86
5 mm	84
3.35 mm	82
2 mm	78
1.18 mm	71
600 µm	50
425 µm	35
300 µm	18
212 µm	11
150 µm	8
63 µm	6

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

Grading Analysis	
D85	5.6 mm
D60	880.5 µm
D10	193.0 µm
Uniformity Coefficient	4.6

Particle Proportions	
Cobbles + Boulders	0%
Gravel	22%
Sand	72%
Silt/Clay	6%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with no dispersant used, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

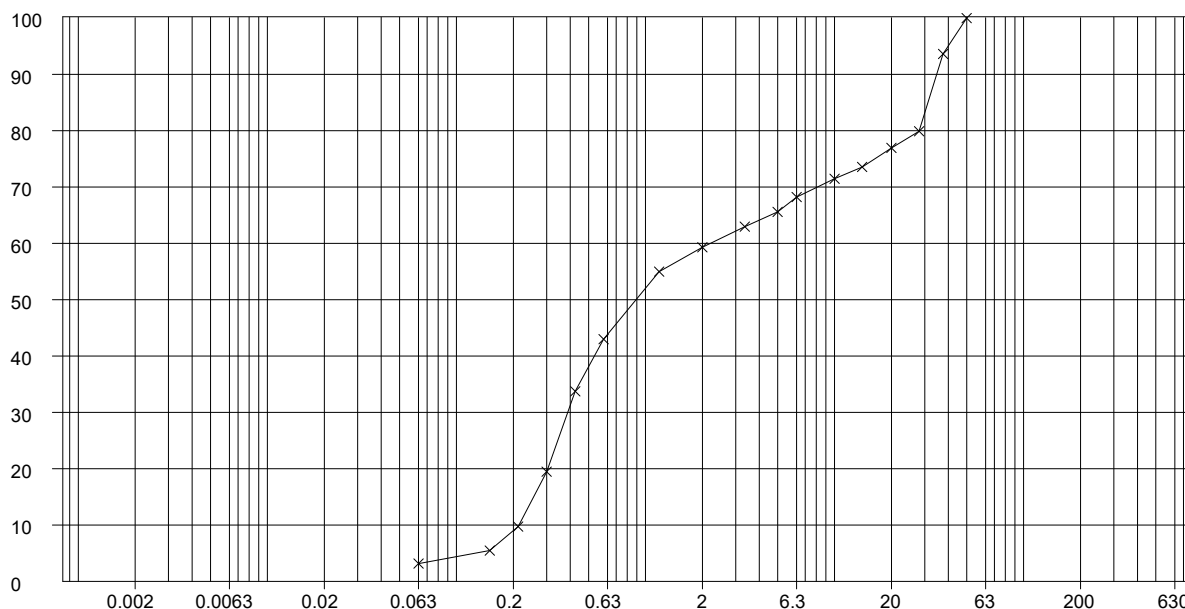
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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH05	2.20	B8	N/A	Brown silty clayey gravelly SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	94
28 mm	80
20 mm	77
14 mm	74
10 mm	71
6.3 mm	68
5 mm	66
3.35 mm	63
2 mm	59
1.18 mm	55
600 µm	43
425 µm	34
300 µm	19
212 µm	10
150 µm	5
63 µm	3

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

Grading Analysis	
D85	31.5 mm
D60	2.3 mm
D10	214.0 µm
Uniformity Coefficient	10.5

Particle Proportions	
Cobbles + Boulders	0%
Gravel	41%
Sand	56%
Silt/Clay	3%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with no dispersant used, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

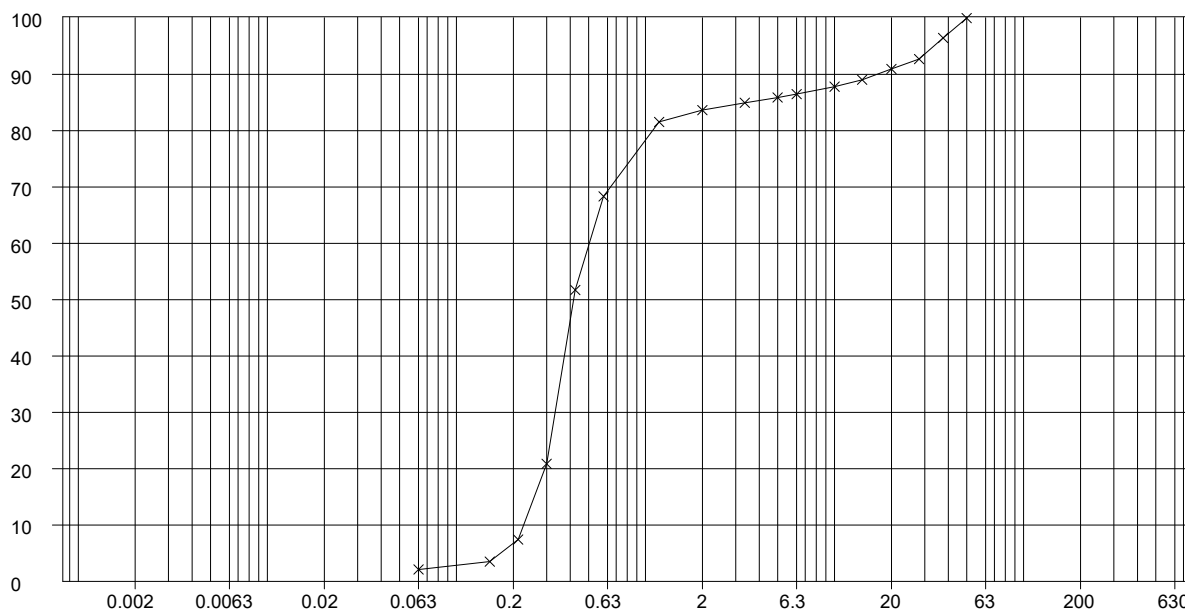
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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH07	3.00	B9	N/A	Brown silty clayey gravelly SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	96
28 mm	93
20 mm	91
14 mm	89
10 mm	88
6.3 mm	87
5 mm	86
3.35 mm	85
2 mm	84
1.18 mm	82
600 µm	68
425 µm	52
300 µm	21
212 µm	7
150 µm	4
63 µm	2

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

Grading Analysis	
D85	3.4 mm
D60	512.1 µm
D10	229.0 µm
Uniformity Coefficient	2.2

Particle Proportions	
Cobbles + Boulders	0%
Gravel	16%
Sand	82%
Silt/Clay	2%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with no dispersant used, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

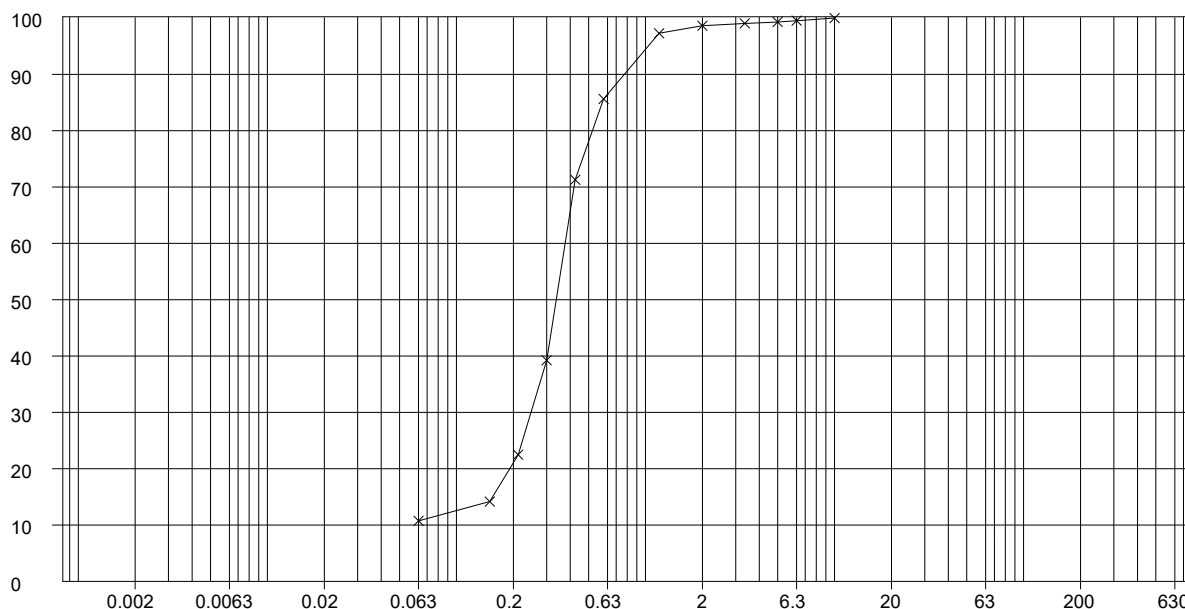
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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH08	1.20	B6	N/A	Brown gravelly silty clayey SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	100
20 mm	100
14 mm	100
10 mm	100
6.3 mm	100
5 mm	99
3.35 mm	99
2 mm	99
1.18 mm	97
600 µm	86
425 µm	71
300 µm	39
212 µm	22
150 µm	14
63 µm	11

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

Grading Analysis	
D85	592.2 µm
D60	380.9 µm
D10	-
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	0%
Gravel	1%
Sand	88%
Silt/Clay	11%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with washing dispersant, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

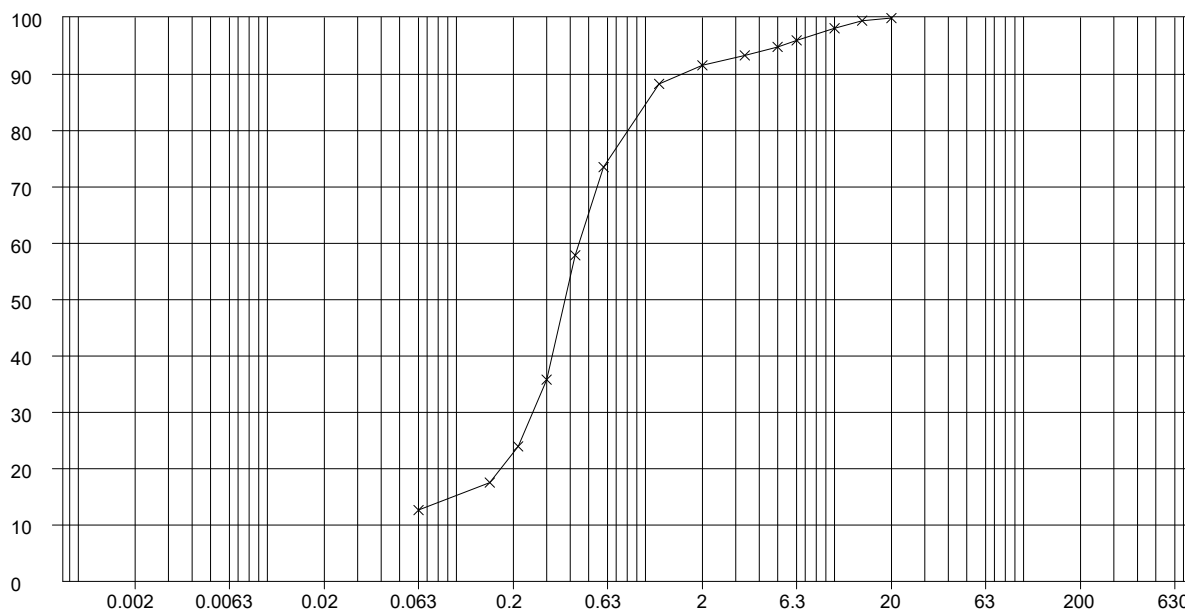
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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH10	1.20	B7	N/A	Brown gravelly silty clayey SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	100
20 mm	100
14 mm	100
10 mm	98
6.3 mm	96
5 mm	95
3.35 mm	93
2 mm	92
1.18 mm	88
600 µm	74
425 µm	58
300 µm	36
212 µm	24
150 µm	18
63 µm	13

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

Grading Analysis	
D85	1.0 mm
D60	448.5 µm
D10	-
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	0%
Gravel	8%
Sand	79%
Silt/Clay	13%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with washing dispersant, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

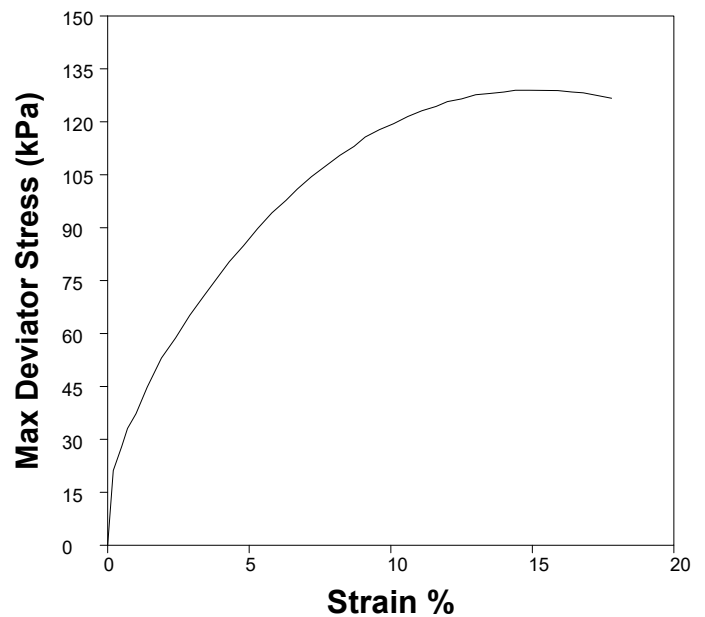
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH01	5.00	U17	Brown gravelly sandy CLAY

Initial Specimen		Length of Sample (mm)		455
		Depth from top of sample (mm)		52
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			207.8	
Diameter of Specimen (mm)			102.3	
Moisture Content (%)			25	
Bulk Density (Mg/m³)			2.05	
Dry Density (Mg/m³)			1.64	
Membrane Thickness (mm)			0.32	
Membrane Type			Latex	
Rate of Strain (%/min)			1.93	
Test Results	Measured Cell Pressure (kPa)		100	
	Strain at Failure (%)		14.4	
	Membrane Correction (kPa)		0.9	
	Corrected Deviator Stress (kPa)		128	
	Shear Stress (kPa)		64	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

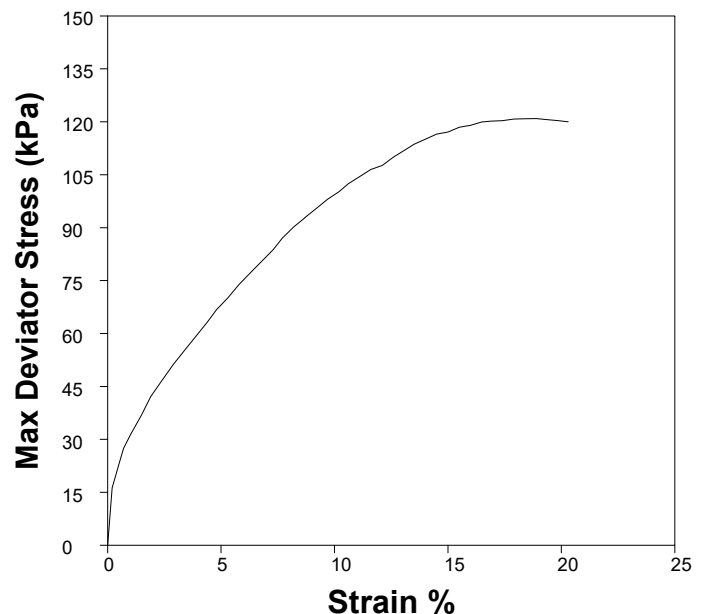
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH02	4.00	U14	Brown gravelly CLAY

Initial Specimen		Length of Sample (mm)		429
		Depth from top of sample (mm)		50
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			206.7	
Diameter of Specimen (mm)			101.7	
Moisture Content (%)			22	
Bulk Density (Mg/m³)			2.04	
Dry Density (Mg/m³)			1.67	
Membrane Thickness (mm)			0.3	
Membrane Type			Latex	
Rate of Strain (%/min)			1.93	
Test Results	Measured Cell Pressure (kPa)		80	
	Strain at Failure (%)		18.9	
	Membrane Correction (kPa)		1.1	
	Corrected Deviator Stress (kPa)		120	
	Shear Stress (kPa)		60	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

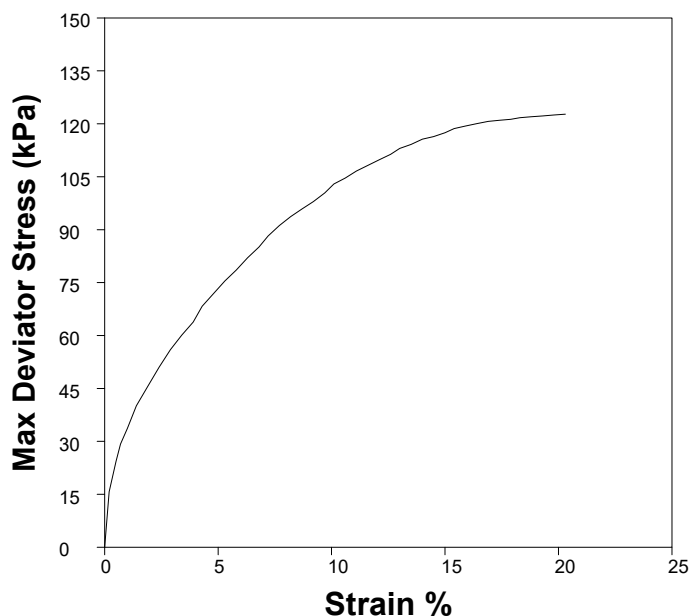
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH03	4.20	U14	Brown gravelly CLAY

Initial Specimen		Length of Sample (mm)		429
		Depth from top of sample (mm)		67
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			207.1	
Diameter of Specimen (mm)			104.5	
Moisture Content (%)			20	
Bulk Density (Mg/m³)			2.06	
Dry Density (Mg/m³)			1.71	
Membrane Thickness (mm)			0.32	
Membrane Type			Latex	
Rate of Strain (%/min)			1.94	
Test Results	Measured Cell Pressure (kPa)		84	
	Strain at Failure (%)		20.3	
	Membrane Correction (kPa)		1.2	
	Corrected Deviator Stress (kPa)		122	
	Shear Stress (kPa)		61	
	Mode of Failure (B/P/C)		Plastic	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

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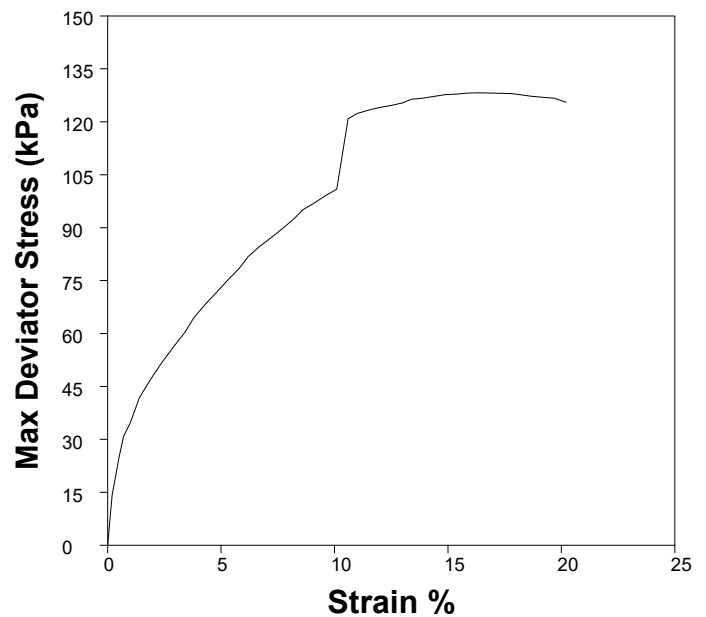
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH04	6.50	UP22	Brown sandy silty CLAY

Initial Specimen		Length of Sample (mm)		256
		Depth from top of sample (mm)		42
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			208.4	
Diameter of Specimen (mm)			105	
Moisture Content (%)			28	
Bulk Density (Mg/m³)			1.91	
Dry Density (Mg/m³)			1.50	
Membrane Thickness (mm)			0.33	
Membrane Type			Latex	
Rate of Strain (%/min)			1.92	
Test Results	Measured Cell Pressure (kPa)		130	
	Strain at Failure (%)		16.3	
	Membrane Correction (kPa)		1.0	
	Corrected Deviator Stress (kPa)		127	
	Shear Stress (kPa)		64	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

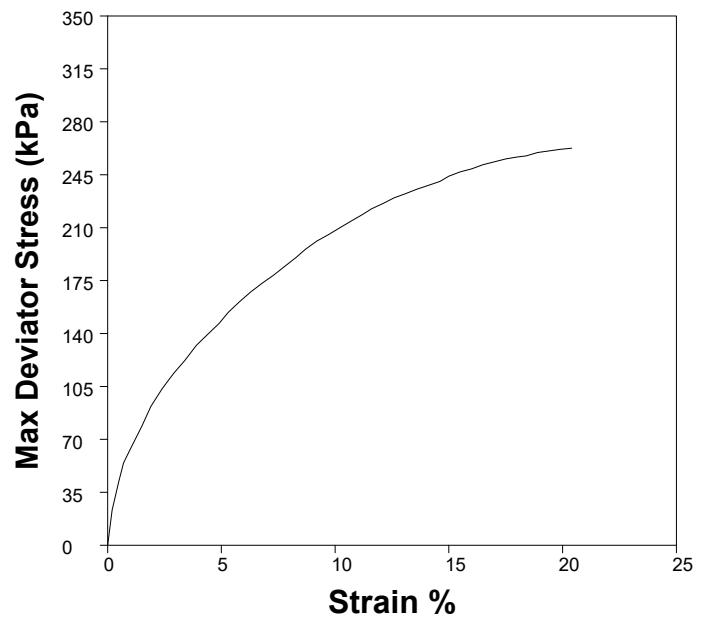
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH06	5.00	U16	Brown CLAY

Initial Specimen		Length of Sample (mm)		452
		Depth from top of sample (mm)		51
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			206	
Diameter of Specimen (mm)			104.1	
Moisture Content (%)			19	
Bulk Density (Mg/m³)			2.07	
Dry Density (Mg/m³)			1.74	
Membrane Thickness (mm)			0.34	
Membrane Type			Latex	
Rate of Strain (%/min)			1.94	
Test Results	Measured Cell Pressure (kPa)		100	
	Strain at Failure (%)		20.4	
	Membrane Correction (kPa)		1.3	
	Corrected Deviator Stress (kPa)		261	
	Shear Stress (kPa)		131	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

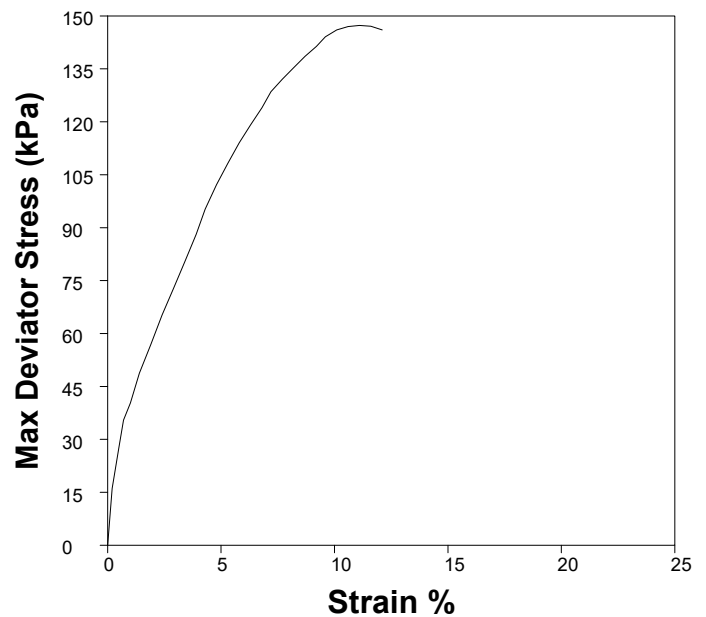
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH07	6.50	U16	Brown sandy CLAY

Initial Specimen		Length of Sample (mm)		452
		Depth from top of sample (mm)		50
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			207.4	
Diameter of Specimen (mm)			102.3	
Moisture Content (%)			22	
Bulk Density (Mg/m³)			2.02	
Dry Density (Mg/m³)			1.65	
Membrane Thickness (mm)			0.31	
Membrane Type			Latex	
Rate of Strain (%/min)			1.93	
Test Results	Measured Cell Pressure (kPa)		130	
	Strain at Failure (%)		11.1	
	Membrane Correction (kPa)		0.7	
	Corrected Deviator Stress (kPa)		147	
	Shear Stress (kPa)		73	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

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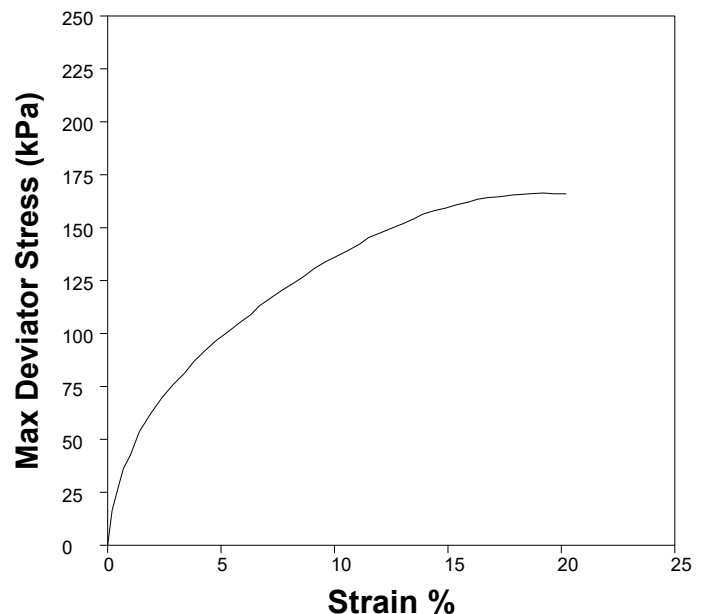
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH09	5.20	U16	Brown CLAY

Initial Specimen		Length of Sample (mm)		454
		Depth from top of sample (mm)		50
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			208	
Diameter of Specimen (mm)			103.2	
Moisture Content (%)			18	
Bulk Density (Mg/m³)			2.05	
Dry Density (Mg/m³)			1.74	
Membrane Thickness (mm)			0.33	
Membrane Type			Latex	
Rate of Strain (%/min)			1.93	
Test Results	Measured Cell Pressure (kPa)		104	
	Strain at Failure (%)		19.2	
	Membrane Correction (kPa)		1.2	
	Corrected Deviator Stress (kPa)		165	
	Shear Stress (kPa)		83	
	Mode of Failure (B/P/C)		Plastic	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



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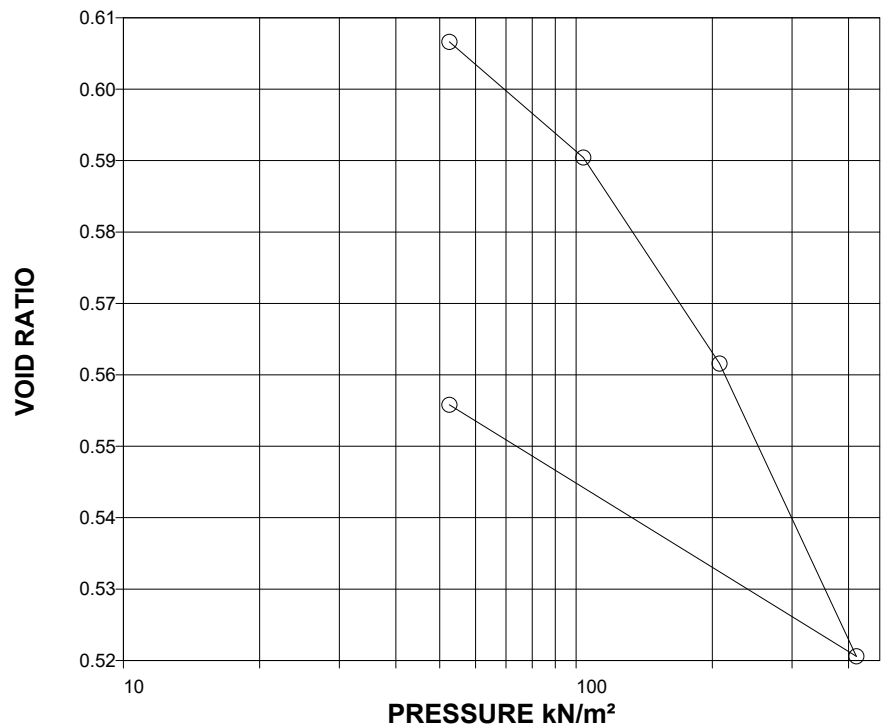
ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Description
BH09	5.20	U16	Brown CLAY

Initial Specimen		Length of Sample (mm)	450
		Depth from top of sample (mm)	50
		Condition of Sample:	Undisturbed
		Orientation:	Vertical

Diameter (mm)	75.05
Particle Density (Mg/m ³)	2.65 (Assumed)
Swelling Pressure (kN/m ²)	
Lab Temp (°C)	20

	Initial	Final
Height (mm)	18.88	18.03
Wet Weight (g)	171.62	170.04
Moisture Content (%)	26	25
Bulk Density (Mg/m ³)	2.05	2.13
Dry Density (Mg/m ³)	1.63	1.71
Void Ratio	0.626	0.550
Degree of Saturation (%)	109.22	119.49



Pressure kN/m ²	m _v m ² /MN	c _v m ² /year	Void Ratio
52.5	0.26	30	0.607
103.75	0.21	3.1	0.590
207.5	0.19	2.7	0.562
416.25	0.13	2.0	0.521
52.5	0.07	13	0.556

Pressure kN/m ²	m _v m ² /MN	c _v m ² /year	Void Ratio

Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Site : Siemens Development Phase 1 & 2

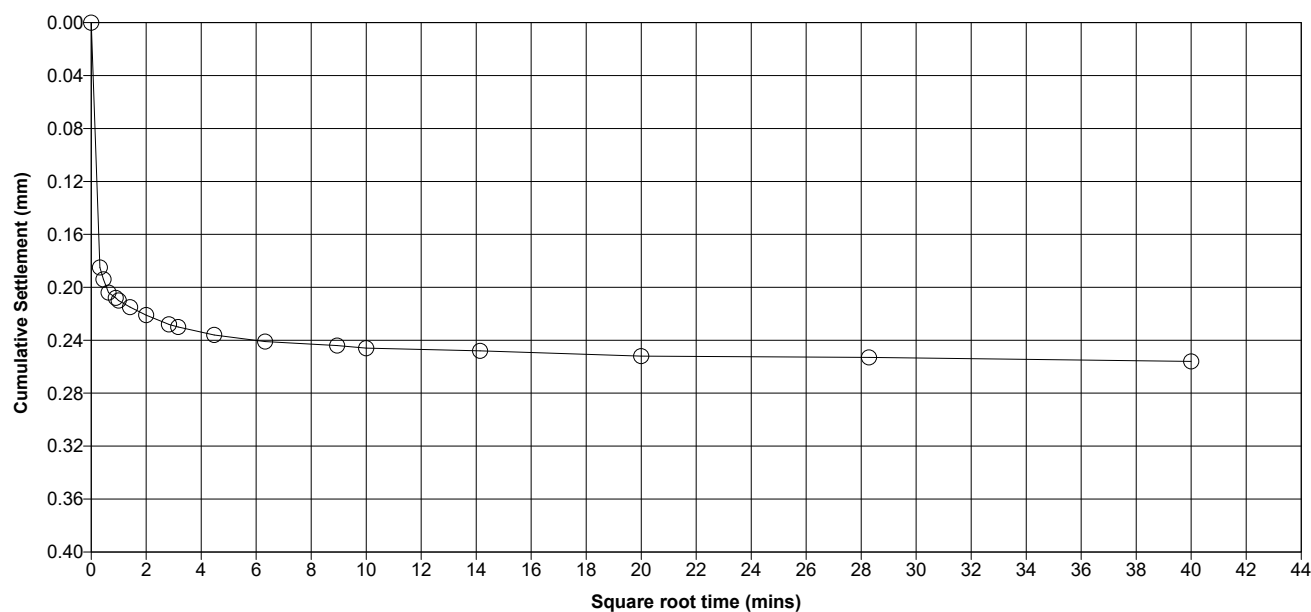
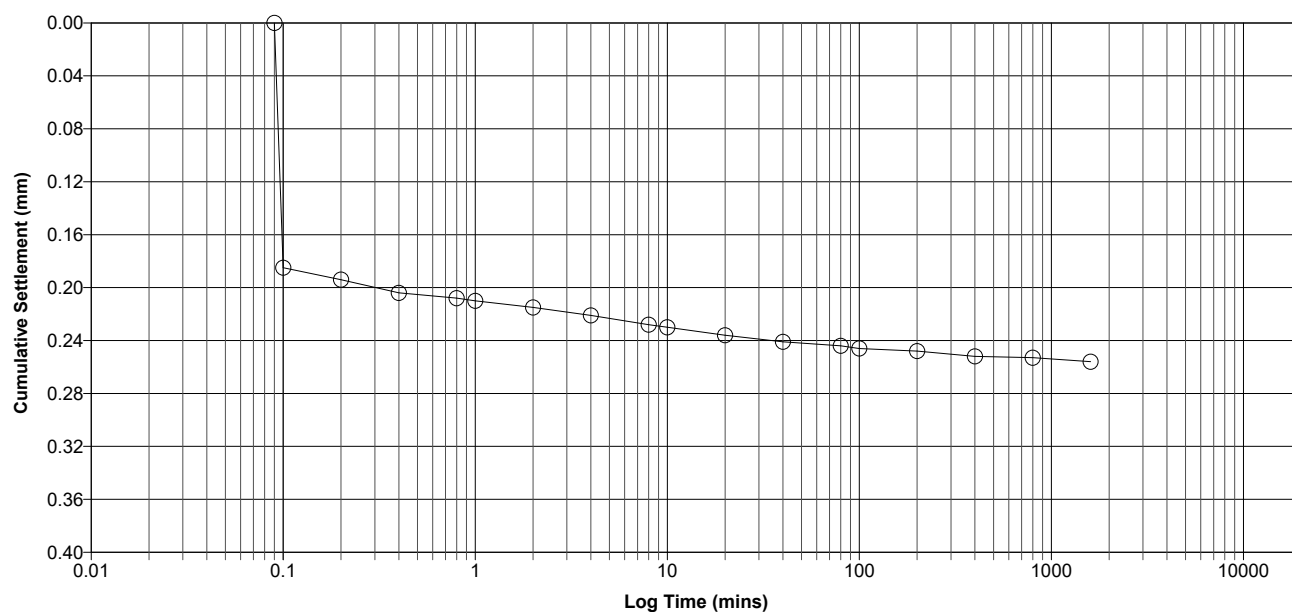
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ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Stage	Description
BH09	5.20	U16	1	Brown CLAY


Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Site : Siemens Development Phase 1 & 2

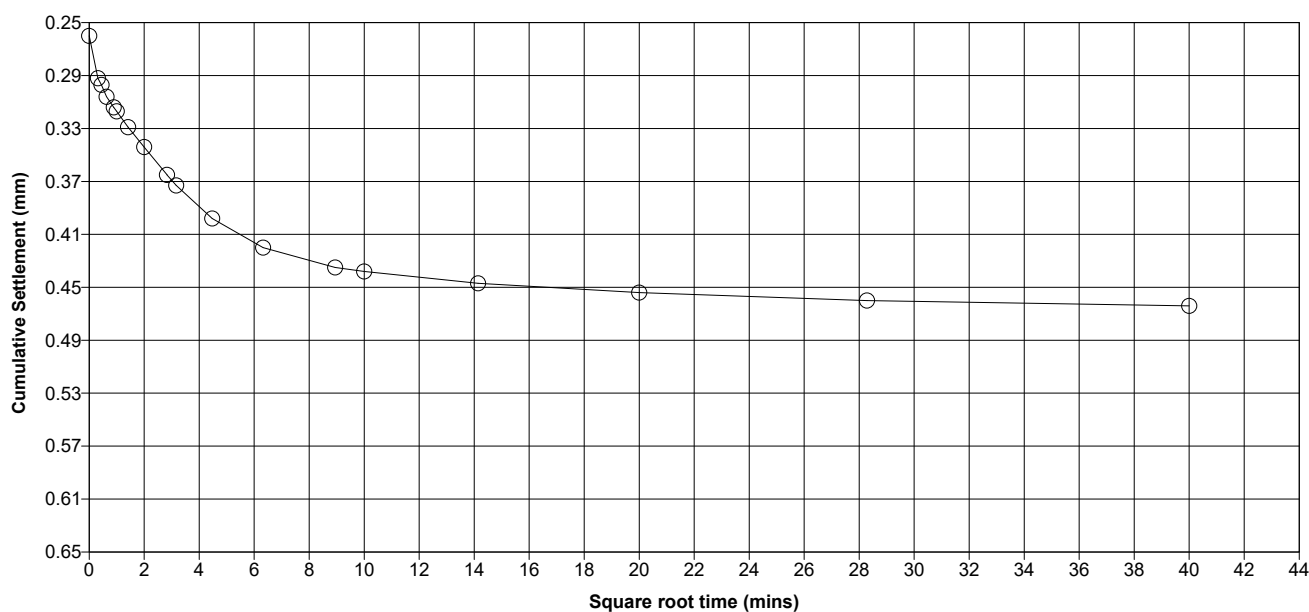
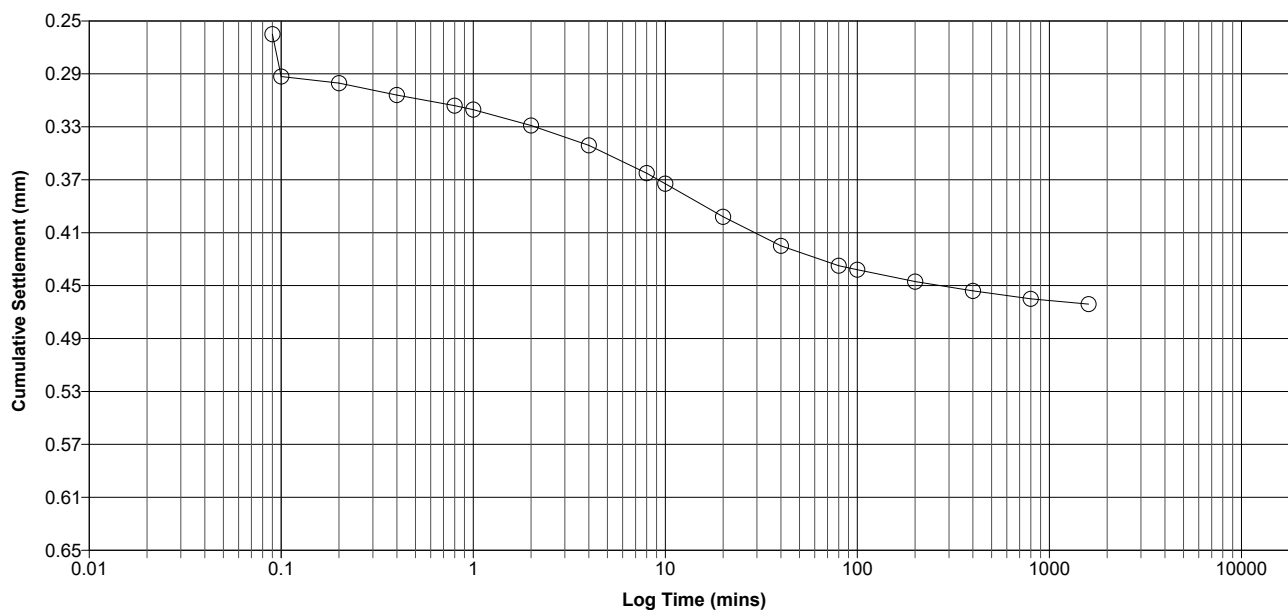
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ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Stage	Description
BH09	5.20	U16	2	Brown CLAY


Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Site : Siemens Development Phase 1 & 2

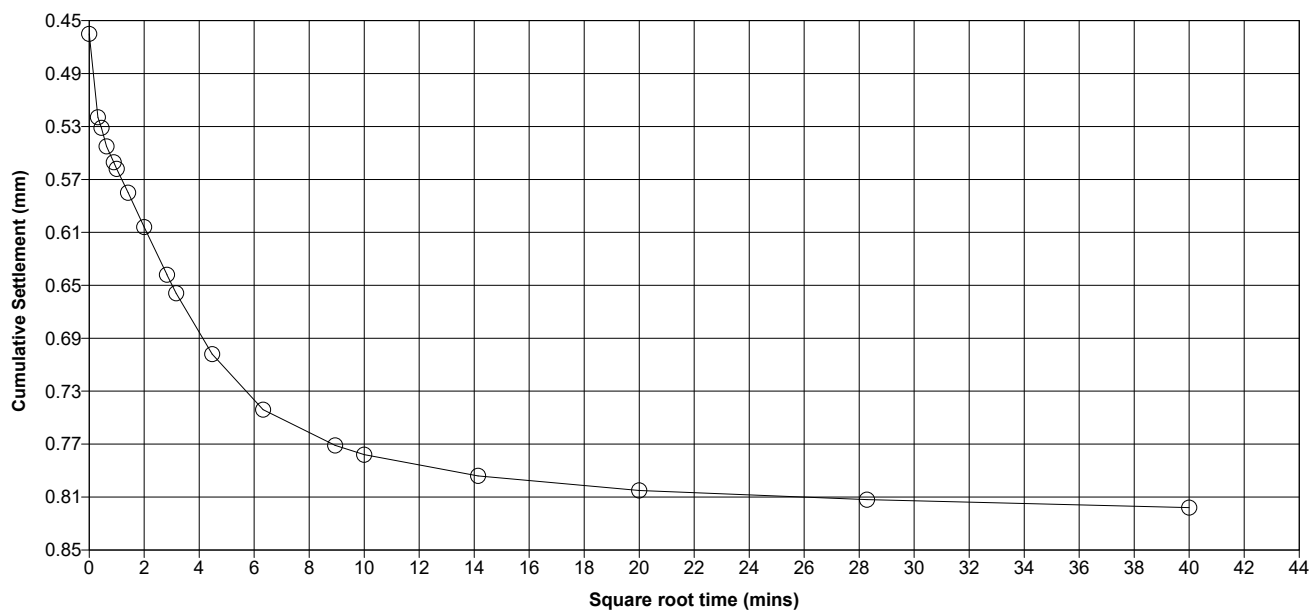
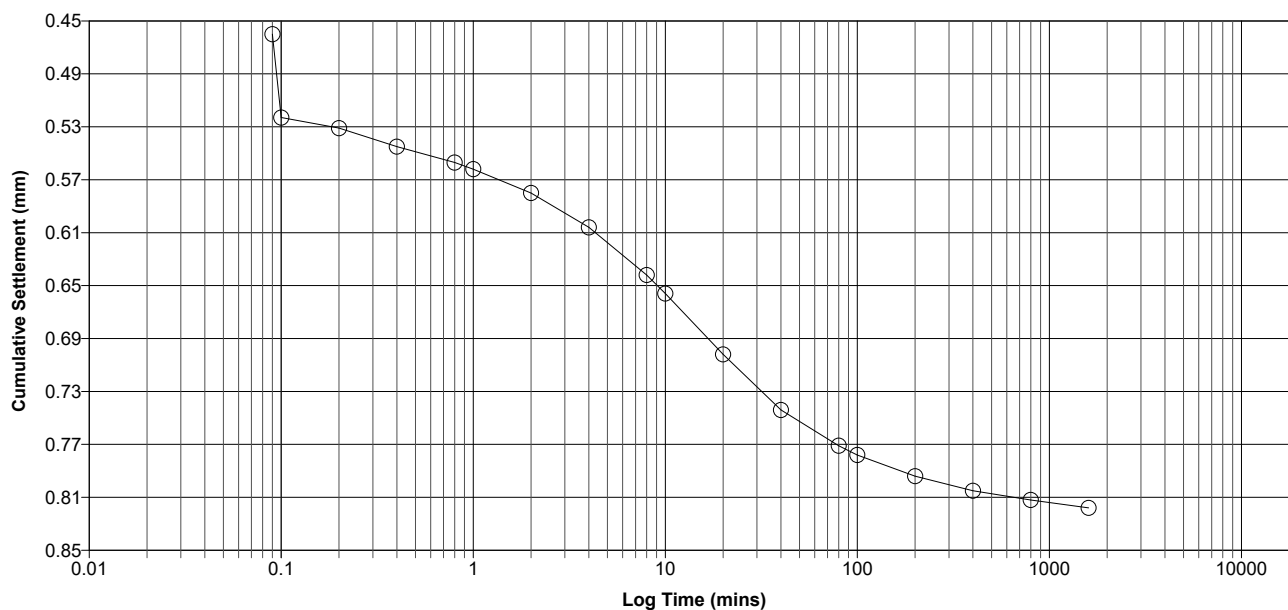
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ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Stage	Description
BH09	5.20	U16	3	Brown CLAY


Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Site : Siemens Development Phase 1 & 2

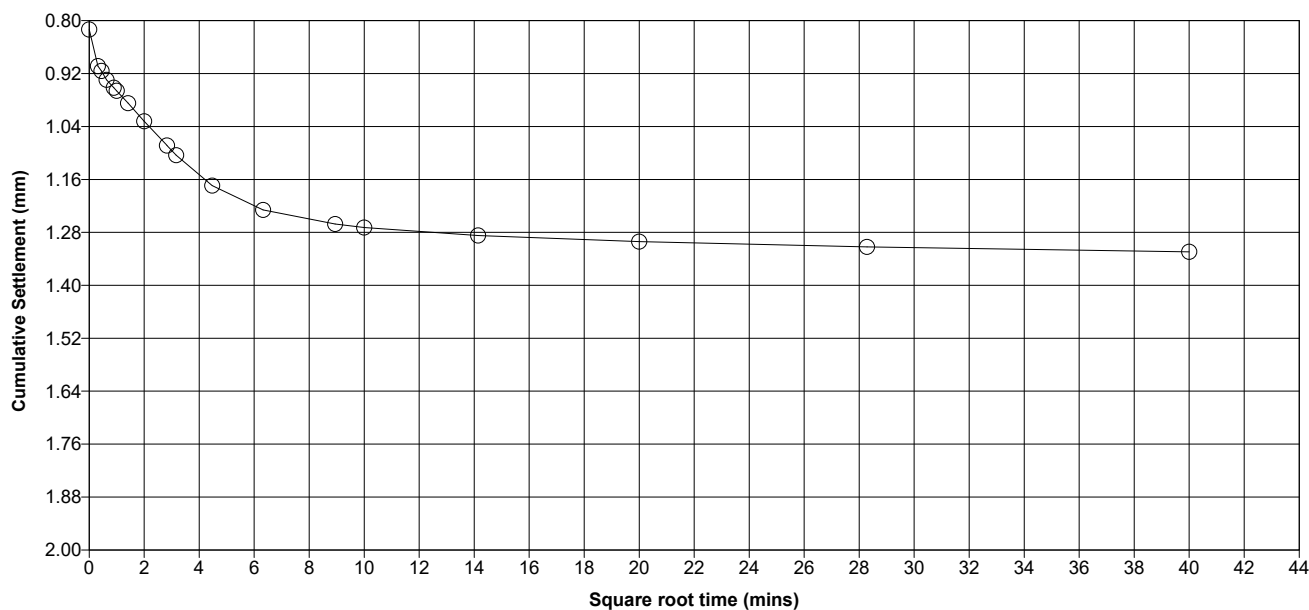
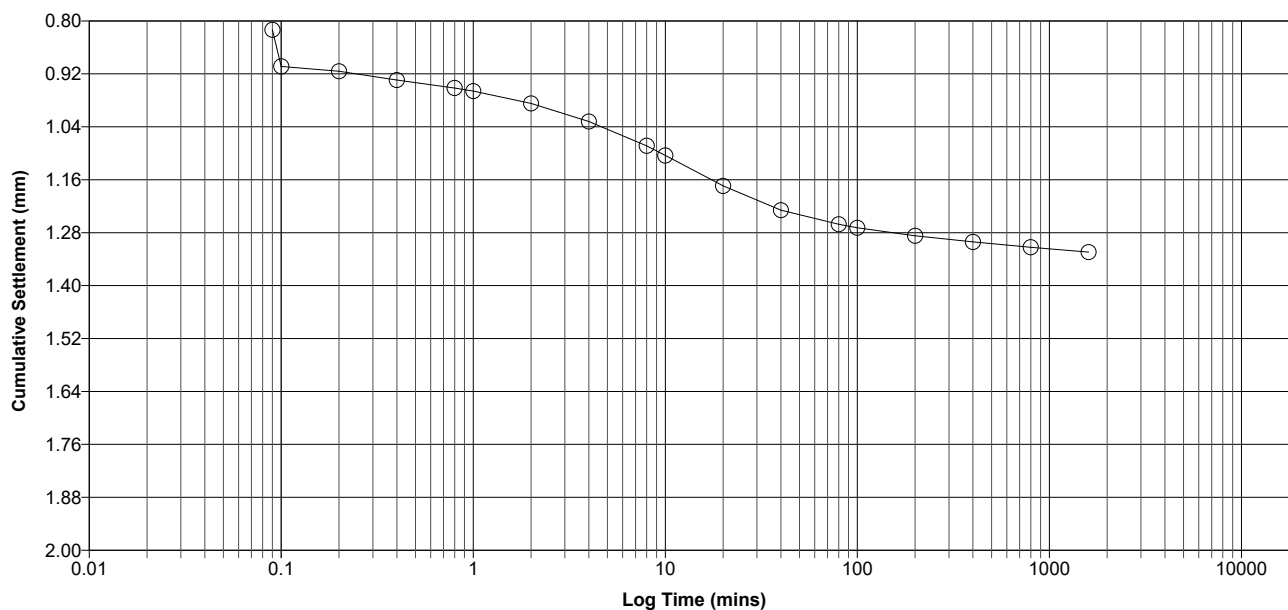
Job Number
41787A

Client : Booth King Partnership Ltd

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ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Stage	Description
BH09	5.20	U16	4	Brown CLAY


Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Site : Siemens Development Phase 1 & 2

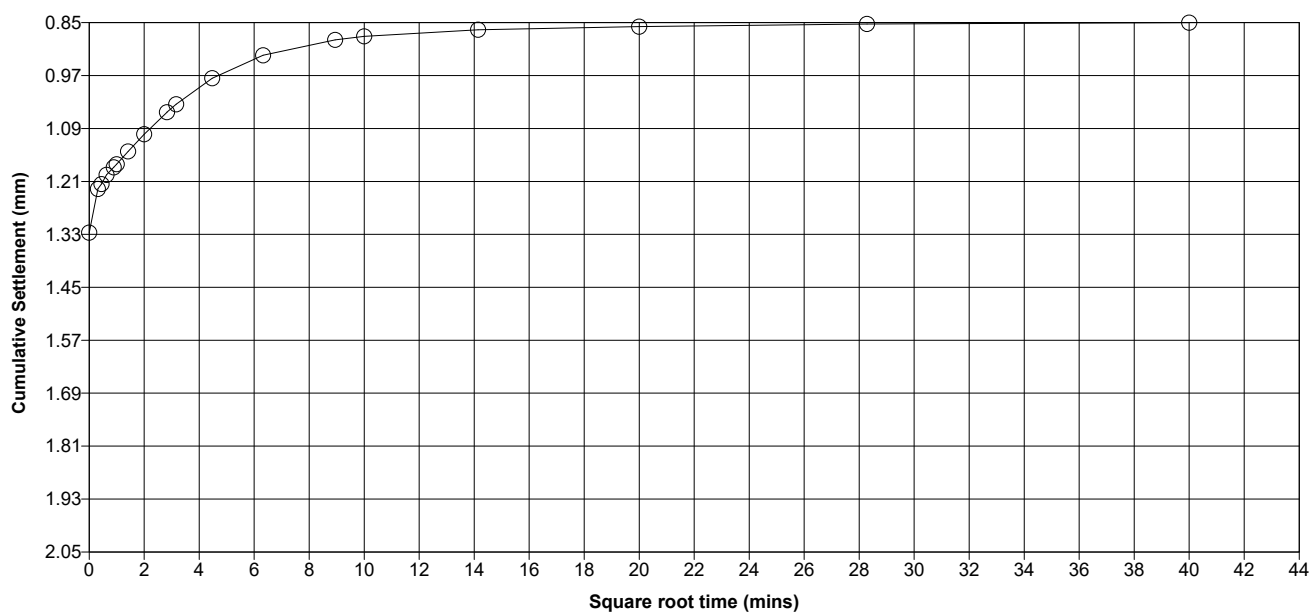
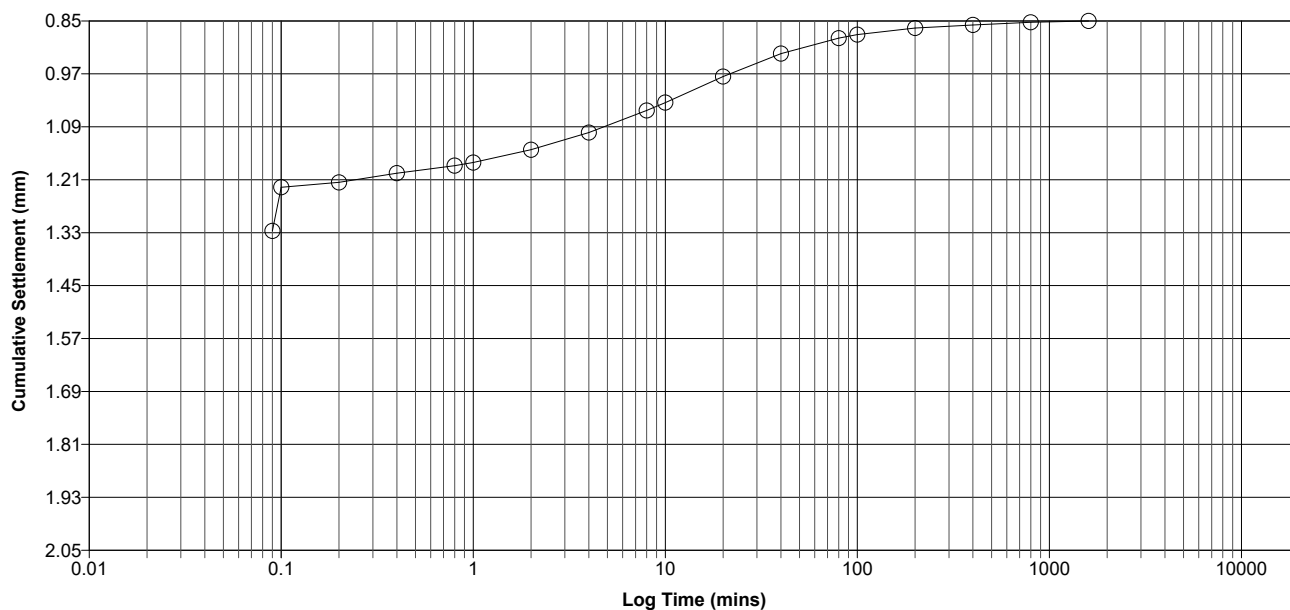
Job Number
41787A

Client : Booth King Partnership Ltd

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ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Stage	Description
BH09	5.20	U16	5	Brown CLAY


Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Test Report : **41787A/1**

Site : Siemens Development Phase 1 & 2

Job Number : 41787A

Originating Client : Booth King Partnership Ltd

All opinions and interpretations contained within this report are outside of our Scope of Accreditation.

The following tests contained within this report are not UKAS Accredited.

Date of Issued : 21/12/2015

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Ian Farmer Associates (1998) Ltd
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F.A.O. Mr A Latimer

TEST REPORT - 41787A/2

Site : Siemens Development Phase 1 & 2

Job Number : 41787A

Originating Client : Booth King Partnership Ltd

Originating Reference : 41787A

Date Sampled : Not given

Date Scheduled : 24/11/2015

Date Testing Started : 30/11/2015

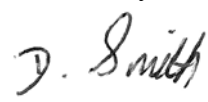
Date Testing Finished : 21/12/2015

Remarks :

- First Report for above Job Number
- Samples will be disposed of 28 days after the report is issued unless otherwise agreed
- This report may contain results from tests which are not included within the scope of the UKAS accreditation. Please see final sheet for details.

Data Input By:  Jemma Clark

Position : Laboratory Administrator Date : 14/01/2016

Authorised By:  Daniel Smith

Position : Laboratory Supervisor Date : 14/01/2016

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Job Number	41787A
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DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY AND LIQUIDITY INDEX

Borehole/ Trial Pit	Depth (m)	Sample	Natural / Sieved	Natural Moisture Content %	Sample Passing 425µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
					Percentage %	Moisture Content %						
BH01	5.00	U17	Natural	25	94	26	41	20	21	0.29	CI	Brown gravelly sandy CLAY
BH02	4.00	U14	Natural	22	96	23	43	20	23	0.13	CI	Brown gravelly CLAY
BH03	4.20	U14	Natural	20	99	21	36	16	20	0.25	CI	Brown gravelly CLAY
BH04	4.20	U15	Natural	19	97	20	36	14	22	0.27	CI	Brown sandy silty CLAY
BH06	5.00	U16	Natural	19	99	19	46	20	26	-0.04	CI	Brown CLAY
BH09	3.70	D12	Natural	20	93	21	41	19	22	0.09	CI	Brown sandy CLAY

Method of Preparation : BS 1377:PART 1:1990:7.4 Preparation of samples for classification tests BS 1377:PART 2:1990:4.2 & 5.2 Sample preparations

Method of Test : BS 1377:PART 2:1990:3.2 Determination of moisture content 4.3 Determination of the liquid limit 5.3 Determination of the plastic limit and plasticity index

Site : Siemens Development Phase 1 & 2

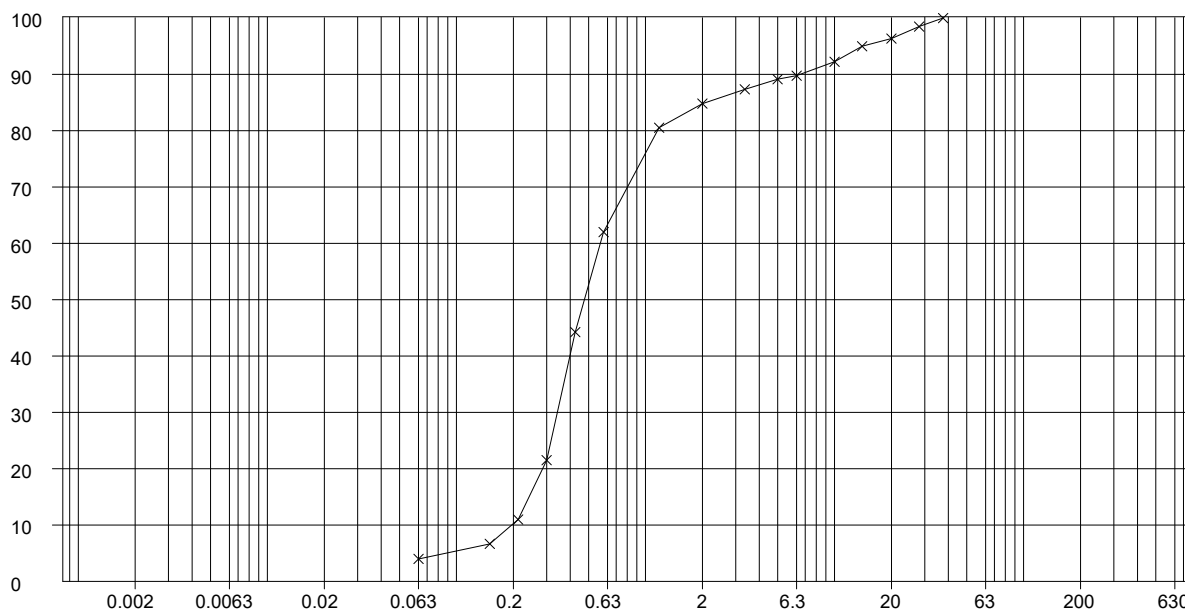
Job Number
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Client : Booth King Partnership Ltd

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH01	2.00	B9	N/A	Brown silty clayey gravelly SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	99
20 mm	96
14 mm	95
10 mm	92
6.3 mm	90
5 mm	89
3.35 mm	87
2 mm	85
1.18 mm	81
600 µm	62
425 µm	44
300 µm	22
212 µm	11
150 µm	7
63 µm	4

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

Grading Analysis	
D85	2.1 mm
D60	580.1 µm
D10	198.0 µm
Uniformity Coefficient	2.9

Particle Proportions	
Cobbles + Boulders	0%
Gravel	15%
Sand	81%
Silt/Clay	4%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with no dispersant used, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

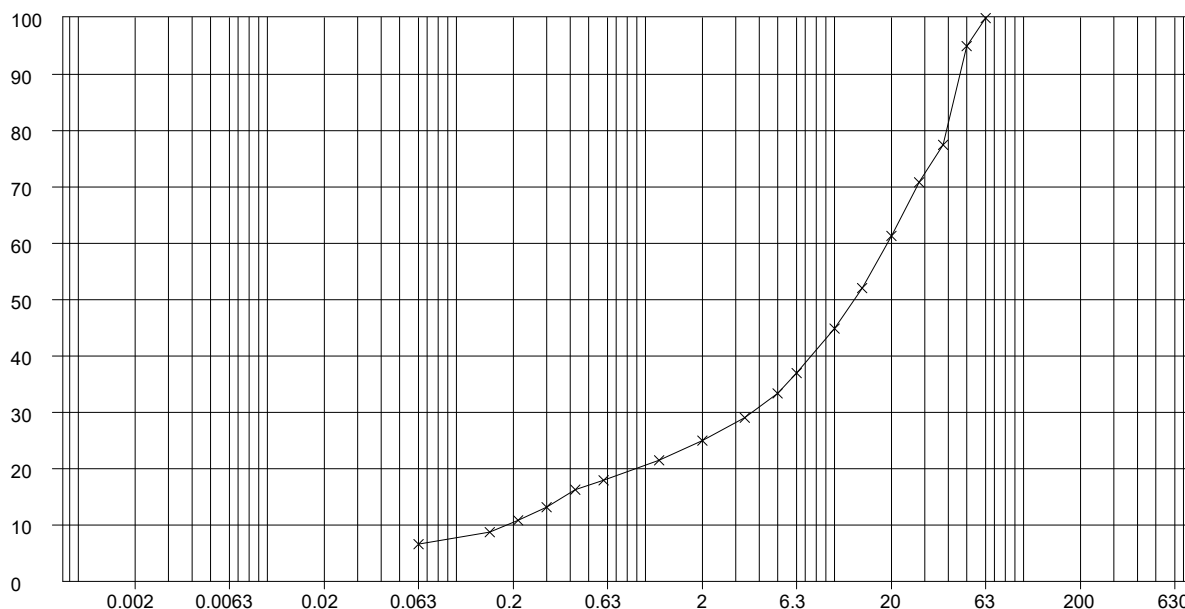
Job Number
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Client : Booth King Partnership Ltd

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH03	0.50	B2	N/A	Brown silty clayey sandy GRAVEL includes cobbles



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	95
37.5 mm	77
28 mm	71
20 mm	61
14 mm	52
10 mm	45
6.3 mm	37
5 mm	33
3.35 mm	29
2 mm	25
1.18 mm	22
600 µm	18
425 µm	16
300 µm	13
212 µm	11
150 µm	9
63 µm	7

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

Grading Analysis	
D85	42.9 mm
D60	19.1 mm
D10	187.0 µm
Uniformity Coefficient	102.4

Particle Proportions	
Cobbles + Boulders	1%
Gravel	74%
Sand	18%
Silt/Clay	7%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with no dispersant used, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

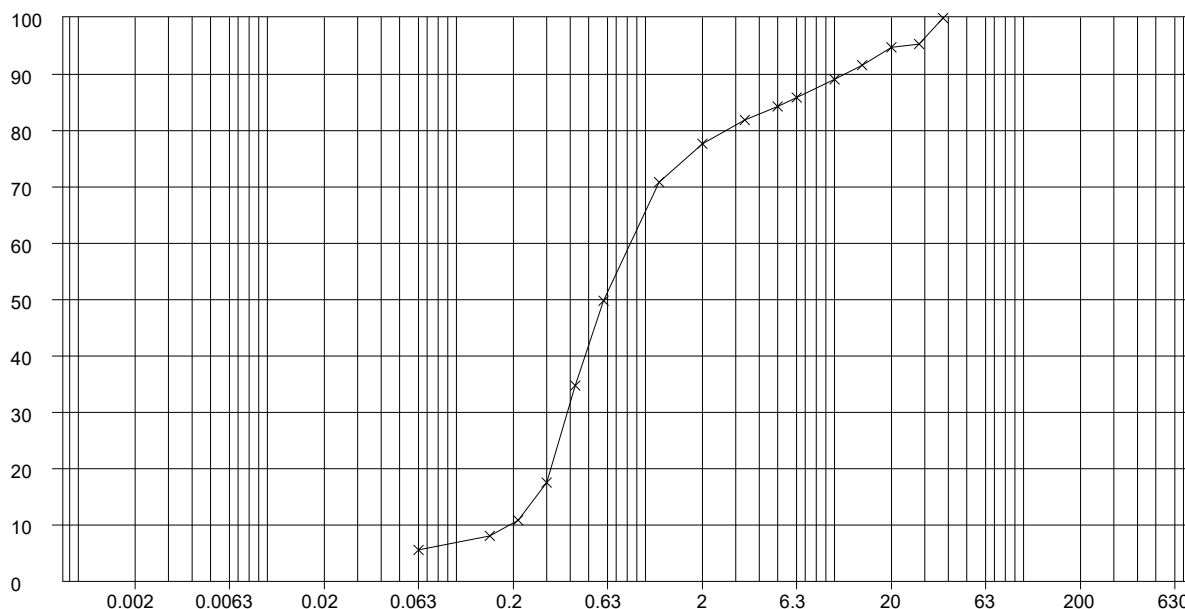
Client : Booth King Partnership Ltd

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41787A

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH04	1.20	B6	N/A	Brown silty clayey gravelly SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	95
20 mm	95
14 mm	92
10 mm	89
6.3 mm	86
5 mm	84
3.35 mm	82
2 mm	78
1.18 mm	71
600 µm	50
425 µm	35
300 µm	18
212 µm	11
150 µm	8
63 µm	6

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

Grading Analysis	
D85	5.6 mm
D60	880.5 µm
D10	193.0 µm
Uniformity Coefficient	4.6

Particle Proportions	
Cobbles + Boulders	0%
Gravel	22%
Sand	72%
Silt/Clay	6%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with no dispersant used, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

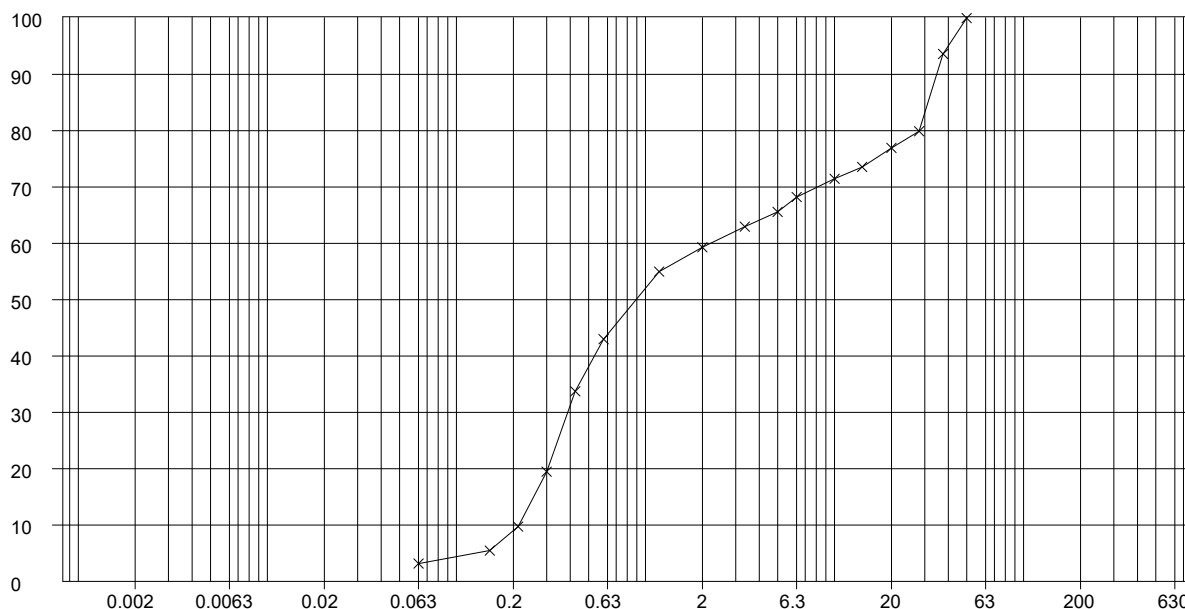
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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH05	2.20	B8	N/A	Brown silty clayey gravelly SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	94
28 mm	80
20 mm	77
14 mm	74
10 mm	71
6.3 mm	68
5 mm	66
3.35 mm	63
2 mm	59
1.18 mm	55
600 µm	43
425 µm	34
300 µm	19
212 µm	10
150 µm	5
63 µm	3

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

Grading Analysis	
D85	31.5 mm
D60	2.3 mm
D10	214.0 µm
Uniformity Coefficient	10.5

Particle Proportions	
Cobbles + Boulders	0%
Gravel	41%
Sand	56%
Silt/Clay	3%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with no dispersant used, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

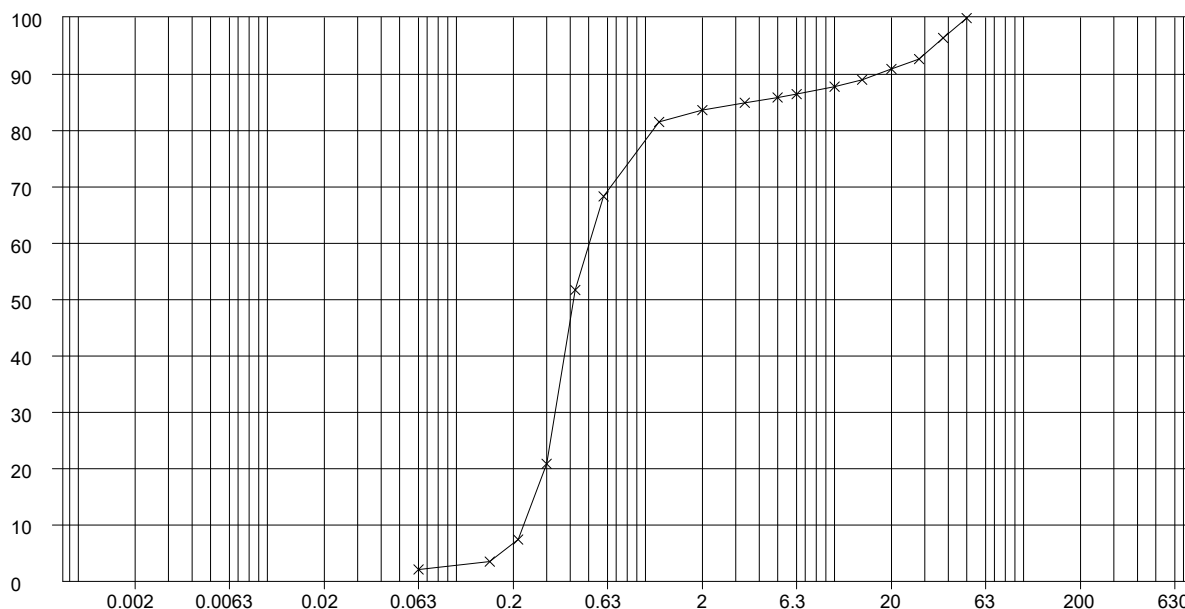
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Client : Booth King Partnership Ltd

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH07	3.00	B9	N/A	Brown silty clayey gravelly SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	96
28 mm	93
20 mm	91
14 mm	89
10 mm	88
6.3 mm	87
5 mm	86
3.35 mm	85
2 mm	84
1.18 mm	82
600 µm	68
425 µm	52
300 µm	21
212 µm	7
150 µm	4
63 µm	2

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

Grading Analysis	
D85	3.4 mm
D60	512.1 µm
D10	229.0 µm
Uniformity Coefficient	2.2

Particle Proportions	
Cobbles + Boulders	0%
Gravel	16%
Sand	82%
Silt/Clay	2%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with no dispersant used, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

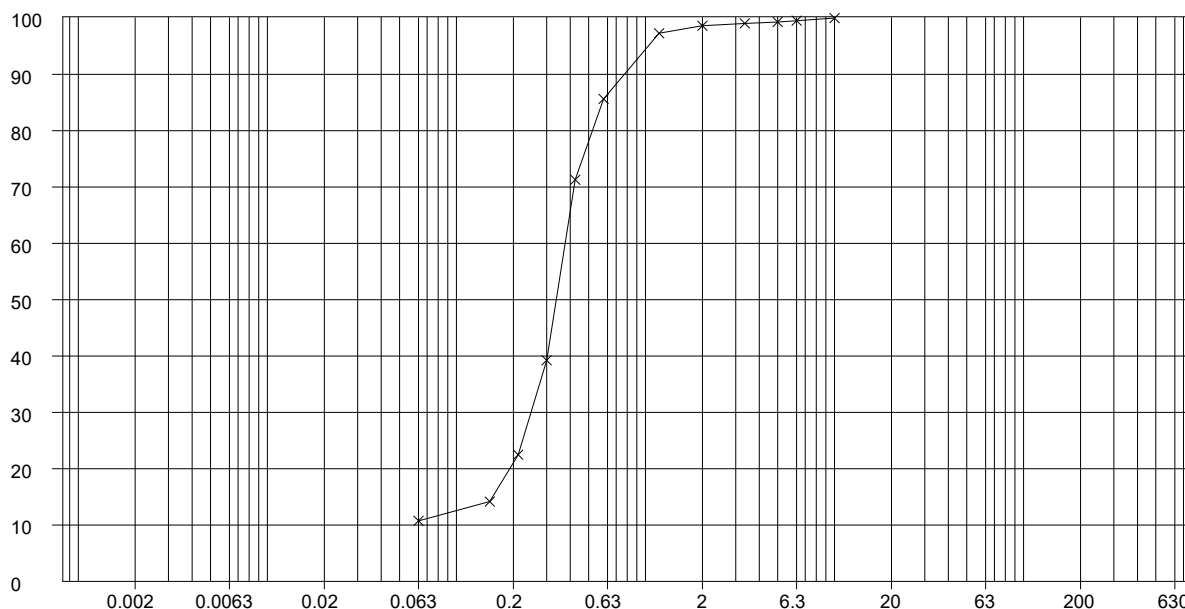
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Client : Booth King Partnership Ltd

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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH08	1.20	B6	N/A	Brown gravelly silty clayey SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	100
20 mm	100
14 mm	100
10 mm	100
6.3 mm	100
5 mm	99
3.35 mm	99
2 mm	99
1.18 mm	97
600 µm	86
425 µm	71
300 µm	39
212 µm	22
150 µm	14
63 µm	11

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

Grading Analysis	
D85	592.2 µm
D60	380.9 µm
D10	-
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	0%
Gravel	1%
Sand	88%
Silt/Clay	11%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with washing dispersant, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :

Site : Siemens Development Phase 1 & 2

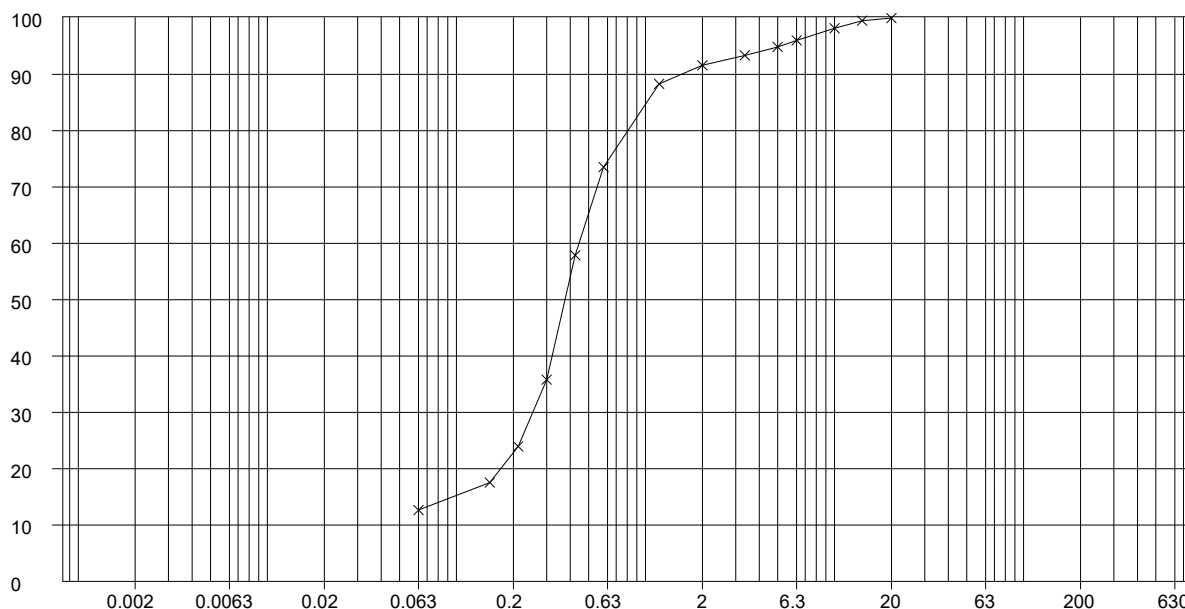
Client : Booth King Partnership Ltd

Job Number
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DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Pipette/ Hydrometer	Description
BH10	1.20	B7	N/A	Brown gravelly silty clayey SAND



Sieve / Particle Size	% Passing
200 mm	100
150 mm	100
125 mm	100
90 mm	100
75 mm	100
63 mm	100
50 mm	100
37.5 mm	100
28 mm	100
20 mm	100
14 mm	100
10 mm	98
6.3 mm	96
5 mm	95
3.35 mm	93
2 mm	92
1.18 mm	88
600 µm	74
425 µm	58
300 µm	36
212 µm	24
150 µm	18
63 µm	13

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

Grading Analysis	
D85	1.0 mm
D60	448.5 µm
D10	-
Uniformity Coefficient	-

Particle Proportions	
Cobbles + Boulders	0%
Gravel	8%
Sand	79%
Silt/Clay	13%

Method of Preparation : BS 1377:PART 1:1990:7.3 Initial preparation 7.4.5 Particle size tests

Preparation Details : Sample washed with washing dispersant, Oven Dried at 105 - 110°C

Method of Test : BS 1377:PART 2:1990:9 Determination of particle size distribution

Remarks :



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

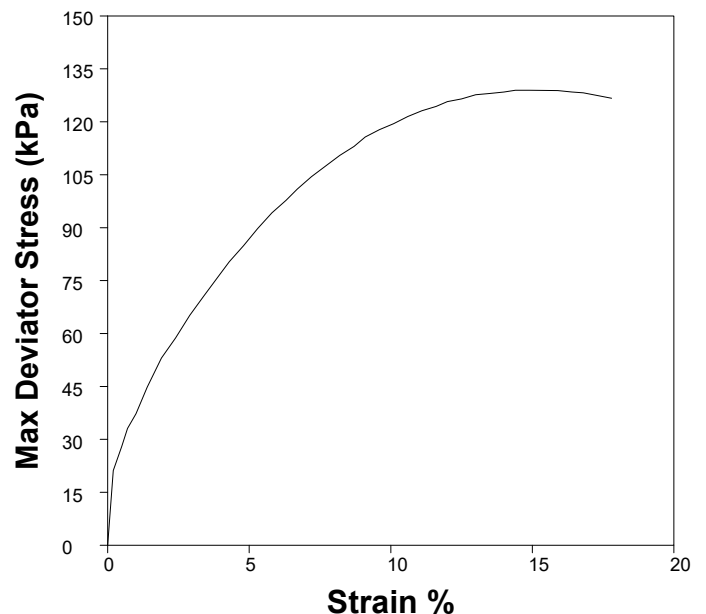
Job Number
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH01	5.00	U17	Brown gravelly sandy CLAY

Initial Specimen		Length of Sample (mm)		455
		Depth from top of sample (mm)		52
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			207.8	
Diameter of Specimen (mm)			102.3	
Moisture Content (%)			25	
Bulk Density (Mg/m³)			2.05	
Dry Density (Mg/m³)			1.64	
Membrane Thickness (mm)			0.32	
Membrane Type			Latex	
Rate of Strain (%/min)			1.93	
Test Results	Measured Cell Pressure (kPa)		100	
	Strain at Failure (%)		14.4	
	Membrane Correction (kPa)		0.9	
	Corrected Deviator Stress (kPa)		128	
	Shear Stress (kPa)		64	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

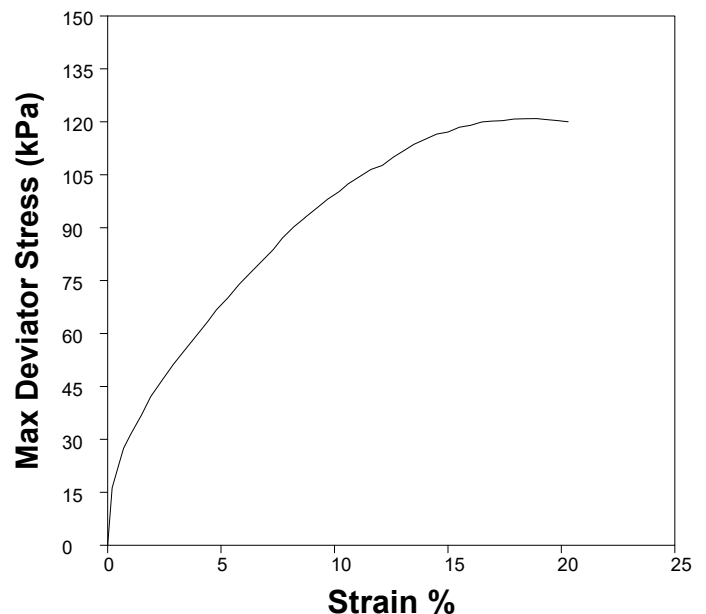
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH02	4.00	U14	Brown gravelly CLAY

Initial Specimen		Length of Sample (mm)		429
		Depth from top of sample (mm)		50
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			206.7	
Diameter of Specimen (mm)			101.7	
Moisture Content (%)			22	
Bulk Density (Mg/m³)			2.04	
Dry Density (Mg/m³)			1.67	
Membrane Thickness (mm)			0.3	
Membrane Type			Latex	
Rate of Strain (%/min)			1.93	
Test Results	Measured Cell Pressure (kPa)		80	
	Strain at Failure (%)		18.9	
	Membrane Correction (kPa)		1.1	
	Corrected Deviator Stress (kPa)		120	
	Shear Stress (kPa)		60	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

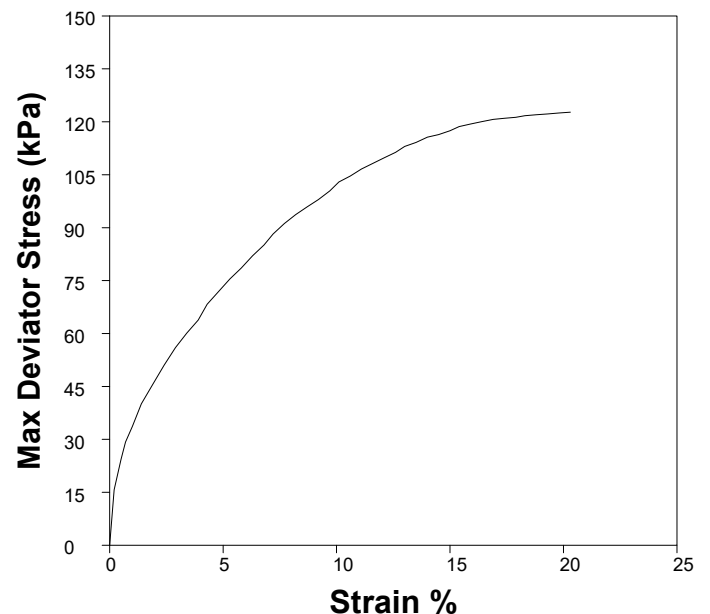
Job Number
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH03	4.20	U14	Brown gravelly CLAY

Initial Specimen		Length of Sample (mm)		429
		Depth from top of sample (mm)		67
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			207.1	
Diameter of Specimen (mm)			104.5	
Moisture Content (%)			20	
Bulk Density (Mg/m³)			2.06	
Dry Density (Mg/m³)			1.71	
Membrane Thickness (mm)			0.32	
Membrane Type			Latex	
Rate of Strain (%/min)			1.94	
Test Results	Measured Cell Pressure (kPa)		84	
	Strain at Failure (%)		20.3	
	Membrane Correction (kPa)		1.2	
	Corrected Deviator Stress (kPa)		122	
	Shear Stress (kPa)		61	
	Mode of Failure (B/P/C)		Plastic	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

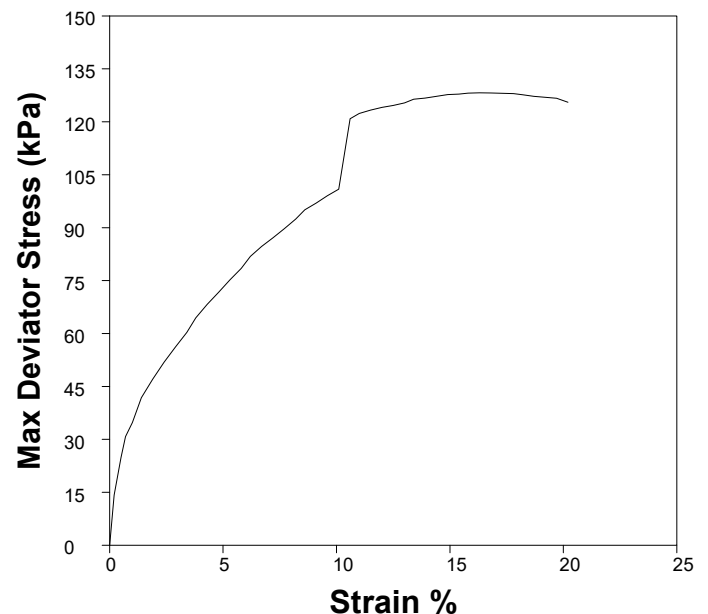
Job Number
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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH04	6.50	UP22	Brown sandy silty CLAY

Initial Specimen		Length of Sample (mm)		256
		Depth from top of sample (mm)		42
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			208.4	
Diameter of Specimen (mm)			105	
Moisture Content (%)			28	
Bulk Density (Mg/m³)			1.91	
Dry Density (Mg/m³)			1.50	
Membrane Thickness (mm)			0.33	
Membrane Type			Latex	
Rate of Strain (%/min)			1.92	
Test Results	Measured Cell Pressure (kPa)		130	
	Strain at Failure (%)		16.3	
	Membrane Correction (kPa)		1.0	
	Corrected Deviator Stress (kPa)		127	
	Shear Stress (kPa)		64	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

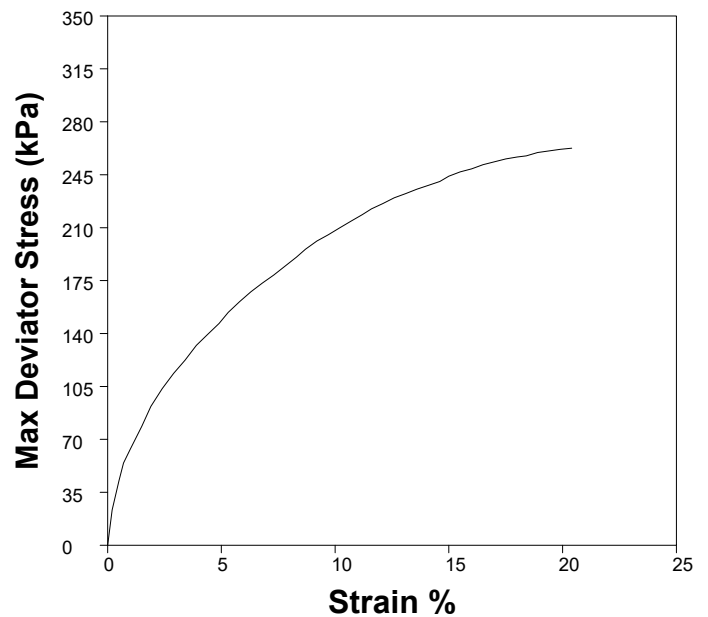
Job Number
41787A

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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH06	5.00	U16	Brown CLAY

Initial Specimen		Length of Sample (mm)		452
		Depth from top of sample (mm)		51
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			206	
Diameter of Specimen (mm)			104.1	
Moisture Content (%)			19	
Bulk Density (Mg/m³)			2.07	
Dry Density (Mg/m³)			1.74	
Membrane Thickness (mm)			0.34	
Membrane Type			Latex	
Rate of Strain (%/min)			1.94	
Test Results	Measured Cell Pressure (kPa)		100	
	Strain at Failure (%)		20.4	
	Membrane Correction (kPa)		1.3	
	Corrected Deviator Stress (kPa)		261	
	Shear Stress (kPa)		131	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

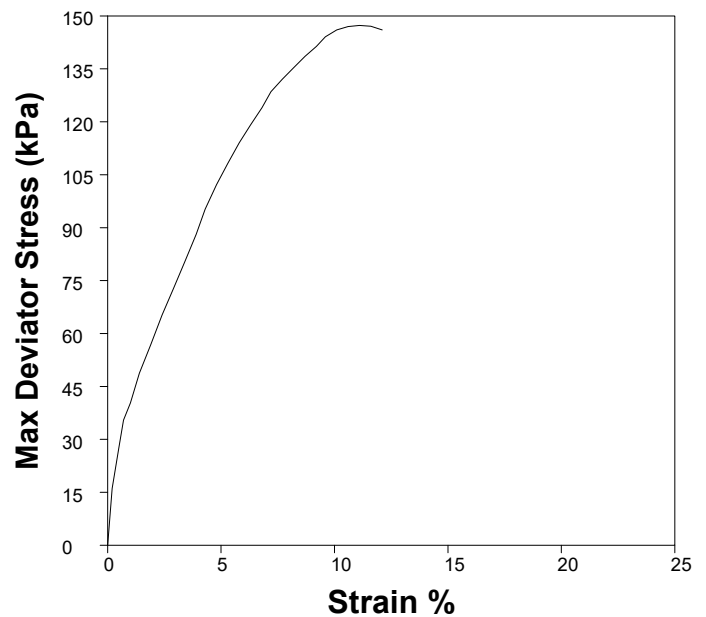
Job Number
41787A

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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH07	6.50	U16	Brown sandy CLAY

Initial Specimen		Length of Sample (mm)		452
		Depth from top of sample (mm)		50
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			207.4	
Diameter of Specimen (mm)			102.3	
Moisture Content (%)			22	
Bulk Density (Mg/m³)			2.02	
Dry Density (Mg/m³)			1.65	
Membrane Thickness (mm)			0.31	
Membrane Type			Latex	
Rate of Strain (%/min)			1.93	
Test Results	Measured Cell Pressure (kPa)		130	
	Strain at Failure (%)		11.1	
	Membrane Correction (kPa)		0.7	
	Corrected Deviator Stress (kPa)		147	
	Shear Stress (kPa)		73	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

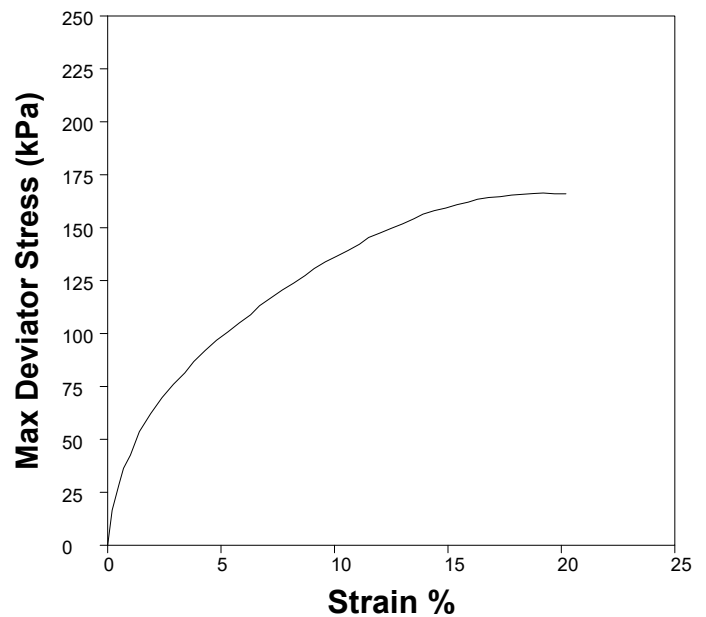
Job Number
41787A

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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH09	5.20	U16	Brown CLAY

Initial Specimen		Length of Sample (mm)		454
		Depth from top of sample (mm)		50
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			208	
Diameter of Specimen (mm)			103.2	
Moisture Content (%)			18	
Bulk Density (Mg/m³)			2.05	
Dry Density (Mg/m³)			1.74	
Membrane Thickness (mm)			0.33	
Membrane Type			Latex	
Rate of Strain (%/min)			1.93	
Test Results	Measured Cell Pressure (kPa)		104	
	Strain at Failure (%)		19.2	
	Membrane Correction (kPa)		1.2	
	Corrected Deviator Stress (kPa)		165	
	Shear Stress (kPa)		83	
	Mode of Failure (B/P/C)		Plastic	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

Job Number
41787A

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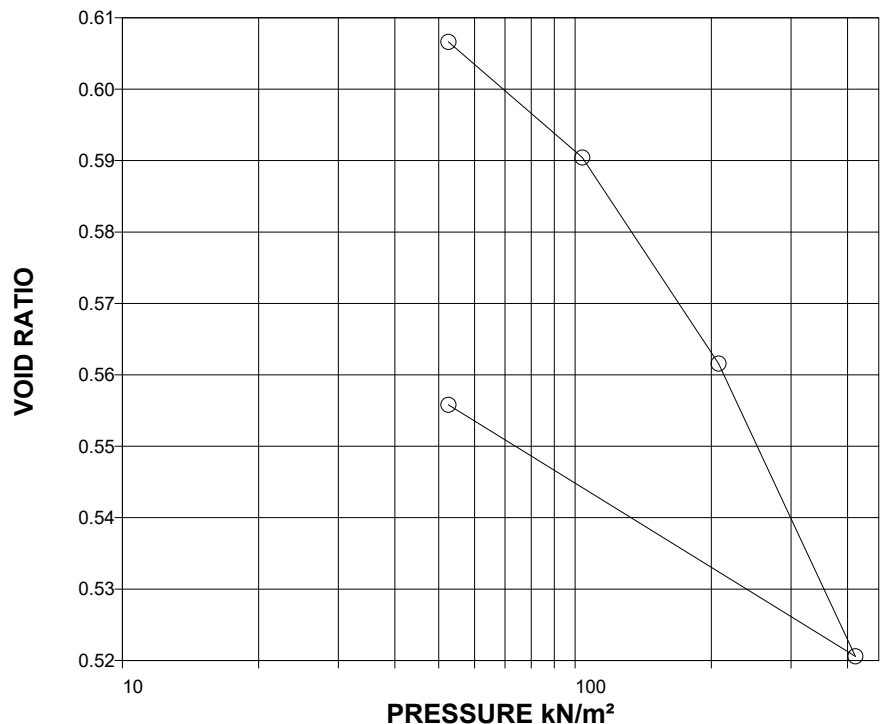
ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Description
BH09	5.20	U16	Brown CLAY

Initial Specimen		Length of Sample (mm)	450
		Depth from top of sample (mm)	50
		Condition of Sample:	Undisturbed
		Orientation:	Vertical

Diameter (mm)	75.05
Particle Density (Mg/m ³)	2.65 (Assumed)
Swelling Pressure (kN/m ²)	
Lab Temp (°C)	20

	Initial	Final
Height (mm)	18.88	18.03
Wet Weight (g)	171.62	170.04
Moisture Content (%)	26	25
Bulk Density (Mg/m ³)	2.05	2.13
Dry Density (Mg/m ³)	1.63	1.71
Void Ratio	0.626	0.550
Degree of Saturation (%)	109.22	119.49



Pressure kN/m ²	m _v m ² /MN	c _v m ² /year	Void Ratio
52.5	0.26	30	0.607
103.75	0.21	3.1	0.590
207.5	0.19	2.7	0.562
416.25	0.13	2.0	0.521
52.5	0.07	13	0.556

Pressure kN/m ²	m _v m ² /MN	c _v m ² /year	Void Ratio

Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Site : Siemens Development Phase 1 & 2

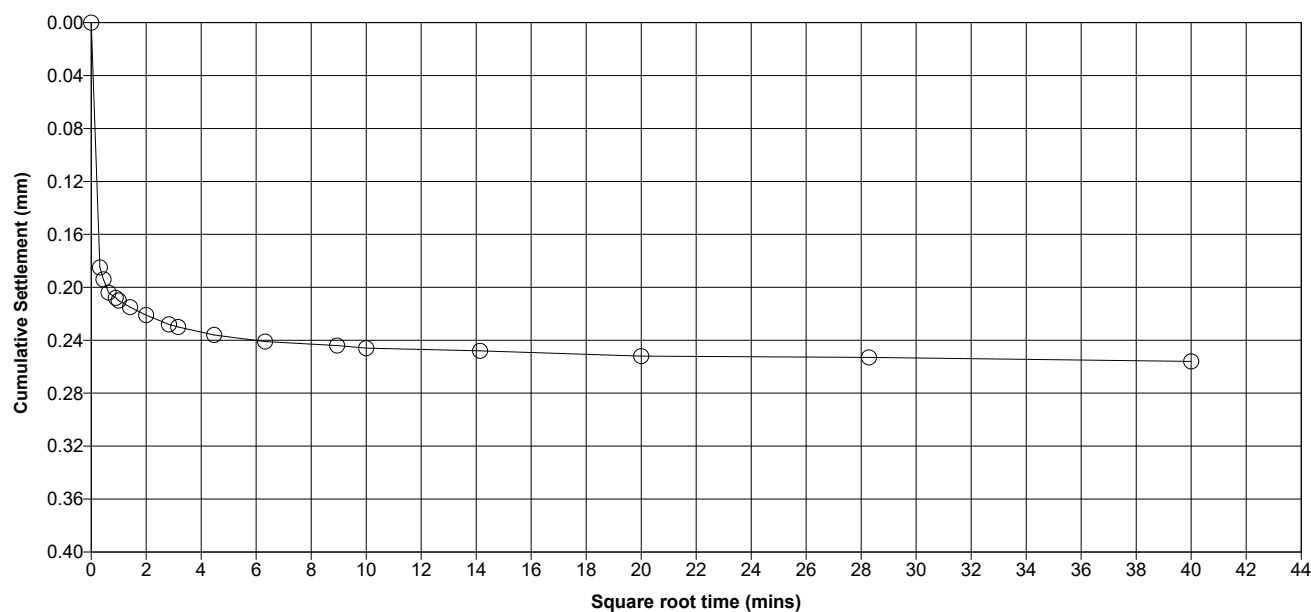
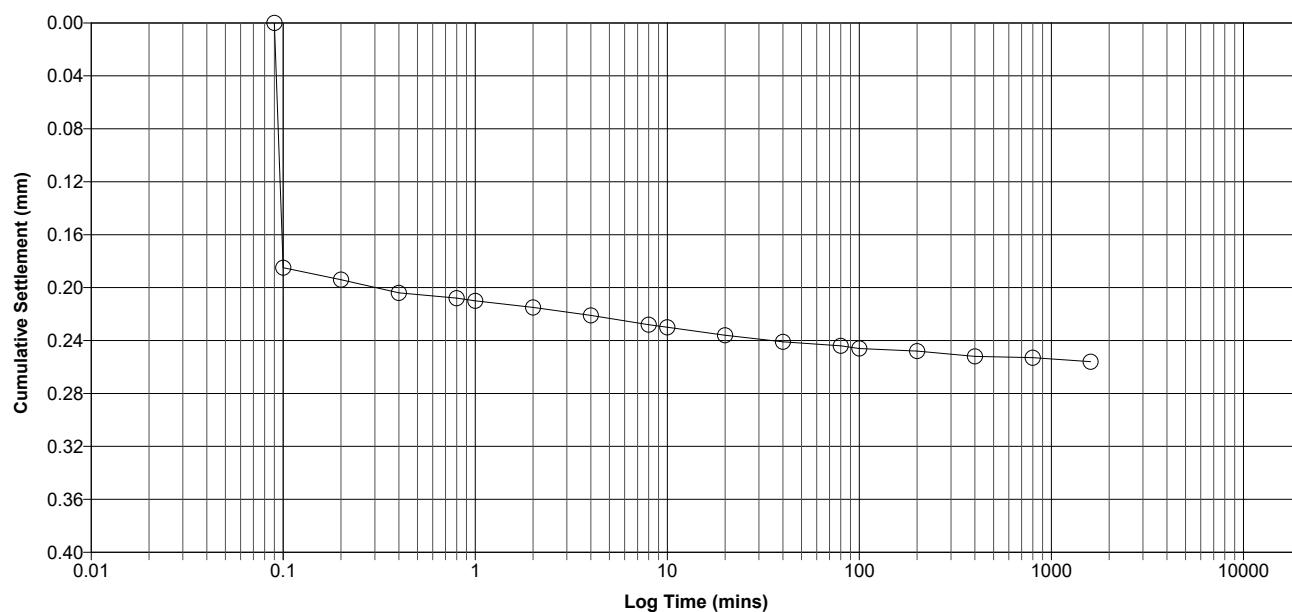
Job Number
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Client : Booth King Partnership Ltd

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ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Stage	Description
BH09	5.20	U16	1	Brown CLAY


Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Site : Siemens Development Phase 1 & 2

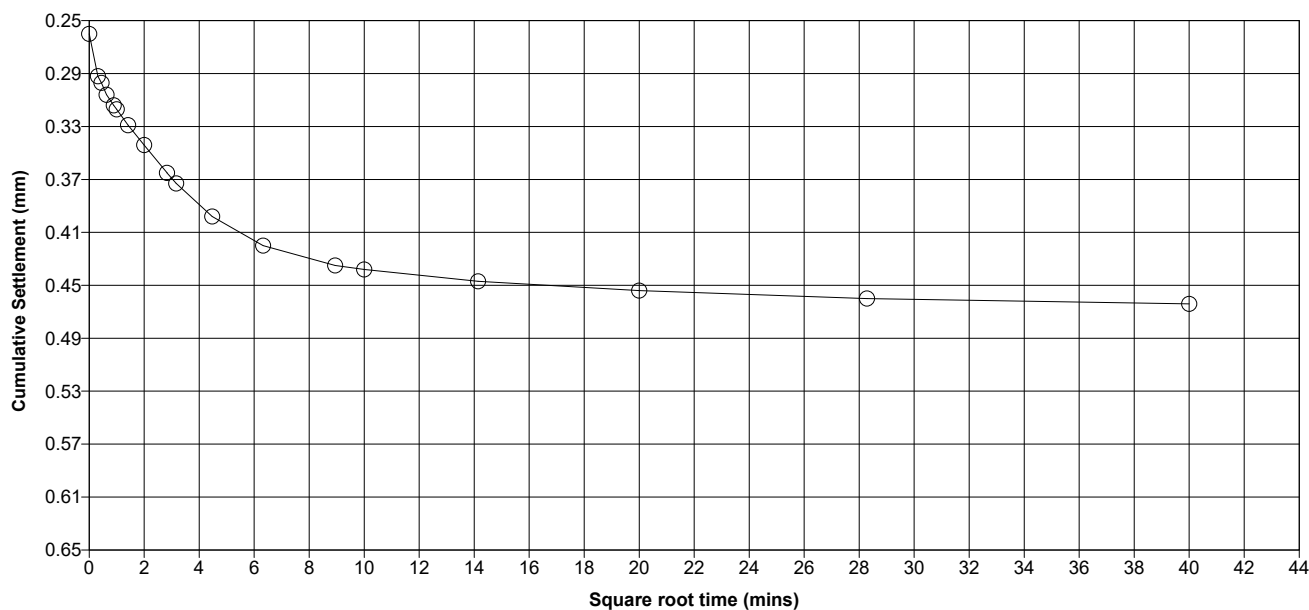
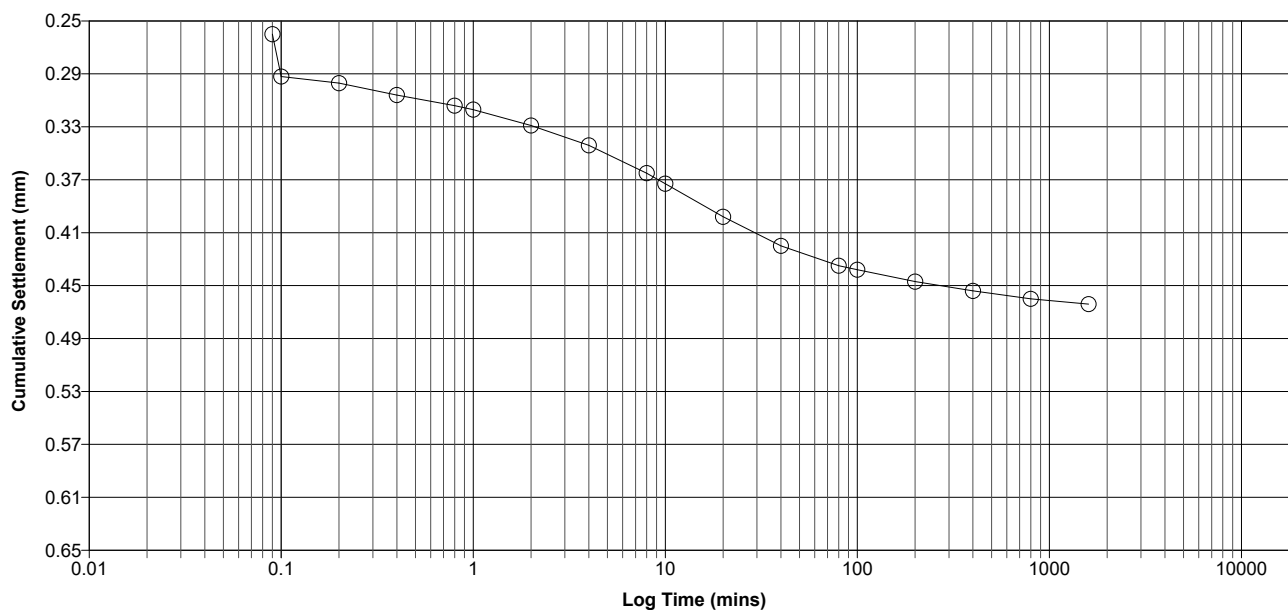
Job Number
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Client : Booth King Partnership Ltd

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ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Stage	Description
BH09	5.20	U16	2	Brown CLAY


Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Site : Siemens Development Phase 1 & 2

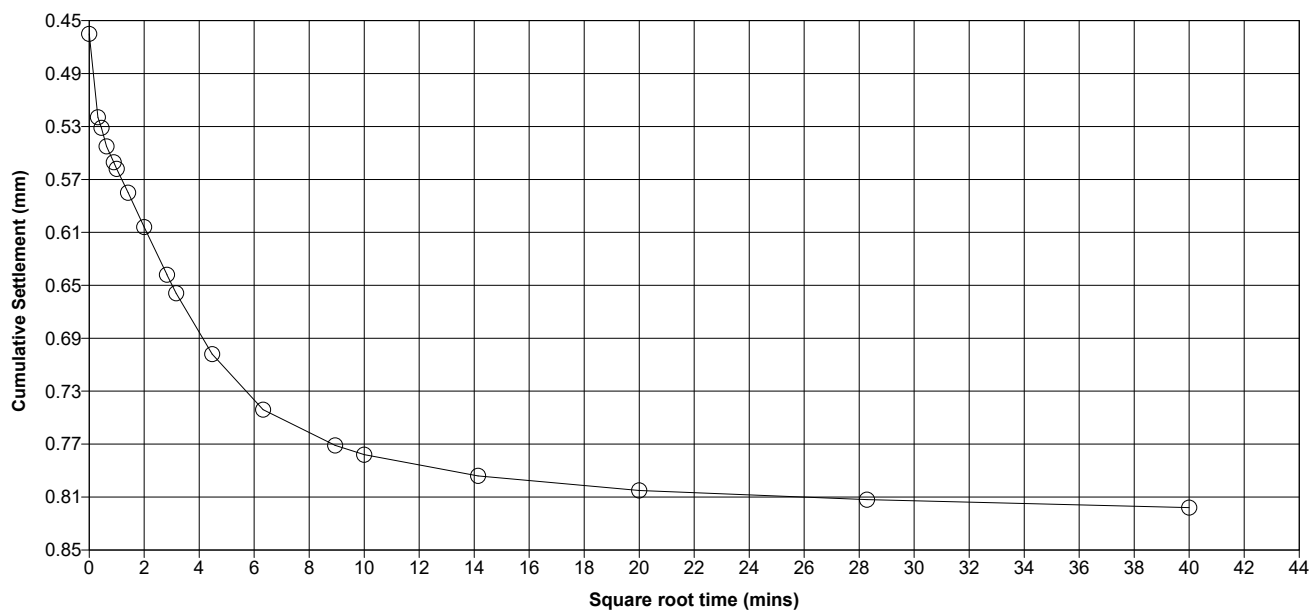
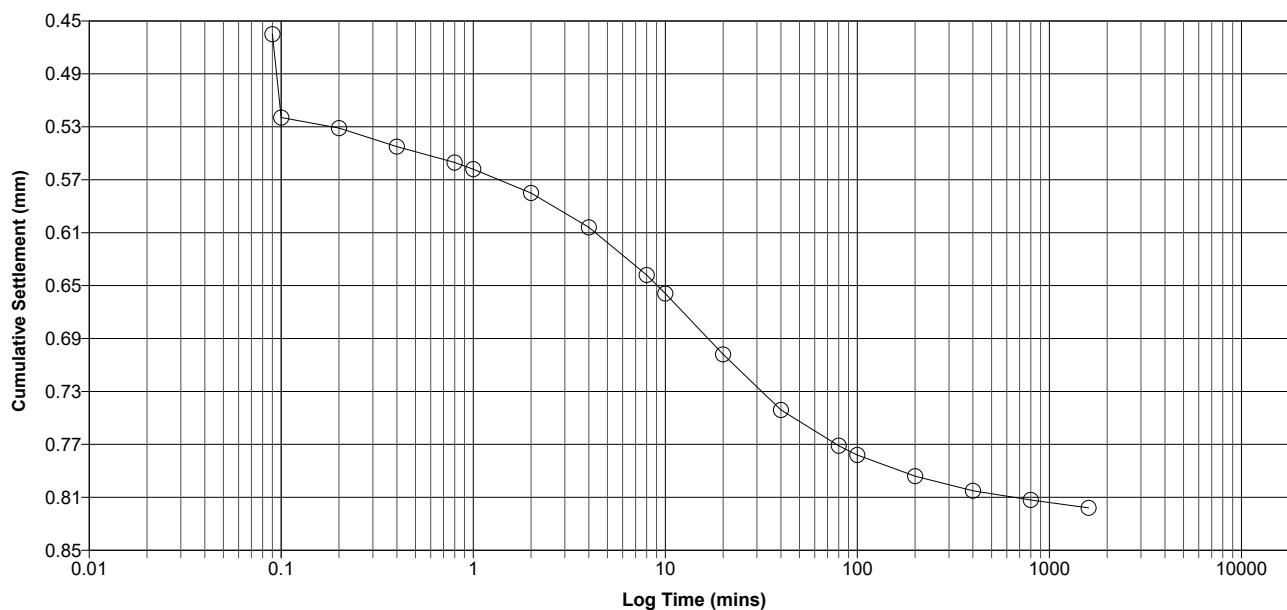
Job Number
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Client : Booth King Partnership Ltd

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ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Stage	Description
BH09	5.20	U16	3	Brown CLAY


Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Site : Siemens Development Phase 1 & 2

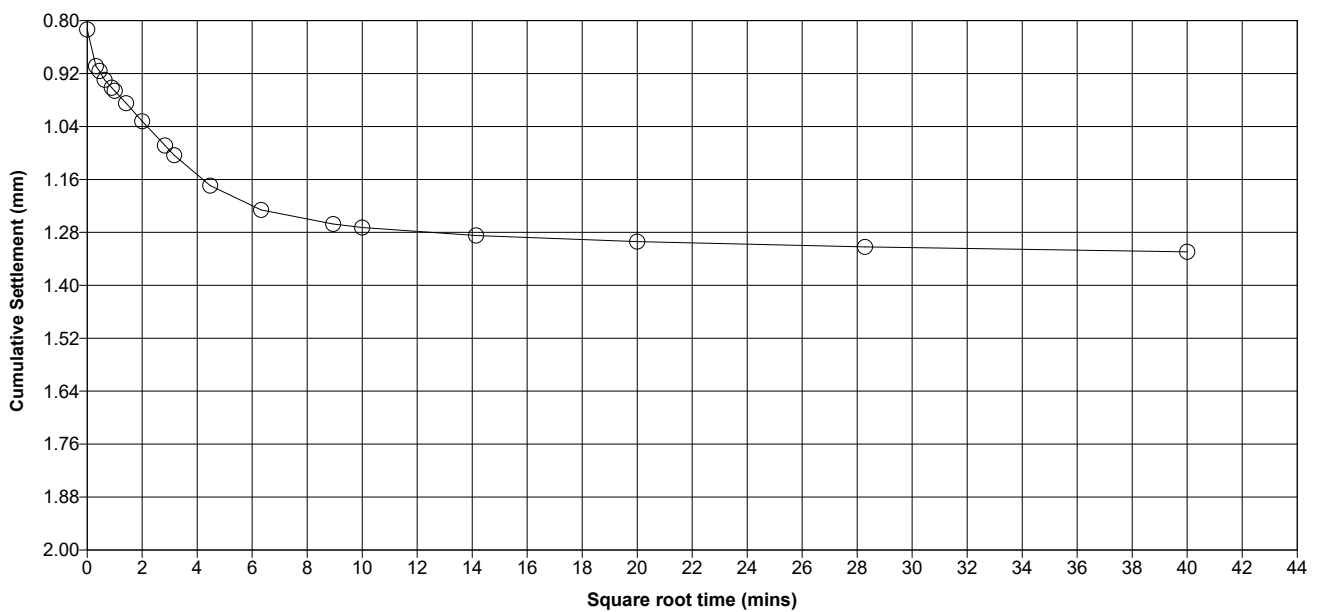
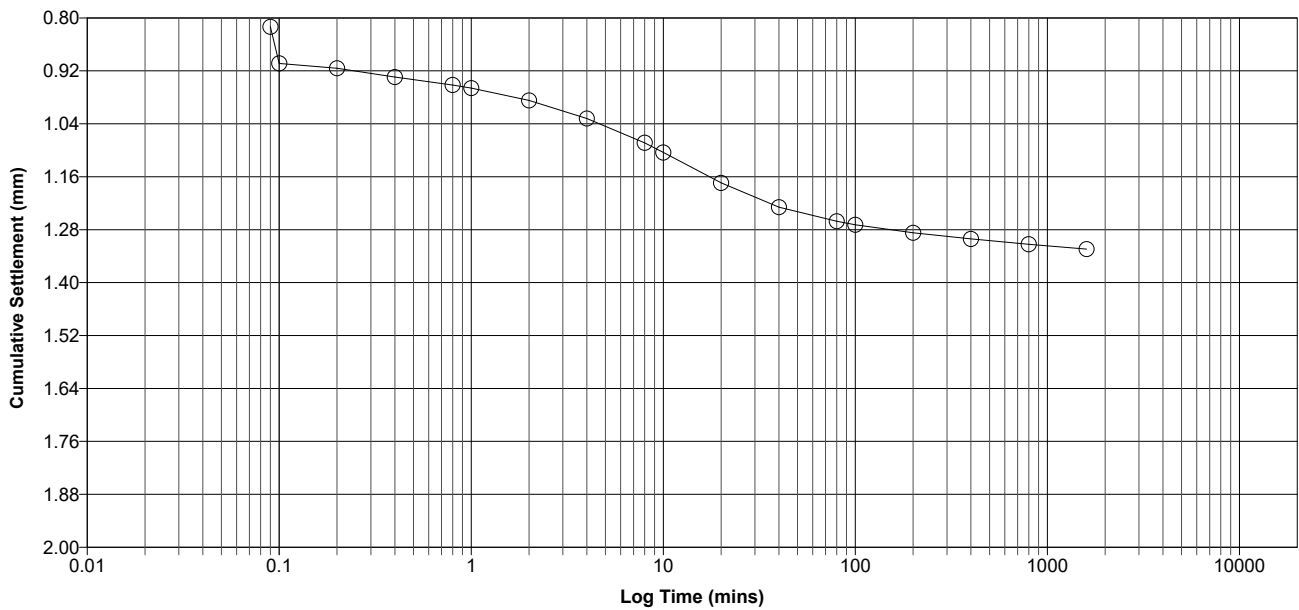
Job Number
41787A

Client : Booth King Partnership Ltd

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ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Stage	Description
BH09	5.20	U16	4	Brown CLAY


Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Site : Siemens Development Phase 1 & 2

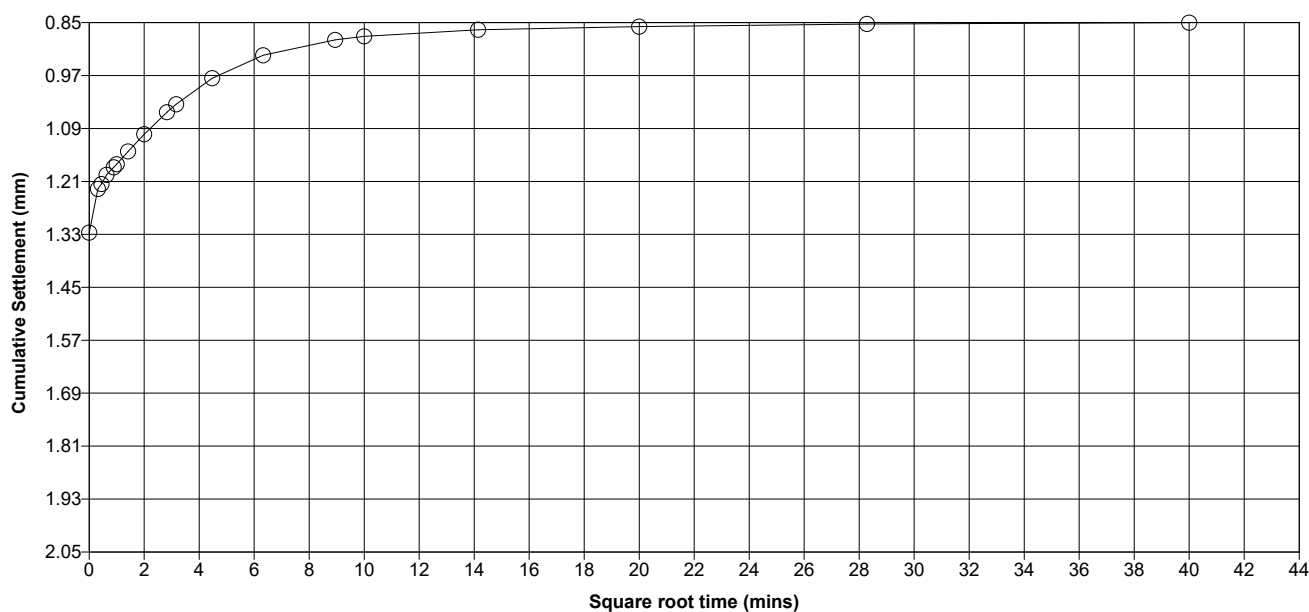
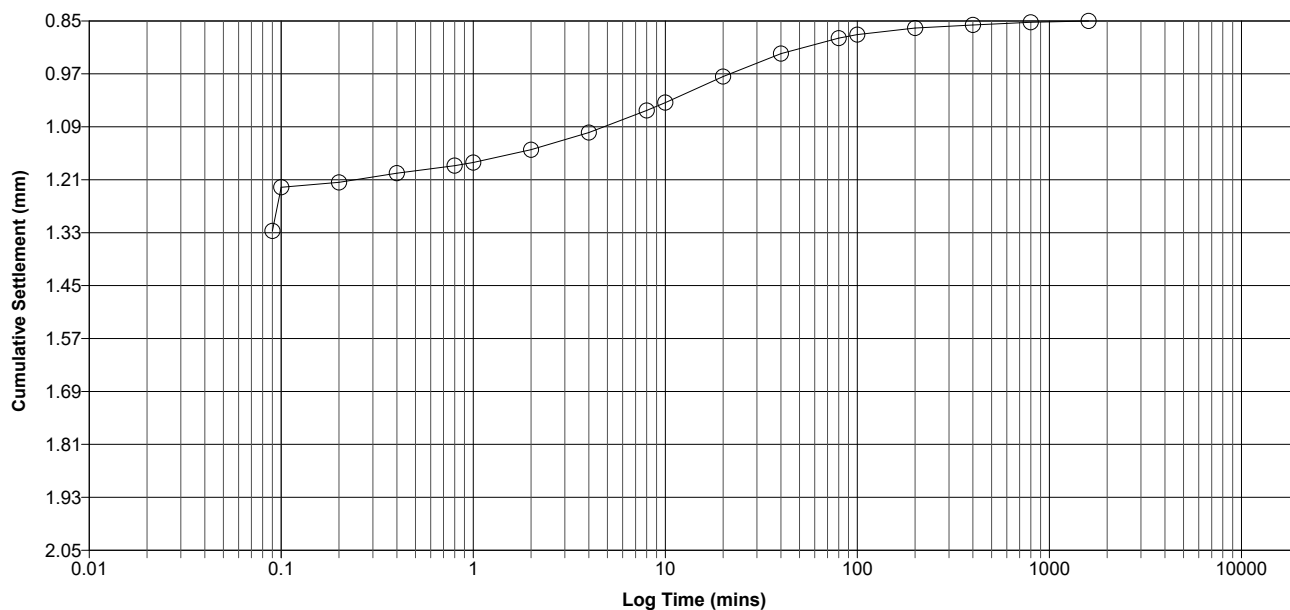
Job Number
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Client : Booth King Partnership Ltd

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ONE-DIMENSIONAL CONSOLIDATION TEST

Borehole / Trial Pit	Depth (m)	Sample	Stage	Description
BH09	5.20	U16	5	Brown CLAY


Method of Preparation : BS 1377:PART 5:1990:3.3, 3.4

Method of Test : BS 1377:PART 5:1990:3.5. Using Square-root-time method

Remarks : Square-root-time

Test Report : **41787A/2**

Site : Siemens Development Phase 1 & 2

Job Number : 41787A

Originating Client : Booth King Partnership Ltd

All opinions and interpretations contained within this report are outside of our Scope of Accreditation.

The following tests contained within this report are not UKAS Accredited.

Date of Issued : 14/01/2016

Unit 4 Faraday Close, Pattinson North Industrial Estate, Washington, Tyne & Wear, NE38 8QJ.
Tel. 0191 4828500 Fax. 0191 4828520 Email. washington@ianfarmer.co.uk Internet. www.ianfarmer.co.uk

Ian Farmer Associates (1998) Ltd
17 Rivington Court
Warrington
Cheshire
WA1 4RT

F.A.O. Mr A Latimer

TEST REPORT - 41787B/1

Site : Siemens Development Phase 1 & 2

Job Number : 41787B

Originating Client : Booth King Partnership Ltd

Originating Reference : 41787B

Date Sampled : Not given

Date Scheduled : 26/11/15

Date Testing Started : 02/12/15

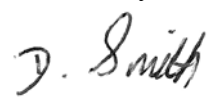
Date Testing Finished : 11/12/15

Remarks :

- First Report for above Job Number
- Samples will be disposed of 28 days after the report is issued unless otherwise agreed
- This report may contain results from tests which are not included within the scope of the UKAS accreditation. Please see final sheet for details.

Data Input By:  Jemma Clark

Position : Laboratory Administrator Date : 11/12/15

Authorised By:  Daniel Smith

Position : Laboratory Supervisor Date : 11/12/15

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Job Number
41787B

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DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY AND LIQUIDITY INDEX

Borehole/ Trial Pit	Depth (m)	Sample	Natural / Sieved	Natural Moisture Content %	Sample Passing 425µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
					Percentage %	Moisture Content %						
BH06	8.00	U21	Natural	28	100	28	49	22	27	0.22	CI	Brown gravelly CLAY

Method of Preparation : BS 1377:PART 1:1990:7.4 Preparation of samples for classification tests BS 1377:PART 2:1990:4.2 & 5.2 Sample preparations

Method of Test : BS 1377:PART 2:1990:3.2 Determination of moisture content 4.3 Determination of the liquid limit 5.3 Determination of the plastic limit and plasticity index



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

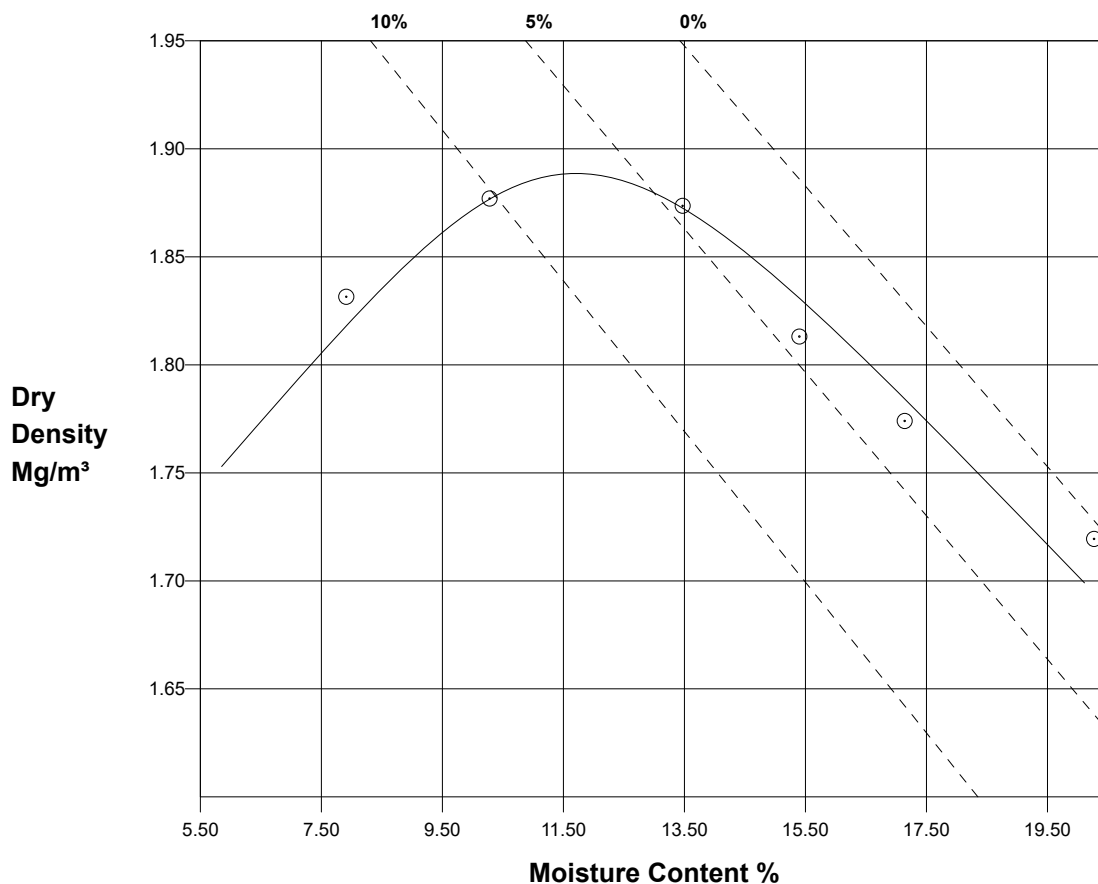
Job Number
41787B

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DETERMINATION OF DRY DENSITY/MOISTURE CONTENT RELATIONSHIP

Borehole / Trial Pit	Depth (m)	Sample	Description
BH01	1.20	B7	Brown gravelly SAND

Percentage retained 37.5 mm	0 %	Max size of cohesive lumps	20 mm
Percentage retained 20.0 mm	0 %	Single or separate samples	Single
Grading Zone	1	Particle density	2.65 Assumed
Mould Type	1 Litre/proctor	Method of compaction	2.5kg Rammer
MAX DRY DENSITY	1.89 Mg/m ³	OPTIMUM MOISTURE CONTENT	12 %



Method of Preparation : BS 1377:PART 1:7.6, BS 1377:PART 4:1990:3.2 Preparation of samples for compaction tests

Method of Test : BS 1377:PART 4:1990:3.4/3.4 Determination using 2.5 kg rammer or 3.5/3.6 Determination using 4.5kg rammer: PART 2:1990:8.2 Determination of particle density

Remarks :



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

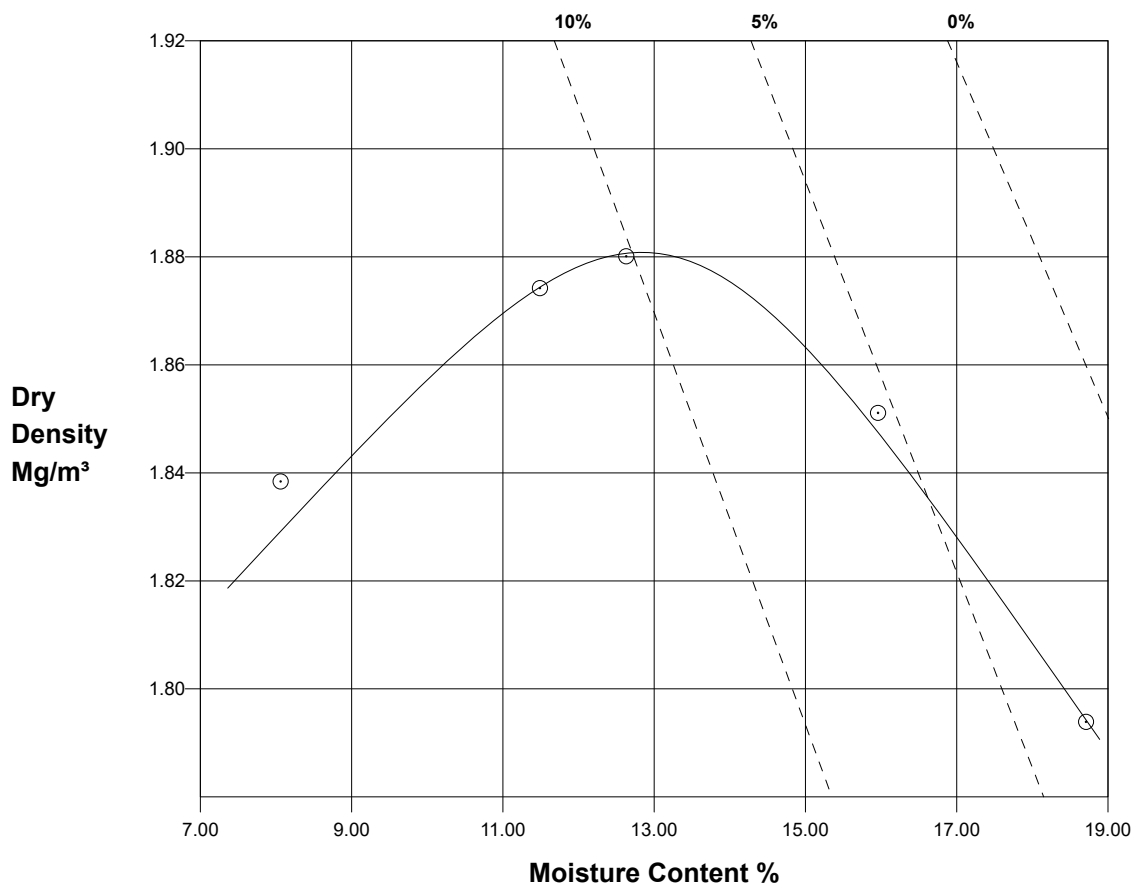
Job Number
41787B

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DETERMINATION OF DRY DENSITY/MOISTURE CONTENT RELATIONSHIP

Borehole / Trial Pit	Depth (m)	Sample	Description
BH04	1.20	B6	Grey gravelly SAND

Percentage retained 37.5 mm	0 %	Max size of cohesive lumps	20 mm
Percentage retained 20.0 mm	1 %	Single or separate samples	Single
Grading Zone	2	Particle density	2.85 Assumed
Mould Type	1 Litre/proctor	Method of compaction	2.5kg Rammer
MAX DRY DENSITY	1.88 Mg/m ³	OPTIMUM MOISTURE CONTENT	13 %



Method of Preparation : BS 1377:PART 1:7.6, BS 1377:PART 4:1990:3.2 Preparation of samples for compaction tests

Method of Test : BS 1377:PART 4:1990:3.4/3.4 Determination using 2.5 kg rammer or 3.5/3.6 Determination using 4.5kg rammer: PART 2:1990:8.2 Determination of particle density

Remarks :



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

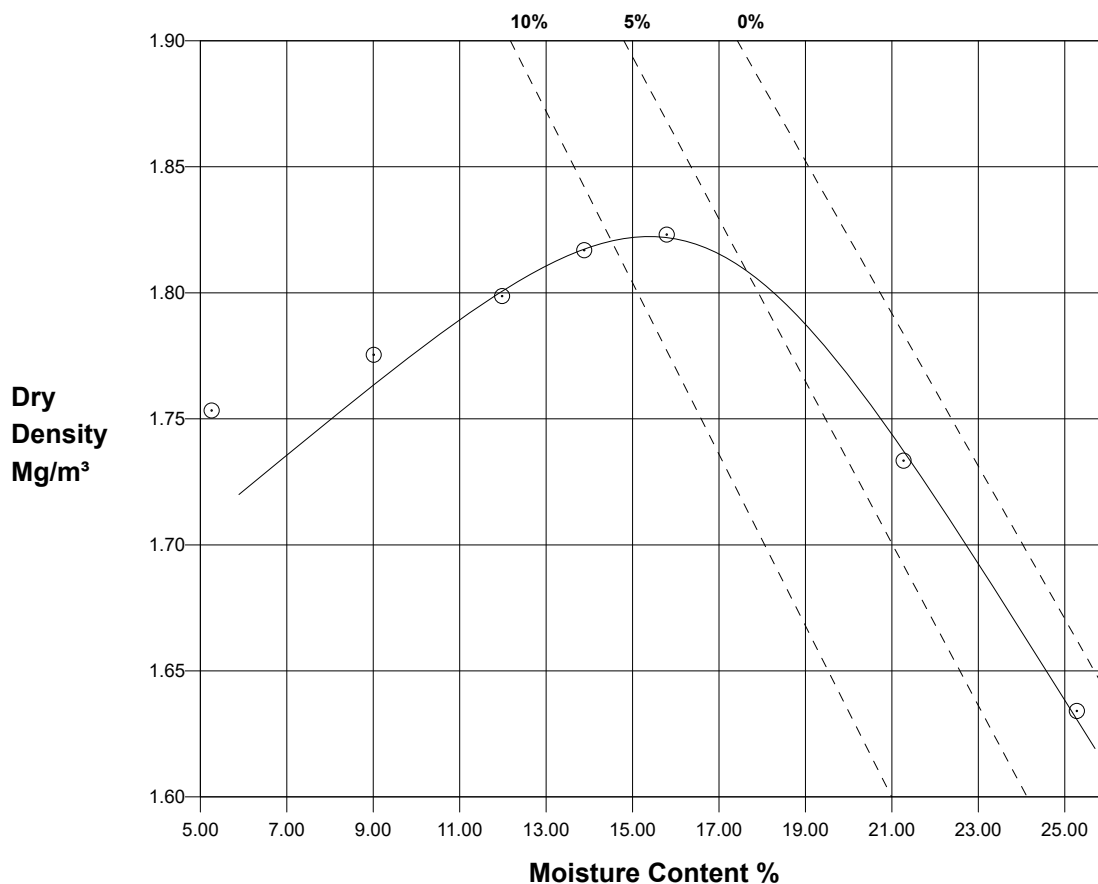
Job Number
41787B

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DETERMINATION OF DRY DENSITY/MOISTURE CONTENT RELATIONSHIP

Borehole / Trial Pit	Depth (m)	Sample	Description
BH07	1.20	B4	Grey gravelly SAND

Percentage retained 37.5 mm	0 %	Max size of cohesive lumps	20 mm
Percentage retained 20.0 mm	2 %	Single or separate samples	Single
Grading Zone	2	Particle density	2.85 Assumed
Mould Type	1 Litre/proctor	Method of compaction	2.5kg Rammer
MAX DRY DENSITY	1.82 Mg/m ³	OPTIMUM MOISTURE CONTENT	16 %



Method of Preparation : BS 1377:PART 1:7.6, BS 1377:PART 4:1990:3.2 Preparation of samples for compaction tests

Method of Test : BS 1377:PART 4:1990:3.4/3.4 Determination using 2.5 kg rammer or 3.5/3.6 Determination using 4.5kg rammer: PART 2:1990:8.2 Determination of particle density

Remarks :



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

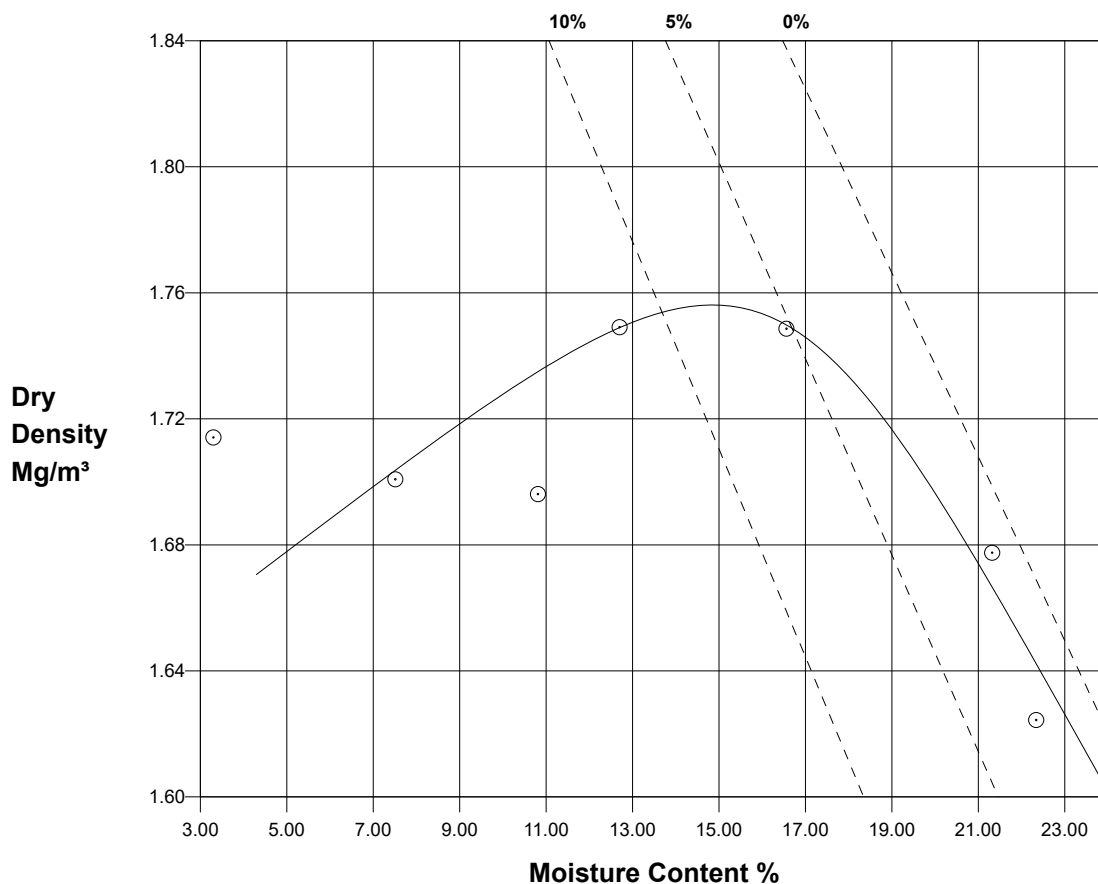
Job Number
41787B

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DETERMINATION OF DRY DENSITY/MOISTURE CONTENT RELATIONSHIP

Borehole / Trial Pit	Depth (m)	Sample	Description
BH09	1.20	B5	Brown gravelly SAND

Percentage retained 37.5 mm	0 %	Max size of cohesive lumps	20 mm
Percentage retained 20.0 mm	0 %	Single or separate samples	Single
Grading Zone	1	Particle density	2.65 Assumed
Mould Type	1 Litre/proctor	Method of compaction	2.5kg Rammer
MAX DRY DENSITY	1.75 Mg/m ³	OPTIMUM MOISTURE CONTENT	15 %



Method of Preparation : BS 1377:PART 1:7.6, BS 1377:PART 4:1990:3.2 Preparation of samples for compaction tests

Method of Test : BS 1377:PART 4:1990:3.4/3.4 Determination using 2.5 kg rammer or 3.5/3.6 Determination using 4.5kg rammer: PART 2:1990:8.2 Determination of particle density

Remarks :



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

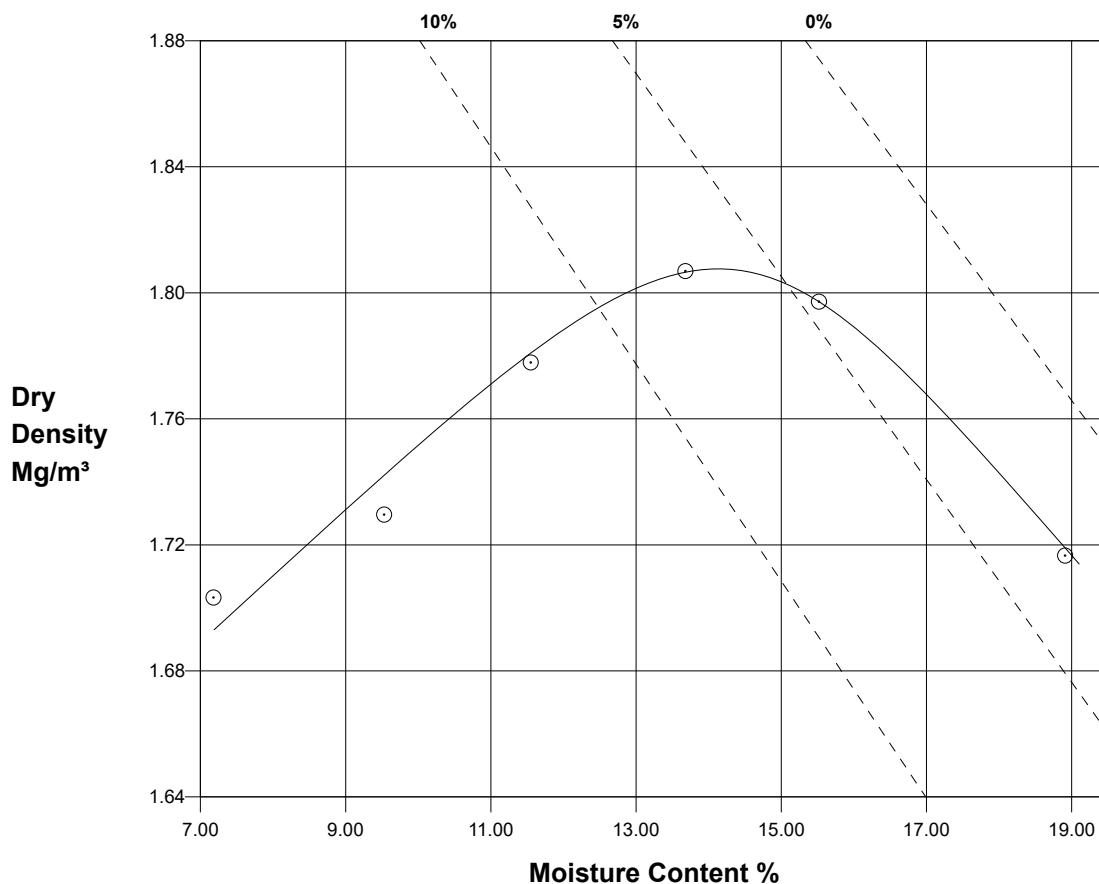
Job Number
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DETERMINATION OF DRY DENSITY/MOISTURE CONTENT RELATIONSHIP

Borehole / Trial Pit	Depth (m)	Sample	Description
BH10	2.00	B10	Brown gravelly SAND

Percentage retained 37.5 mm	0 %	Max size of cohesive lumps	20 mm
Percentage retained 20.0 mm	3 %	Single or separate samples	Single
Grading Zone	2	Particle density	2.65 Assumed
Mould Type	1 Litre/proctor	Method of compaction	2.5kg Rammer
MAX DRY DENSITY	1.81 Mg/m ³	OPTIMUM MOISTURE CONTENT	14 %



Method of Preparation : BS 1377:PART 1:7.6, BS 1377:PART 4:1990:3.2 Preparation of samples for compaction tests

Method of Test : BS 1377:PART 4:1990:3.4/3.4 Determination using 2.5 kg rammer or 3.5/3.6 Determination using 4.5kg rammer: PART 2:1990:8.2 Determination of particle density

Remarks :



Site : Siemens Development Phase 1 & 2

Client : Booth King Partnership Ltd

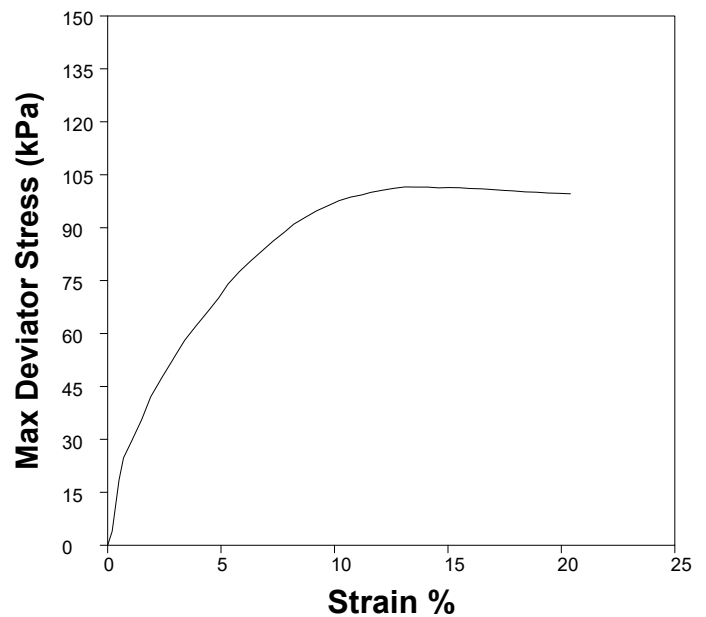
Job Number
41787B

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**DETERMINATION OF MOISTURE CONTENT, DENSITY AND UNDRAINED SHEAR STRENGTH
IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE (DEFINITIVE METHOD)**

Borehole / Trial Pit	Depth (m)	Sample	Description
BH06	8.00	U21	Brown gravelly CLAY

Initial Specimen		Length of Sample (mm)		387
		Depth from top of sample (mm)		13
		Condition of Sample:		Undisturbed
		Orientation:		Vertical
Test Type			Single Stage	
Length of Specimen (mm)			206.2	
Diameter of Specimen (mm)			102	
Moisture Content (%)			28	
Bulk Density (Mg/m³)			2.03	
Dry Density (Mg/m³)			1.58	
Membrane Thickness (mm)			0.41	
Membrane Type			Latex	
Rate of Strain (%/min)			1.94	
Test Results	Measured Cell Pressure (kPa)		160	
	Strain at Failure (%)		13.1	
	Membrane Correction (kPa)		1.1	
	Corrected Deviator Stress (kPa)		100	
	Shear Stress (kPa)		50	
	Mode of Failure (B/P/C)		Compound	



Method of Preparation : BS 1377:PT1:1990:7.4.2 Moisture Content, BS 1377:PT1:1990:8.3 Preparation of undisturbed samples for testing or BS 1377:PT1:1990:7.7.5.2 Preparation of disturbed samples for testing.

Method of Test : BS 1377:PT2:1990:3.2 Determination of Moisture Content.
BS 1377:PT2:1990:7.2 Determination of density by linear measurement.
BS 1377:PT7:1990:8.4 Determination of undrained shear strength in triaxial compression without measurement of pore pressure (Definitive method)

Remarks : Membrane Type: Latex

Test Report : **41787B/1**

Site : Siemens Development Phase 1 & 2
Job Number : 41787B
Originating Client : Booth King Partnership Ltd

All opinions and interpretations contained within this report are outside of our Scope of Accreditation.

The following tests contained within this report are not UKAS Accredited.

Date of Issued : 11/12/15



Certificate of Analysis

Certificate Number 15-51712

03-Dec-15

Client Ian Farmer Associates
17 Rivington Court
Hardwick Grange
Woolston
Warrington
Cheshire
WA1 4RT

Our Reference 15-51712

Client Reference 41787

Order No (not supplied)

Contract Title SIEMENS

Description 7 Soil samples.

Date Received 27-Nov-15

Date Started 27-Nov-15

Date Completed 03-Dec-15

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

A handwritten signature in black ink, appearing to read 'Rob Brown'.

Rob Brown
Business Manager



Summary of Chemical Analysis

Soil Samples

Our Ref 15-51712
 Client Ref 41787
 Contract Title SIEMENS

Lab No	906965	906966	906967	906968	906969	906970	906971
Sample ID	BH01	BH02	BH03	BH05	BH06	BH07	BH09
Depth	1.20	2.00	0.50	0.20	0.50	2.00	2.00
Other ID			ES2		1	6	ES7
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	09/11/15	10/11/15	13/11/15	13/11/15	13/11/15	16/11/15	16/11/15
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units							
Inorganics										
pH	DETSC 2008#			7.5	8.4	11.3	9.1	8.0	8.0	7.4
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	34	< 10	1000	58	40	< 10	< 10

Information in Support of the Analytical Results

Our Ref 15-51712
Client Ref 41787
Contract SIEMENS

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
906965	BH01 1.20 SOIL	09/11/15	PT 1L		
906966	BH02 2.00 SOIL	10/11/15	PT 1L		
906967	BH03 0.50 SOIL	13/11/15	GJ 250ml, GJ 60ml, PT 1L	pH + Conductivity (7 days)	
906968	BH05 0.20 SOIL	13/11/15	PT 1L		
906969	BH06 0.50 SOIL	13/11/15	GJ 250ml, GJ 60ml, PT 1L	pH + Conductivity (7 days)	
906970	BH07 2.00 SOIL	16/11/15	GJ 250ml, GJ 60ml, PT 1L		
906971	BH09 2.00 SOIL	16/11/15	GJ 250ml, GJ 60ml, PT 1L		

Key: P-Plastic T-Tub G-Glass J-Jar

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Soil Analysis Notes

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

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

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

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months



Certificate of Analysis

Certificate Number 15-51713

03-Dec-15

Client Ian Farmer Associates
17 Rivington Court
Hardwick Grange
Woolston
Warrington
Cheshire
WA1 4RT

Our Reference 15-51713

Client Reference 41787

Order No (not supplied)

Contract Title SIEMENS

Description 12 Soil samples.

Date Received 27-Nov-15

Date Started 27-Nov-15

Date Completed 03-Dec-15

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

A handwritten signature in black ink, appearing to read 'Rob Brown'.

Rob Brown
Business Manager



Summary of Chemical Analysis Soil Samples

Our Ref 15-51713

Client Ref 41787

Contract Title SIEMENS

Lab No	906972	906973	906974	906975	906976	906977	906978	906979	906980	906981	906982	906983
Sample ID	WS01	WS02	WS03	WS04	WS05	WS06	WS07	WS08	WS09	WS11	WS12	WS07
Depth	1.30	0.80	2.30	0.50	1.80	1.00	1.00	1.20	1.00	1.80	1.00	3.50
Other ID												
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	13/11/15	13/11/15	13/11/15	16/11/15	13/11/15	16/11/15	19/11/15	16/11/15	13/11/15	13/11/15	13/11/15	16/11/15
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units												
Inorganics															
pH	DETSC 2008#			8.5	7.7	8.0	7.3	7.6	7.8	8.2	7.6	7.2	7.6	7.8	7.6
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	< 10	36	< 10	42	< 10	84	19	34	12	< 10	< 10	15

Information in Support of the Analytical Results

Our Ref 15-51713
Client Ref 41787
Contract SIEMENS

Containers Received & Deviating Samples

Lab No	Sample ID	Date		Containers Received	Holding time exceeded for tests	Inappropriate container for tests
		Sampled				
906972	WS01 1.30 SOIL	13/11/15		PT 1L		
906973	WS02 0.80 SOIL	13/11/15		PT 1L		
906974	WS03 2.30 SOIL	13/11/15		PT 1L		
906975	WS04 0.50 SOIL	16/11/15		PT 1L		
906976	WS05 1.80 SOIL	13/11/15		PT 1L		
906977	WS06 1.00 SOIL	16/11/15		PT 1L		
906978	WS07 1.00 SOIL	19/11/15		PT 1L	pH + Conductivity (7 days)	
906979	WS08 1.20 SOIL	16/11/15		PT 1L		
906980	WS09 1.00 SOIL	13/11/15		GJ 250ml, GJ 60ml, PT 1L	pH + Conductivity (7 days)	
906981	WS11 1.80 SOIL	13/11/15		PT 1L		
906982	WS12 1.00 SOIL	13/11/15		PT 1L		
906983	WS07 3.50 SOIL	16/11/15		PT 1L		

Key: P-Plastic T-Tub G-Glass J-Jar

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Soil Analysis Notes

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

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

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

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months



Certificate of Analysis

Certificate Number 15-52254

09-Dec-15

Client Ian Farmer Associates
4 Faraday Close
District 15
Pattinson North Industrial Est
Washington
Tyne & Wear
NE38 8QJ

Our Reference 15-52254

Client Reference 41787A

Order No (not supplied)

Contract Title SIEMENS

Description 2 Soil samples.

Date Received 02-Dec-15

Date Started 03-Dec-15

Date Completed 09-Dec-15

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

A handwritten signature in black ink, appearing to read 'Rob Brown'.

Rob Brown
Business Manager



Summary of Chemical Analysis

Soil Samples

Our Ref 15-52254
 Client Ref 41787A
 Contract Title SIEMENS

Lab No	909760	909761
Sample ID	BH03	BH07
Depth		
Other ID	14	16
Sample Type	U	U
Sampling Date	12/11/15	17/11/15
Sampling Time	n/s	n/s

Test	Method	LOD	Units		
Inorganics					
pH	DETSC 2008#			6.3	6.6
Sulphate Aqueous Extract as SO ₄	DETSC 2076#	10	mg/l	13	24

Information in Support of the Analytical Results

Our Ref 15-52254
Client Ref 41787A
Contract SIEMENS

Containers Received & Deviating Samples

Lab No	Sample ID	Date		Containers Received	Holding time exceeded for tests	Inappropriate container for tests
		Sampled				
909760	BH03 SOIL	12/11/15		PT 1L		
909761	BH07 SOIL	17/11/15		PT 1L		

Key: P-Plastic T-Tub

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Soil Analysis Notes

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

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

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

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

APPENDIX 4
CHEMICAL TESTS



Certificate of Analysis

Certificate Number 15-50445

20-Nov-15

Client Ian Farmer Associates
17 Rivington Court
Hardwick Grange
Woolston
Warrington
Cheshire
WA1 4RT

Our Reference 15-50445

Client Reference 41787

Order No 49689

Contract Title Siemens Development

Description 4 Soil samples.

Date Received 16-Nov-15

Date Started 16-Nov-15

Date Completed 20-Nov-15

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

A handwritten signature in black ink, appearing to read 'Rob Brown'.

Rob Brown
Business Manager



Summary of Chemical Analysis

Matrix Descriptions

Our Ref 15-50445

Client Ref 41787

Contract Title Siemens Development

Sample ID	Other ID	Depth	Lab No	Completed	Matrix Description
BH01	ES5	1	899823	20/11/2015	Dark brown, gravelly, sandy CLAY
BH02		0.8	899824	20/11/2015	Brown, gravelly, clayey and SAND
BH02		2	899825	20/11/2015	Brown, gravelly, clayey and SAND
BH05	ES3	0.5	899826	20/11/2015	Brown, gravelly, clayey and SAND

Summary of Chemical Analysis

Soil Samples

Our Ref 15-50445

Client Ref 41787

Contract Title Siemens Development

Lab No	899823	899824	899825	899826
Sample ID	BH01	BH02	BH02	BH05
Depth	1.00	0.80	2.00	0.50
Other ID	ES5			ES3
Sample Type	SOIL	SOIL	SOIL	SOIL
Sampling Date	09/11/15	10/11/15	10/11/15	13/11/15
Sampling Time	n/s	n/s	n/s	n/s

Test	Method	LOD	Units				
Metals							
Arsenic	DETSC 2301#	0.2	mg/kg	12	4.8	17	3.1
Boron (water soluble)	DETSC 2123#	0.2	mg/kg	1.5	1.5	0.7	0.6
Cadmium	DETSC 2301#	0.1	mg/kg	0.2	< 0.1	0.6	< 0.1
Chromium	DETSC 2301#	0.15	mg/kg	11	9.3	22	8.8
Hexavalent Chromium	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	28	7.4	22	4.6
Lead	DETSC 2301#	0.3	mg/kg	51	13	58	4.2
Mercury	DETSC 2325#	0.05	mg/kg	26	0.10	1.4	< 0.05
Nickel	DETSC 2301#	1	mg/kg	13	6.5	11	6.8
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5
Zinc	DETSC 2301#	1	mg/kg	39	14	45	10
Inorganics							
pH	DETSC 2008#			7.9	10.7	8.5	9.2
Cyanide Total	DETSC 2130#	0.1	mg/kg	< 0.1			0.2
Organic matter	DETSC 2002#	0.1	%	1.2	1.0	1.0	1.1
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	110	180	27	25
PAHs							
Acenaphthene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Anthracene	DETSC 3301	0.1	mg/kg	0.4	< 0.1	0.1	< 0.1
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	0.5	< 0.1	< 0.1	< 0.1
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	0.4	< 0.1	< 0.1	< 0.1
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	0.3	< 0.1	< 0.1	< 0.1
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	0.2	< 0.1	< 0.1	< 0.1
Chrysene	DETSC 3301	0.1	mg/kg	0.6	< 0.1	< 0.1	< 0.1
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Fluoranthene	DETSC 3301	0.1	mg/kg	1.1	< 0.1	0.5	< 0.1
Fluorene	DETSC 3301	0.1	mg/kg	0.2	< 0.1	< 0.1	< 0.1
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	DETSC 3301	0.1	mg/kg	1.3	< 0.1	0.2	< 0.1
Pyrene	DETSC 3301	0.1	mg/kg	1.2	< 0.1	0.5	< 0.1
PAH	DETSC 3301	1.6	mg/kg	6.1	< 1.6	< 1.6	< 1.6
Phenols							
Phenol - Monohydric	DETSC 2130#	0.3	mg/kg	< 0.3		< 0.3	

Summary of Asbestos Analysis

Soil Samples

Our Ref 15-50445

Client Ref 41787

Contract Title Siemens Development

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
899823	BH01 ES5 1.00	SOIL	NAD	none	Keith Wilson
899824	BH02 0.80	SOIL	NAD	none	Keith Wilson
899826	BH05 ES3 0.50	SOIL	NAD	none	Keith Wilson

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 15-50445
 Client Ref 41787
 Contract Siemens Development

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
899823	BH01 1.00 SOIL	09/11/15	GJ 250ml, GJ 60ml, PT 1L		
899824	BH02 0.80 SOIL	10/11/15	GJ 250ml, PT 1L		
899825	BH02 2.00 SOIL	10/11/15	GJ 250ml, PT 1L		
899826	BH05 0.50 SOIL	13/11/15	GJ 250ml, GJ 60ml, PT 1L		

Key: G-Glass P-Plastic J-Jar T-Tub

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The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

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

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETS 2002	Organic matter	%	0.1	Air Dried	No	Yes	Yes
DETS 2003	Loss on ignition	%	0.01	Air Dried	No	Yes	Yes
DETS 2008	pH	pH Units	1	Air Dried	No	Yes	Yes
DETS 2024	Sulphide	mg/kg	10	Air Dried	No	Yes	Yes
DETS 2076	Sulphate Aqueous Extract as SO ₄	mg/l	10	Air Dried	No	Yes	Yes
DETS 2084	Total Carbon	%	0.5	Air Dried	No	Yes	Yes
DETS 2084	Total Organic Carbon	%	0.5	Air Dried	No	Yes	Yes
DETS 2119	Ammoniacal Nitrogen as N	mg/kg	0.5	Air Dried	No	Yes	Yes
DETS 2130	Cyanide free	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2130	Cyanide total	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETS 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes
DETS 2321	Total Sulphate as SO ₄	%	0.01	Air Dried	No	Yes	Yes
DETS 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETS 3049	Sulphur (free)	mg/kg	0.75	Air Dried	No	Yes	Yes
DETS 2123	Boron (water soluble)	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Arsenic	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Barium	mg/kg	1.5	Air Dried	No	Yes	Yes
DETS 2301	Beryllium	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Cadmium Available	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2301	Cadmium	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2301	Cobalt	mg/kg	0.7	Air Dried	No	Yes	Yes
DETS 2301	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETS 2301	Copper	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Manganese	mg/kg	20	Air Dried	No	Yes	Yes
DETS 2301	Molybdenum	mg/kg	0.4	Air Dried	No	Yes	Yes
DETS 2301	Nickel	mg/kg	1	Air Dried	No	Yes	Yes
DETS 2301	Lead	mg/kg	0.3	Air Dried	No	Yes	Yes
DETS 2301	Selenium	mg/kg	0.5	Air Dried	No	Yes	Yes
DETS 2301	Zinc	mg/kg	1	Air Dried	No	Yes	Yes
DETS 3072	Ali/Aro C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C12	mg/kg	1.5	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C12-C16	mg/kg	1.2	As Received	No	Yes	Yes
DETS 3072	Aliphatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C16-C21	mg/kg	1.5	As Received	No	Yes	Yes
DETS 3072	Aliphatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETS 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C12	mg/kg	0.9	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C12-C16	mg/kg	0.5	As Received	No	Yes	Yes
DETS 3072	Aromatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C16-C21	mg/kg	0.6	As Received	No	Yes	Yes
DETS 3072	Aromatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 062	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Ethylbenzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	m+p Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	o Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3311	C10-C24 Diesel Range Organics (DRO)	mg/kg	10	As Received	No	Yes	Yes
DETS 3311	C24-C40 Lube Oil Range Organics (LORO)	mg/kg	10	As Received	No	Yes	Yes
DETS 3311	EPH (C10-C40)	mg/kg	10	As Received	No	Yes	Yes

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETS 3303	Acenaphthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Acenaphthylene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(a)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(a)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(b)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(k)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(g,h,i)perylene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Dibenzo(a,h)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Indeno(1,2,3-c,d)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Naphthalene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Phenanthrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3401	PCB 28 + PCB 31	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 52	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 101	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 118	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 153	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 138	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 180	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB Total	mg/kg	0.01	As Received	No	Yes	Yes

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.



Certificate of Analysis

Certificate Number 15-50751

26-Nov-15

Client Ian Farmer Associates
17 Rivington Court
Hardwick Grange
Woolston
Warrington
Cheshire
WA1 4RT

Our Reference 15-50751

Client Reference 41787

Order No 49706

Contract Title Siemens Development

Description 6 Soil samples.

Date Received 18-Nov-15

Date Started 18-Nov-15

Date Completed 26-Nov-15

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

A handwritten signature in black ink, appearing to read 'Rob Brown'.

Rob Brown
Business Manager



Summary of Chemical Analysis

Matrix Descriptions

Our Ref 15-50751

Client Ref 41787

Contract Title Siemens Development

Sample ID	Depth	Lab No	Completed	Matrix Description
WS02	0.5	901439	26/11/2015	Brown, gravelly, very sandy CLAY
WS05	1	901440	26/11/2015	Grey very gravelly, very sandy CLAY
WS07	1	901441	26/11/2015	Grey very gravelly, very sandy CLAY
WS08	1	901442	26/11/2015	Brown very very gravelly, very sandy CLAY
BH03	1	901443	26/11/2015	Brown, gravelly, very sandy CLAY (Made ground -) brick
BH09	1	901444	26/11/2015	Brown, gravelly, sandy CLAY

Summary of Chemical Analysis

Soil Samples

Our Ref 15-50751

Client Ref 41787

Contract Title Siemens Development

Lab No	901439	901440	901441	901442	901443	901444
Sample ID	WS02	WS05	WS07	WS08	BH03	BH09
Depth	0.50	1.00	1.00	1.00	1.00	1.00
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	13/11/15	13/11/15	16/11/15	16/11/15	13/11/15	13/11/15
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Metals									
Arsenic	DETSC 2301#	0.2	mg/kg	17	3.7	3.7	19	7.2	1.9
Boron (water soluble)	DETSC 2123#	0.2	mg/kg	0.4	0.4	0.4	0.3	1.7	0.9
Cadmium	DETSC 2301#	0.1	mg/kg	0.6	0.1	0.4	0.8	0.4	< 0.1
Chromium	DETSC 2301#	0.15	mg/kg	22	9.6	13	14	23	6.1
Hexavalent Chromium	DETSC 2204*	1	mg/kg	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	27	4.9	6.1	5.9	57	3.4
Lead	DETSC 2301#	0.3	mg/kg	48	6.8	17	11	62	4.1
Mercury	DETSC 2325#	0.05	mg/kg	0.31	< 0.05	< 0.05	< 0.05	0.09	< 0.05
Nickel	DETSC 2301#	1	mg/kg	16	6.5	6.8	8.6	15	7.0
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Zinc	DETSC 2301#	1	mg/kg	44	16	110	25	150	15
Inorganics									
pH	DETSC 2008#			7.1	8.5	8.9	8.0	10.9	7.1
Organic matter	DETSC 2002#	0.1	%	3.0	0.5	0.7	1.1	2.2	1.0
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	15		12		1900	
Petroleum Hydrocarbons									
Aliphatic C5-C6	DETSC 3321*	0.01	mg/kg				< 0.01		
Aliphatic C6-C8	DETSC 3321*	0.01	mg/kg				< 0.01		
Aliphatic C8-C10	DETSC 3321*	0.01	mg/kg				< 0.01		
Aliphatic C10-C12	DETSC 3072#	1.5	mg/kg				< 1.5		
Aliphatic C12-C16	DETSC 3072#	1.2	mg/kg				< 1.2		
Aliphatic C16-C21	DETSC 3072#	1.5	mg/kg				< 1.5		
Aliphatic C21-C35	DETSC 3072#	3.4	mg/kg				< 3.4		
Aliphatic C5-C35	DETSC 3072*	10	mg/kg				< 10		
Aromatic C5-C7	DETSC 3321*	0.01	mg/kg				< 0.01		
Aromatic C7-C8	DETSC 3321*	0.01	mg/kg				< 0.01		
Aromatic C8-C10	DETSC 3321*	0.01	mg/kg				< 0.01		
Aromatic C10-C12	DETSC 3072#	0.9	mg/kg				< 0.9		
Aromatic C12-C16	DETSC 3072#	0.5	mg/kg				< 0.5		
Aromatic C16-C21	DETSC 3072#	0.6	mg/kg				< 0.6		
Aromatic C21-C35	DETSC 3072#	1.4	mg/kg				< 1.4		
Aromatic C5-C35	DETSC 3072*	10	mg/kg				< 10		
TPH Ali/Aro	DETSC 3072*	10	mg/kg				< 10		
PAHs									
Acenaphthene	DETSC 3301	0.1	mg/kg	0.1		< 0.1			< 0.1
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1		< 0.1			< 0.1
Anthracene	DETSC 3301	0.1	mg/kg	0.4		< 0.1			< 0.1
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	0.9		< 0.1			< 0.1
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	< 0.1		< 0.1			< 0.1
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1		< 0.1			< 0.1
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1		< 0.1			< 0.1

Summary of Chemical Analysis Soil Samples

Our Ref 15-50751

Client Ref 41787

Contract Title Siemens Development

Lab No	901439	901440	901441	901442	901443	901444
Sample ID	WS02	WS05	WS07	WS08	BH03	BH09
Depth	0.50	1.00	1.00	1.00	1.00	1.00
Other ID						
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sampling Date	13/11/15	13/11/15	16/11/15	16/11/15	13/11/15	13/11/15
Sampling Time	n/s	n/s	n/s	n/s	n/s	n/s

Test	Method	LOD	Units						
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1		< 0.1			< 0.1
Chrysene	DETSC 3301	0.1	mg/kg	0.5		< 0.1			< 0.1
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1		< 0.1			< 0.1
Fluoranthene	DETSC 3301	0.1	mg/kg	1.4		< 0.1			< 0.1
Fluorene	DETSC 3301	0.1	mg/kg	0.2		< 0.1			< 0.1
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1		< 0.1			< 0.1
Naphthalene	DETSC 3301	0.1	mg/kg	0.2		< 0.1			< 0.1
Phenanthrene	DETSC 3301	0.1	mg/kg	1.3		< 0.1			< 0.1
Pyrene	DETSC 3301	0.1	mg/kg	1.2		< 0.1			< 0.1
PAH	DETSC 3301	1.6	mg/kg	6.2		< 1.6			< 1.6
Phenols									
Phenol - Monohydric	DETSC 2130#	0.3	mg/kg	< 0.3		< 0.3			

Summary of Asbestos Analysis

Soil Samples

Our Ref 15-50751

Client Ref 41787

Contract Title Siemens Development

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
901439	WS02 0.50	SOIL	NAD	none	Jeff Cruddas
901441	WS07 1.00	SOIL	NAD	none	Jeff Cruddas
901442	WS08 1.00	SOIL	NAD	none	Jeff Cruddas
901443	BH03 1.00	SOIL	NAD	none	Jeff Cruddas

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * - not included in laboratory scope of accreditation.

Information in Support of the Analytical Results

Our Ref 15-50751
 Client Ref 41787
 Contract Siemens Development

Containers Received & Deviating Samples

Lab No	Sample ID	Date Sampled	Containers Received	Holding time exceeded for tests	Inappropriate container for tests
901439	WS02 0.50 SOIL	13/11/15	GJ 250ml, GJ 60ml, PT 1L		
901440	WS05 1.00 SOIL	13/11/15	GJ 250ml, GJ 60ml, PT 1L		
901441	WS07 1.00 SOIL	16/11/15	GJ 250ml, GJ 60ml, PT 1L		
901442	WS08 1.00 SOIL	16/11/15	GJ 250ml, GJ 60ml, PT 1L		
901443	BH03 1.00 SOIL	13/11/15	GJ 250ml, GJ 60ml, PT 1L		
901444	BH09 1.00 SOIL	13/11/15	GJ 250ml, GJ 60ml, PT 1L		

Key: G-Glass P-Plastic J-Jar T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

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

Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.

The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

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

Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETS 2002	Organic matter	%	0.1	Air Dried	No	Yes	Yes
DETS 2003	Loss on ignition	%	0.01	Air Dried	No	Yes	Yes
DETS 2008	pH	pH Units	1	Air Dried	No	Yes	Yes
DETS 2024	Sulphide	mg/kg	10	Air Dried	No	Yes	Yes
DETS 2076	Sulphate Aqueous Extract as SO ₄	mg/l	10	Air Dried	No	Yes	Yes
DETS 2084	Total Carbon	%	0.5	Air Dried	No	Yes	Yes
DETS 2084	Total Organic Carbon	%	0.5	Air Dried	No	Yes	Yes
DETS 2119	Ammoniacal Nitrogen as N	mg/kg	0.5	Air Dried	No	Yes	Yes
DETS 2130	Cyanide free	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2130	Cyanide total	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETS 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes
DETS 2321	Total Sulphate as SO ₄	%	0.01	Air Dried	No	Yes	Yes
DETS 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETS 3049	Sulphur (free)	mg/kg	0.75	Air Dried	No	Yes	Yes
DETS 2123	Boron (water soluble)	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Arsenic	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Barium	mg/kg	1.5	Air Dried	No	Yes	Yes
DETS 2301	Beryllium	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Cadmium Available	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2301	Cadmium	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2301	Cobalt	mg/kg	0.7	Air Dried	No	Yes	Yes
DETS 2301	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETS 2301	Copper	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Manganese	mg/kg	20	Air Dried	No	Yes	Yes
DETS 2301	Molybdenum	mg/kg	0.4	Air Dried	No	Yes	Yes
DETS 2301	Nickel	mg/kg	1	Air Dried	No	Yes	Yes
DETS 2301	Lead	mg/kg	0.3	Air Dried	No	Yes	Yes
DETS 2301	Selenium	mg/kg	0.5	Air Dried	No	Yes	Yes
DETS 2301	Zinc	mg/kg	1	Air Dried	No	Yes	Yes
DETS 3072	Ali/Aro C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C12	mg/kg	1.5	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C12-C16	mg/kg	1.2	As Received	No	Yes	Yes
DETS 3072	Aliphatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C16-C21	mg/kg	1.5	As Received	No	Yes	Yes
DETS 3072	Aliphatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETS 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C12	mg/kg	0.9	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C12-C16	mg/kg	0.5	As Received	No	Yes	Yes
DETS 3072	Aromatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C16-C21	mg/kg	0.6	As Received	No	Yes	Yes
DETS 3072	Aromatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 062	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Ethylbenzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	m+p Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	o Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3311	C10-C24 Diesel Range Organics (DRO)	mg/kg	10	As Received	No	Yes	Yes
DETS 3311	C24-C40 Lube Oil Range Organics (LORO)	mg/kg	10	As Received	No	Yes	Yes
DETS 3311	EPH (C10-C40)	mg/kg	10	As Received	No	Yes	Yes

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETS 3303	Acenaphthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Acenaphthylene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(a)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(a)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(b)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(k)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(g,h,i)perylene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Dibenzo(a,h)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Indeno(1,2,3-c,d)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Naphthalene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Phenanthrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3401	PCB 28 + PCB 31	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 52	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 101	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 118	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 153	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 138	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 180	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB Total	mg/kg	0.01	As Received	No	Yes	Yes

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.



Certificate of Analysis

Certificate Number 15-51045

26-Nov-15

Client Ian Farmer Associates
17 Rivington Court
Hardwick Grange
Woolston
Warrington
Cheshire
WA1 4RT

Our Reference 15-51045

Client Reference 41787

Order No 49706

Contract Title SIEMENS DEVELOPMENT

Description One Soil sample.

Date Received 20-Nov-15

Date Started 20-Nov-15

Date Completed 26-Nov-15

Test Procedures Identified by prefix DETSn (details on request).

Notes Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

A handwritten signature in black ink, appearing to read 'Rob Brown'.

Rob Brown
Business Manager



Summary of Chemical Analysis

Matrix Descriptions

Our Ref 15-51045

Client Ref 41787

Contract Title SIEMENS DEVELOPMENT

Sample ID	Depth	Lab No	Completed	Matrix Description
WS11	1	903051	26/11/2015	Dark brown and brown, gravelly, sandy CLAY

Summary of Chemical Analysis Soil Samples

Our Ref 15-51045

Client Ref 41787

Contract Title SIEMENS DEVELOPMENT

Lab No	903051
Sample ID	WS11
Depth	1.00
Other ID	
Sample Type	SOIL
Sampling Date	13/11/15
Sampling Time	n/s

Test	Method	LOD	Units	
Metals				
Arsenic	DETSC 2301#	0.2	mg/kg	1.1
Boron (water soluble)	DETSC 2123#	0.2	mg/kg	0.5
Cadmium	DETSC 2301#	0.1	mg/kg	< 0.1
Chromium	DETSC 2301#	0.15	mg/kg	6.9
Hexavalent Chromium	DETSC 2204*	1	mg/kg	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	2.9
Lead	DETSC 2301#	0.3	mg/kg	3.1
Mercury	DETSC 2325#	0.05	mg/kg	< 0.05
Nickel	DETSC 2301#	1	mg/kg	10
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5
Zinc	DETSC 2301#	1	mg/kg	14
Inorganics				
pH	DETSC 2008#			8.1
Organic matter	DETSC 2002#	0.1	%	0.4

Information in Support of the Analytical Results

Our Ref 15-51045
Client Ref 41787
Contract SIEMENS DEVELOPMENT

Containers Received & Deviating Samples

Lab No	Sample ID	Date		Containers Received	Holding time exceeded for tests	Inappropriate container for tests
		Sampled				
903051	WS11 1.00 SOIL	13/11/15	PT 1L			
Key: P-Plastic T-Tub DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.						

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.
Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.
The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETS 2002	Organic matter	%	0.1	Air Dried	No	Yes	Yes
DETS 2003	Loss on ignition	%	0.01	Air Dried	No	Yes	Yes
DETS 2008	pH	pH Units	1	Air Dried	No	Yes	Yes
DETS 2024	Sulphide	mg/kg	10	Air Dried	No	Yes	Yes
DETS 2076	Sulphate Aqueous Extract as SO ₄	mg/l	10	Air Dried	No	Yes	Yes
DETS 2084	Total Carbon	%	0.5	Air Dried	No	Yes	Yes
DETS 2084	Total Organic Carbon	%	0.5	Air Dried	No	Yes	Yes
DETS 2119	Ammoniacal Nitrogen as N	mg/kg	0.5	Air Dried	No	Yes	Yes
DETS 2130	Cyanide free	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2130	Cyanide total	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETS 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes
DETS 2321	Total Sulphate as SO ₄	%	0.01	Air Dried	No	Yes	Yes
DETS 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETS 3049	Sulphur (free)	mg/kg	0.75	Air Dried	No	Yes	Yes
DETS 2123	Boron (water soluble)	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Arsenic	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Barium	mg/kg	1.5	Air Dried	No	Yes	Yes
DETS 2301	Beryllium	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Cadmium Available	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2301	Cadmium	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2301	Cobalt	mg/kg	0.7	Air Dried	No	Yes	Yes
DETS 2301	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETS 2301	Copper	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Manganese	mg/kg	20	Air Dried	No	Yes	Yes
DETS 2301	Molybdenum	mg/kg	0.4	Air Dried	No	Yes	Yes
DETS 2301	Nickel	mg/kg	1	Air Dried	No	Yes	Yes
DETS 2301	Lead	mg/kg	0.3	Air Dried	No	Yes	Yes
DETS 2301	Selenium	mg/kg	0.5	Air Dried	No	Yes	Yes
DETS 2301	Zinc	mg/kg	1	Air Dried	No	Yes	Yes
DETS 3072	Ali/Aro C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C12	mg/kg	1.5	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C12-C16	mg/kg	1.2	As Received	No	Yes	Yes
DETS 3072	Aliphatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C16-C21	mg/kg	1.5	As Received	No	Yes	Yes
DETS 3072	Aliphatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETS 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C12	mg/kg	0.9	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C12-C16	mg/kg	0.5	As Received	No	Yes	Yes
DETS 3072	Aromatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C16-C21	mg/kg	0.6	As Received	No	Yes	Yes
DETS 3072	Aromatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 062	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Ethylbenzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	m+p Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	o Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3311	C10-C24 Diesel Range Organics (DRO)	mg/kg	10	As Received	No	Yes	Yes
DETS 3311	C24-C40 Lube Oil Range Organics (LORO)	mg/kg	10	As Received	No	Yes	Yes
DETS 3311	EPH (C10-C40)	mg/kg	10	As Received	No	Yes	Yes

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETS 3303	Acenaphthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Acenaphthylene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(a)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(a)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(b)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(k)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(g,h,i)perylene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Dibenzo(a,h)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Indeno(1,2,3-c,d)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Naphthalene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Phenanthrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3401	PCB 28 + PCB 31	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 52	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 101	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 118	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 153	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 138	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 180	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB Total	mg/kg	0.01	As Received	No	Yes	Yes

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.



Certificate of Analysis

Certificate Number 15-51104-1

08-Jan-16

Client Ian Farmer Associates
17 Rivington Court
Hardwick Grange
Woolston
Warrington
Cheshire
WA1 4RT

Our Reference 15-51104-1

Client Reference 41787

Order No 49747

Contract Title Siemens Development

Description 2 Soil samples.

Date Received 21-Nov-15

Date Started 21-Nov-15

Date Completed 08-Jan-16

Test Procedures Identified by prefix DETSn (details on request).

Notes This report supersedes 15-51104. Extra testing

Opinions and interpretations are outside the scope of UKAS accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. Observations and interpretations are outside the scope of ISO 17025. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

A handwritten signature in black ink, appearing to read 'Rob Brown'.

Rob Brown
Business Manager



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Summary of Chemical Analysis

Matrix Descriptions

Our Ref 15-51104-1

Client Ref 41787

Contract Title Siemens Development

Sample ID	Other ID	Depth	Lab No	Completed	Matrix Description
BH10	ES5	1	903468	30/11/2015	Dark brown,, slightly clayey, gravelly SAND
BH06	3	1	903469	30/11/2015	Brown slightly gravelly, clayey SAND

Summary of Chemical Analysis

Soil Samples

Our Ref 15-51104-1

Client Ref 41787

Contract Title Siemens Development

Lab No	903468	903469
Sample ID	BH10	BH06
Depth	1.00	1.00
Other ID	ES5	3
Sample Type	SOIL	SOIL
Sampling Date	18/11/15	13/11/15
Sampling Time	n/s	n/s

Test	Method	LOD	Units		
Asbestos Quantification OHR	DETSC 1102	0		Y	
Metals					
Arsenic	DETSC 2301#	0.2	mg/kg	15	6.0
Boron (water soluble)	DETSC 2123#	0.2	mg/kg	0.5	0.3
Cadmium	DETSC 2301#	0.1	mg/kg	1.1	0.3
Chromium	DETSC 2301#	0.15	mg/kg	19	13
Hexavalent Chromium	DETSC 2204*	1	mg/kg	< 1.0	< 1.0
Copper	DETSC 2301#	0.2	mg/kg	14	10
Lead	DETSC 2301#	0.3	mg/kg	27	14
Mercury	DETSC 2325#	0.05	mg/kg	0.11	< 0.05
Nickel	DETSC 2301#	1	mg/kg	9.7	8.4
Selenium	DETSC 2301#	0.5	mg/kg	< 0.5	< 0.5
Zinc	DETSC 2301#	1	mg/kg	37	26
Inorganics					
pH	DETSC 2008#			7.3	7.7
Organic matter	DETSC 2002#	0.1	%	2.1	0.8
Sulphate Aqueous Extract as SO4	DETSC 2076#	10	mg/l	1400	1300
PAHs					
Acenaphthene	DETSC 3301	0.1	mg/kg	< 0.1	
Acenaphthylene	DETSC 3301	0.1	mg/kg	< 0.1	
Anthracene	DETSC 3301	0.1	mg/kg	0.2	
Benzo(a)anthracene	DETSC 3301	0.1	mg/kg	0.5	
Benzo(a)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	
Benzo(b)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	
Benzo(g,h,i)perylene	DETSC 3301	0.1	mg/kg	< 0.1	
Benzo(k)fluoranthene	DETSC 3301	0.1	mg/kg	< 0.1	
Chrysene	DETSC 3301	0.1	mg/kg	0.4	
Dibenzo(a,h)anthracene	DETSC 3301	0.1	mg/kg	< 0.1	
Fluoranthene	DETSC 3301	0.1	mg/kg	0.9	
Fluorene	DETSC 3301	0.1	mg/kg	< 0.1	
Indeno(1,2,3-c,d)pyrene	DETSC 3301	0.1	mg/kg	< 0.1	
Naphthalene	DETSC 3301	0.1	mg/kg	< 0.1	
Phenanthrene	DETSC 3301	0.1	mg/kg	0.9	
Pyrene	DETSC 3301	0.1	mg/kg	0.7	
PAH	DETSC 3301	1.6	mg/kg	3.6	
Phenols					
Phenol - Monohydric	DETSC 2130#	0.3	mg/kg	< 0.3	

Summary of Asbestos Analysis Soil Samples

Our Ref 15-51104-1

Client Ref 41787

Contract Title Siemens Development

Lab No	Sample ID	Material Type	Result	Comment*	Analyst
903468	BH10 ES5 1.00	SOIL	Chrysotile	Small bundle of Chrysotile present	Jeff Cruddas

Crocidolite = Blue Asbestos, Amosite = Brown Asbestos, Chrysotile = White Asbestos. Anthophyllite, Actinolite and Tremolite are other forms of Asbestos. Samples are analysed by DETSC 1101 using polarised light microscopy in accordance with HSG248 and documented in-house methods. NAD = No Asbestos Detected. Where a sample is NAD, the result is based on analysis of at least 2 sub-samples and should be taken to mean 'no asbestos detected in sample'. Key: * -not included in laboratory scope of accreditation.

Summary of Asbestos Quantification Analysis

Soil Samples

Our Ref 15-51104-1

Client Ref 41787

Contract Title Siemens Development

Lab No	903468
Sample ID	BH10
Depth	1.00
Other ID	ES5
Sample Type	SOIL
Sampling Date	18/11/15
Sampling Time	

Test	Method	Units	
Total Mass% Asbestos (a+b+c)	DETSC 1102	Mass %	< 0.001
Gravimetric Quantification (a)	DETSC 1102	Mass %	na
Detailed Gravimetric Quantification (b)	DETSC 1102	Mass %	<0.001
Quantification by PCOM (c)	DETSC 1102	Mass %	na
Potentially Respirable Fibres (d)	DETSC 1102	Fibres/g	na
Breakdown of Gravimetric Analysis (a)			
Mass of Sample		g	504.75
ACMs present*		type	
Mass of ACM in sample		g	
% ACM by mass		%	
% asbestos in ACM		%	
% asbestos in sample		%	
Breakdown of Detailed Gravimetric Analysis (b)			
% Amphibole bundles in sample		Mass %	na
% Serpentine bundles in sample		Mass %	<0.001
Breakdown of PCOM Analysis (c)			
% Amphibole fibres in sample		Mass %	na
% Serpentine fibres in sample		Mass %	na
Breakdown of Potentially Respirable Fibre Analysis (d)			
Amphibole fibres		Fibres/g	na
Chrysotile fibres		Fibres/g	na

* Denotes test or material description outside of UKAS accreditation.
 % asbestos in Asbestos Containing Materials (ACMs) is determined by
 by reference to HSG 264.
 Recommended sample size for quantification is approximately 1kg
 # denotes deviating sample

Information in Support of the Analytical Results

Our Ref 15-51104-1
Client Ref 41787
Contract Siemens Development

Containers Received & Deviating Samples

Lab No	Sample ID	Date		Containers Received	Holding time exceeded for tests	Inappropriate container for tests
		Sampled				
903468	BH10 1.00 SOIL	18/11/15		GJ 250ml, GJ 60ml, PT 1L		
903469	BH06 1.00 SOIL	13/11/15		GJ 250ml, GJ 60ml, PT 1L	pH + Conductivity (7 days)	

Key: G-Glass P-Plastic J-Jar T-Tub

DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time and/or inappropriate containers are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 425µm sieve, in accordance with BS1377.
Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.
The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :- Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETS 2002	Organic matter	%	0.1	Air Dried	No	Yes	Yes
DETS 2003	Loss on ignition	%	0.01	Air Dried	No	Yes	Yes
DETS 2008	pH	pH Units	1	Air Dried	No	Yes	Yes
DETS 2024	Sulphide	mg/kg	10	Air Dried	No	Yes	Yes
DETS 2076	Sulphate Aqueous Extract as SO ₄	mg/l	10	Air Dried	No	Yes	Yes
DETS 2084	Total Carbon	%	0.5	Air Dried	No	Yes	Yes
DETS 2084	Total Organic Carbon	%	0.5	Air Dried	No	Yes	Yes
DETS 2119	Ammoniacal Nitrogen as N	mg/kg	0.5	Air Dried	No	Yes	Yes
DETS 2130	Cyanide free	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2130	Cyanide total	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2130	Phenol - Monohydric	mg/kg	0.3	Air Dried	No	Yes	Yes
DETS 2130	Thiocyanate	mg/kg	0.6	Air Dried	No	Yes	Yes
DETS 2321	Total Sulphate as SO ₄	%	0.01	Air Dried	No	Yes	Yes
DETS 2325	Mercury	mg/kg	0.05	Air Dried	No	Yes	Yes
DETS 3049	Sulphur (free)	mg/kg	0.75	Air Dried	No	Yes	Yes
DETS 2123	Boron (water soluble)	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Arsenic	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Barium	mg/kg	1.5	Air Dried	No	Yes	Yes
DETS 2301	Beryllium	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Cadmium Available	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2301	Cadmium	mg/kg	0.1	Air Dried	No	Yes	Yes
DETS 2301	Cobalt	mg/kg	0.7	Air Dried	No	Yes	Yes
DETS 2301	Chromium	mg/kg	0.15	Air Dried	No	Yes	Yes
DETS 2301	Copper	mg/kg	0.2	Air Dried	No	Yes	Yes
DETS 2301	Manganese	mg/kg	20	Air Dried	No	Yes	Yes
DETS 2301	Molybdenum	mg/kg	0.4	Air Dried	No	Yes	Yes
DETS 2301	Nickel	mg/kg	1	Air Dried	No	Yes	Yes
DETS 2301	Lead	mg/kg	0.3	Air Dried	No	Yes	Yes
DETS 2301	Selenium	mg/kg	0.5	Air Dried	No	Yes	Yes
DETS 2301	Zinc	mg/kg	1	Air Dried	No	Yes	Yes
DETS 3072	Ali/Aro C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C12	mg/kg	1.5	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C12-C16	mg/kg	1.2	As Received	No	Yes	Yes
DETS 3072	Aliphatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C16-C21	mg/kg	1.5	As Received	No	Yes	Yes
DETS 3072	Aliphatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETS 3072	Aliphatic C21-C35	mg/kg	3.4	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C12	mg/kg	0.9	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C12	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C10-C35	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C12-C16	mg/kg	0.5	As Received	No	Yes	Yes
DETS 3072	Aromatic C12-C16	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C16-C21	mg/kg	0.6	As Received	No	Yes	Yes
DETS 3072	Aromatic C16-C21	mg/kg	10	As Received	No	Yes	Yes
DETS 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 3072	Aromatic C21-C35	mg/kg	1.4	As Received	No	Yes	Yes
DETS 062	Benzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Ethylbenzene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Toluene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	m+p Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 062	o Xylene	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3311	C10-C24 Diesel Range Organics (DRO)	mg/kg	10	As Received	No	Yes	Yes
DETS 3311	C24-C40 Lube Oil Range Organics (LORO)	mg/kg	10	As Received	No	Yes	Yes
DETS 3311	EPH (C10-C40)	mg/kg	10	As Received	No	Yes	Yes

Appendix A - Details of Analysis

Method	Parameter	Units	Limit of Detection	Sample Preparation	Sub-Contracted	UKAS	MCERTS
DETS 3303	Acenaphthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Acenaphthylene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(a)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(a)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(b)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(k)fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Benzo(g,h,i)perylene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Dibenzo(a,h)anthracene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Fluoranthene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Indeno(1,2,3-c,d)pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Naphthalene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Phenanthrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3303	Pyrene	mg/kg	0.03	As Received	No	Yes	Yes
DETS 3401	PCB 28 + PCB 31	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 52	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 101	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 118	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 153	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 138	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB 180	mg/kg	0.01	As Received	No	Yes	Yes
DETS 3401	PCB Total	mg/kg	0.01	As Received	No	Yes	Yes

Method details are shown only for those determinands listed in Annex A of the MCERTS standard. Anything not included on this list falls outside the scope of MCERTS. No Recovery Factors are used in the determination of results. Results reported assume 100% recovery. Full method statements are available on request.

APPENDIX 5

DESIGN CONSIDERATIONS

APPENDIX 5

GEOTECHNICAL DESIGN CONSIDERATIONS

A5.1 ASSESSMENT OF GRANULAR SOIL CONDITION

- A5.1.1 SPT 'N' values reported on the borehole logs are as measured in the field with no corrections applied.
- A5.1.2 However for general design in sands the 'N' values should be normalised to 60% by the following equation:-
- A5.1.3 $N_{60} = E_r/60.N$ where:-
- N is the blow count and
- E_r is the energy ratio of the specific test equipment
- A5.1.4 Further corrections for rod length and overburden pressure in sands may be applied in accordance with BS EN ISO 22476-3, ref 9.6.

A5.2 ASSESSMENT OF COHESIVE SOIL CONDITION

- A5.2.1 In accordance with BS EN ISO 22475-1, ref. 10.6, and BS5930, ref.10.3, the thick walled U100 sample is considered as a Class B sampling technique and will only produce Class 3 to 5 quality samples in accordance with EN 1997-2:2007, ref.10.4.
- A5.2.2 Laboratory strength and consolidation testing should only be carried out on Class 1 quality samples, which can be obtained from a Class A sampling technique, ref. 9.5. This is due to possible disturbance during sampling, giving a weaker strength in testing.
- A5.2.3 Therefore laboratory test values for c_u and m_v obtained from thick walled U100 samples should only be used as guidance and not used as absolute values for the shear strength and compressibility properties of the clay and only used to provide guidance to descriptive strength on the borehole records.
- A5.2.4 Work undertaken by Stroud, ref. 10.11 determined a relationship between SPT 'N' values, plasticity undrained shear strength and compressibility of many over-consolidated clays. Further work by Stroud and Butler, ref.10.12, in which data was analysed from sites covering a wide range of glacial deposits, confirmed there to be a correlation between the 'N' value plasticity undrained shear strength and compressibility.
- A5.2.5 The relationship was of the form:
- $$C_u = f_1 \times N$$
- and
- $$m_v = 1/(f_2 \times N)$$
- Where
- c_u = Un-drained shear strength
- m_v = Coefficient of compressibility
- f_1 and f_2 = Factors
- A5.2.6 It was determined by Stroud that f_1 varied between 4kPa for material of high plasticity and 6kPa for material of low plasticity. Similarly f_2 varied between 400kPa and 600kPa.

A5.3 GUIDELINES FOR THE DESIGN OF PILES FIRST APPROXIMATION OF WORKING LOAD

A5.3.1 PILING PARAMETERS – GENERAL

The ultimate carrying capacity, Q_u , of a particular pile is taken as the sum of the ultimate shaft friction resistance, Q_s , and the ultimate end bearing resistance, Q_b . This may be expressed as follows:-

$$\begin{aligned} Q_u &= Q_s + Q_b \\ &= f.A_s + q.A_b \end{aligned}$$

where

$$\begin{aligned} f &= \text{unit shaft resistance} \\ A_s &= \text{embedded surface area of pile} \\ q &= \text{unit end bearing resistance} \\ A_b &= \text{effective cross-sectional area of pile base} \end{aligned}$$

A5.3.2 COHESIVE SOILS

A5.3.2.1 Shaft Resistance

The ultimate shaft resistance, f , for piles in both compression or tension in cohesive soils is determined by applying a factor to the undrained shear strength, C_s , which exists in the soils along the embedded length of the pile, and is given by:-

$$f = \alpha.C_s$$

Where α is an adhesion factor, which for straight-shafted bored piles may be taken as 0.45 to 0.60.

Ultimate unit shaft friction should not exceed 100kN/m².

A5.3.2.2 End Bearing

For piles terminating in cohesive soils, the ultimate unit end bearing resistance q , is given by:-

$$q = N_c.C_b$$

where C_b is the undrained shear strength at the base of the pile

and N_c is a bearing capacity factor

The value of N_c for a cohesive material is variable, depending on the depth of the penetration of the pile into the bearing stratum. Generally, N_c could be taken to have a value of 9, except in the case of large diameter short piles where a lesser value should be used.

A5.3.3 COHESIONLESS SOILS

A5.3.3.1 Shaft Resistance

For piles driven in cohesionless soils the ultimate unit shaft resistance, f , may be calculated using the following method, which gives:-

$$f = 0.5 \gamma' (D+d) K_s \tan \delta$$

where γ' = average effective unit weight of soil surrounding the pile

D = depth to the pile toe or to the base of the granular stratum whichever is the lesser

d = depth to the top of the granular stratum

δ = angle of friction between pile and soil
(see below)

K_s = a coefficient (see below)

TABLE OF VALUES FOR K_s AND δ

Pile Type	δ	K_s		
		Relative Density		Tension Piles
		Low	High	
Steel	20°	0.5	1.5	0.5
Concrete	0.75 ϕ	1.0	2.0	0.5

The value of ϕ may be interpreted from standard penetration tests.

For bored and cast-in-place piles, $\delta = 22^\circ$ and $K_s = 1$ should be used to allow for loosening of the soil during boring.

It has been found that the ultimate unit shaft resistance does not exceed 100kN/m² and therefore this value should not be exceeded in design.

A5.3.3.2 End Bearing

The unit ultimate end bearing resistance (q) of piles in cohesionless soils may be calculated as follows:-

$$q = \gamma' \cdot D \cdot N_q$$

where γ' = average effective unit weight of soil surrounding the pile

D = depth to pile toe

N_q = bearing capacity factor

Values for N_q , where piles penetrate the bearing stratum by more than five diameters, may be taken from work carried out by Berezantsev, ref.10.19. In addition, the ultimate unit base resistance should not exceed a value of 11,000kN/m². For bored and cast-in-place piles the value of N_q used should correspond to loose soil conditions.

A5.3.4 FACTORS OF SAFETY

A5.3.4.1 Cohesive and Non-cohesive Soils

For cohesive and non-cohesive soils a factor of safety of 3 may be used to obtain the allowable or safe carrying capacity of piles from the ultimate carrying capacity.

APPENDIX 6
CONTAMINATION ASSESSMENT

APPENDIX 6

GENERAL NOTES ON CONTAMINATION ASSESSMENT

A6.1 STATUTORY FRAMEWORK AND DEFINITIONS

A6.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref. 10.20, as;

‘Land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) pollution of controlled waters is being, or is likely to be, caused.’

A6.1.2 The UK guidance on the assessment of contaminated has developed as a direct result of the introduction of these two Acts. The technical guidance supporting the new legislation has been summarised in a number of key documents collectively known as the Contaminated Land Reports (CLRs), a proposed series of twelve documents. Seven were originally published in March 1994, four more were published in April 2002, while the last remaining guidance document, CLR 11, ref. 10.36 was published in 2004. In 2008 CLR reports 7 to 10 were withdrawn by DEFRA and the Environment Agency and updated version of CLR 9 and 10 were produced in the form of Science Reports SR2, ref. 10.33 and SR3, ref. 10.23.

A6.1.3 In establishing whether a site fulfils the statutory definition of ‘contaminated land’ it is necessary to identify, whether a pollutant linkage exists in respect of the land in question and whether the pollutant linkage:

- is resulting in significant harm being caused to the receptor in the pollutant linkage,
- presents a significant possibility of significant harm being caused to that receptor,
- is resulting in the pollution of the controlled waters which constitute the receptor, or
- is likely to result in such pollution.

A6.1.4 A ‘*pollutant linkage*’ may be defined as the link between a contaminant ‘*source*’ and a ‘*receptor*’ by means of a ‘*pathway*’.

A6.2 ASSESSMENT METHODOLOGY

A6.2.1 The guidance proposes a four-stage assessment process for identifying potential pollutant linkages on a site. These stages are set out in the table below:

No.	Process	Description
1	Hazard Identification	Establishing contaminant sources, pathways and receptors (the conceptual model).
2	Hazard Assessment	Analysing the potential for unacceptable risks (what linkages could be present, what could be the effects).
3	Risk Estimation	Trying to establish the magnitude and probability of the possible consequences (what degree of harm might result and to what receptors, and how likely is it).
4	Risk Evaluation	Deciding whether the risk is unacceptable.

A6.2.2 Stages 1 and 2 develop a '*conceptual model*' based upon information collated from desk based studies, and frequently a walkover of the site. The walkover survey should be conducted in general accordance with CLR 2, ref. 10.37. The formation of a conceptual model is an iterative process and as such, it should be updated and refined throughout each stage of the project to reflect any additional information obtained.

A6.2.3 The extent of the desk studies and enquiries to be conducted should be in general accordance with CLR 3, ref.10.22. The information from these enquiries is presented in a desk study report with recommendations, if necessary, for further work based upon the conceptual model. CLR 8, ref. 10.39, together with specific DoE 'Industry Profiles' provides guidance on the nature of contaminants relating to specific industrial processes. Although CLR 8 has been withdrawn, no replacement guidance has been published that lists the contaminants likely to be present on contaminated sites and as such the guidance relating to this issue of CLR 8 is considered to still be relevant.

A6.2.4 If potential pollutant linkages are identified within the conceptual model, a Phase 2 site investigation and report will be recommended. The investigation should be planned in general accordance with CLR 4, ref. 10.1. The number of exploratory holes and samples collected for analysis should be consistent with the size of the site and the level of risk envisaged. This will enable a contamination risk assessment to be conducted, at which point the conceptual model can be updated and relevant pollutant linkages can be identified.

A6.2.5 A two-stage investigation may be more appropriate where time constraints are less of an issue. The first stage investigation being conducted as an initial assessment for the presence of potential sources, a second being a more refined investigation to delineate wherever possible the extent of the identified contamination.

A6.2.6 All site works should be in general accordance with the British Standards, BS 5930:2015, ref. 10.3, ISO 1997, ref. 10.4 and BS 10175:2011, ref. 10.2.

A6.2.7 The generic contamination risk assessment screens the results of the chemical analysis against generic guidance values which are dependent on the proposed end-use of the development.

A6.2.8 The end-use may be defined as one of the following ref. 10.31;

- Residential with homegrown produce – domestic low rise and low density housing with gardens where vegetable may be grown for home consumption
- Residential without homegrown produce – domestic low density and low density housing where no gardens are present.

- Allotments – specific areas where vegetables are grown for home consumption.
- Public open space in close proximity to residential housing – includes the predominantly grassed area adjacent to high density housing and the central green area around which houses are developed. This land-use includes the smaller areas commonly incorporated in newer developments as informal grassed areas or more formal landscaped areas with a mixture of open space and covered soil with planting.
- Public open space in use as general parkland – provided for recreational use and may be used for family visits and picnics, children's play area, sports grounds and dog walking.
- Commercial – industrial premises where there is limited exposure to soil.

A6.2.9 Exposure pathways for each type of end-use are given below:

Standard Land Use	Oral Routes			Dermal Routes		Inhalation Routes			
	Direct soil & dust ingestion	Consumption of homegrown produce	Soil attached to homegrown produce	Indoor	Outdoor	Indoor dust	Outdoor dust	Indoor vapour	Outdoor vapour
Residential with homegrown produce	✓	✓	✓	✓	✓	✓	✓	✓	✓
Residential without homegrown produce	✓	X	X	✓	✓	✓	✓	✓	✓
Allotments	✓	✓	✓	X	✓	X	✓	✓	✓
Public open space – adjacent to dwellings	✓	X	X	✓	✓	✓	✓	X	✓
Public open space – parkland	✓	X	X	X	✓	X	✓	X	✓
Commercial	✓	X	X	✓	X	✓	X	✓	X

A6.2.1 In the first instance, soils will be compared to Suitable 4 Use Levels (S4ULs) published by LQM ref. 10.25. Screening levels for lead are taken from guidance published by DEFRA as no S4UL has been derived, ref. 10.31. Where no S4UL or C4SL is available, the assessment criteria (AC) may be generated using the Contaminated Land Exposure Assessment (CLEA) Software Version 1.07, ref. 10.27. Toxicological and physico-chemical/fate and transport data used to generate the AC will be derived from a hierarchy of data sources as follows:

1. Environment Agency or Department of Environment Food and Rural Affairs (DEFRA) documents;
2. Other documents produced by UK Government or state organisations;
3. European institution documents;
4. International organisation documents;

5. Foreign government institutions.

- A6.2.2 Where appropriate, input data has been drawn from the relevant SGV where available, or existing toxicological reports published by the Environment Agency which have not yet been withdrawn/replaced. Fate and transport data has been derived in the first instance from Environment Agency (2008), ref 10.38.
- A6.2.3 Individual concentrations are compared to the selected screening levels to identify concentrations of contaminants that are above the selected screening criteria. If appropriate, a statistical analysis of the results is conducted, as detailed in CIEH and CL:AIRE 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', ref 10.27.
- A6.2.4 Initially the distribution of the data set is tested using the Shapiro-Wilk normality test to determine if the data set is, or is not, normally distributed. Where the distribution of the data is shown to be normal, the mean value test is applied to determine whether the mean characteristics of the selected soil unit present a significant possibility of significant harm to human health. Where the data is not normally distributed a method based on the Chebychev Theorem can be applied to test the same hypothesis. The significance of the data is further tested using the maximum value test. This determines whether the highest recorded contaminant concentrations are from the same statistical distribution or whether they may represent a 'hot spot'.
- A6.2.5 Where the risk estimation identifies significant concentrations of one or more contaminants, a further risk evaluation needs to be undertaken.
- A6.2.6 The risk evaluation will address the potential pollutant linkages between an identified source of contamination and the likely receptors both on and off site.
- A6.2.7 The potential receptors include:
- 1) Humans – current site occupants, construction workers, future site users and neighbouring site users.
 - 2) Controlled Waters – surface water and groundwater resources
 - 3) Plants – current and future site vegetation
 - 4) Building materials
- A6.2.8 The potential hazards to be considered in relation to contamination are:
- a) Ingestion and inhalation.
 - b) Uptake of contaminants via cultivated vegetables.
 - c) Dermal contact
 - d) Phytotoxicity (the prevention or inhibition of plant growth)
 - e) Contamination of water resources
 - f) Chemical attack on building materials and services
 - g) Fire and explosion
- A6.2.9 Dependent on the outcome of the initial, generic contamination risk assessment, further detailed assessment of the identified risks may be required.

A6.3 Generic Guidance Values Used Within Contamination Risk Assessment

Residential End Use with Homegrown Produce

Residential with Homegrown Produce	Determinant	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
		1% SOM	2.5% SOM	6% SOM	
PAH	Acenaphthene	210	510	1100	LQM/CIEH S4UL
	Acenaphthylene	170	420	920	LQM/CIEH S4UL
	Anthracene	2400	5400	11000	LQM/CIEH S4UL
	Benzo(a)anthracene	7.2	11	13	LQM/CIEH S4UL
	Benzo(a)pyrene	2.2	2.7	3	LQM/CIEH S4UL
	Benzo(b)fluoranthene	2.6	3.3	3.7	LQM/CIEH S4UL
	Benzo(ghi)perylene	320	340	350	LQM/CIEH S4UL
	Benzo(k)fluoranthene	77	93	100	LQM/CIEH S4UL
	Chrysene	15	22	27	LQM/CIEH S4UL
	Dibenzo(ah)anthracene	0.24	0.28	0.30	LQM/CIEH S4UL
	Fluoranthene	280	560	890	LQM/CIEH S4UL
	Fluorene	170	400	860	LQM/CIEH S4UL
	Indeno(123-cd)pyrene	27	36	41	LQM/CIEH S4UL
	Naphthalene	2.3 ^f	5.6 ^f	13 ^f	LQM/CIEH S4UL
	Phenanthrene	95	220	440	LQM/CIEH S4UL
	Pyrene	620	1200	2000	LQM/CIEH S4UL
Other Organics	Phenol	280	550	1100	LQM/CIEH S4UL
Metals	Arsenic	37	37	37	LQM/CIEH S4UL
	Beryllium	1.7	1.7	1.7	LQM/CIEH S4UL
	Boron	290	290	290	LQM/CIEH S4UL
	Cadmium	11	11	11	LQM/CIEH S4UL
	Chromium (III)	910	910	910	LQM/CIEH S4UL
	Chromium (VI)	6	6	6	LQM/CIEH S4UL
	Copper	2400	2400	2400	LQM/CIEH S4UL
	Lead	200	200	200	EA C4SL
	Mercury	40	40	40	LQM/CIEH S4UL
	Nickel	180 ^f	180	180	LQM/CIEH S4UL
	Selenium	250	250	250	LQM/CIEH S4UL
	Vanadium	410 ^e	410	410	LQM/CIEH S4UL
	Zinc	3700	3700	3700	LQM/CIEH S4UL

d = Based on inhalation exposure compared with inhalation ID

e = Based on oral and dermal exposure with oral TDI

f = Based on comparison of exposure from all pathways with TDI oral

Residential with Homegrown Produce	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Guidance Value (mg/kg)	Primary Data Source
	1% SOM	2.5% SOM	6% SOM	
Aliphatic				
EC 5-6	42	78	160	LQM/CIEH S4UL
EC >6-8	100	230	530	LQM/CIEH S4UL
EC >8-10	27	65	150	LQM/CIEH S4UL
EC >10-12	130 (48)	330 (118)	770 (283)	LQM/CIEH S4UL
EC >12-16	1100 (24)	2400 (59)	4400 (142)	LQM/CIEH S4UL
EC >16-35	65000 (8.48)	92000 (21)	110000	LQM/CIEH S4UL
EC >35-44	65000 (8.48)	92000 (21)	110000	LQM/CIEH S4UL
Aromatic				
EC 5-7 (benzene)	70	140	300	LQM/CIEH S4UL
EC >7-8 (toluene)	130	290	660	LQM/CIEH S4UL
EC >8-10	34	83	190	LQM/CIEH S4UL
EC >10-12	74	180	380	LQM/CIEH S4UL
EC >12-16	140	330	660	LQM/CIEH S4UL
EC >16-21	260f	540f	930f	LQM/CIEH S4UL
EC >21-35	1100f	1500f	1700f	LQM/CIEH S4UL
EC >35-44	1100f	1500f	1700f	LQM/CIEH S4UL
Aliphatic and Aromatic				
EC >44-70	1600f	1800f	1900f	LQM/CIEH S4UL
BTEX				
Benzene	0.087	0.17	0.37	LQM/CIEH S4UL
Toluene	130	290	660	LQM/CIEH S4UL
Ethylbenzene	47	110	260	LQM/CIEH S4UL
p Xylenes	56	130	310	LQM/CIEH S4UL
m Xylenes	59	140	320	LQM/CIEH S4UL
o Xylene	60	140	330	LQM/CIEH S4UL

SOM = Soil Organic Matter

Values in brackets indicate the vapour saturation limit where this is exceeded by the GAC or SGV

APPENDIX 7
GAS GENERATION

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

>>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

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Remarks:

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>>> = Flow above detection limit of 30 l/hr, <<< = Negative flow greater than -10 l/hr. >Max = In excess of lower explosive limit.

Remarks:

APPENDIX 7

GENERAL NOTES ON GAS GENERATION

A7.1 GENERAL

- A7.1.1 In the past, a series of guidance documents were published by CIRIA, ref. 10.40, providing advice on hazards associated with methane. This earlier guidance was consolidated in CIRIA Document C659 to provide a risk based approach to gas contaminated land. This was subsequently re-issued as CIRIA Document C665, ref 10.41. In 2007, British Standard, BS8485, ref 10.42, dealing with ground gas was published. It is recommended that guidance in C665 and BS8485 is adopted to provide a consistent approach in dealing with ground gas contamination, the principal details being as follows.
- A7.1.2 This guidance is based on a similar approach to that for dealing with contaminated soil. The presence of hazardous gases could be deemed to be the 'source' in a 'pollutant linkage' that could lead to the conclusion that significant harm is or could be caused to people, buildings or the environment. In such circumstances the land could be deemed 'contaminated', ref. 10.20.
- A7.1.3 Should a potential source of gas be identified in the conceptual model, a gas risk assessment should be carried out, sufficient to demonstrate to the local authority that the proposals mitigate any hazards associated with ground gas. The authority enforces compliance with Approved Document Part C of the Building Regulations, ref. 10.43.

A7.2 APPROACH

- A7.2.1 A flow chart detailing the approach to assessing a site is given in CIRIA document C665, Figure 1.1. This may be summarised as follows.
- Carry out Phase 1 desk study, including initial conceptual model
 - Assess site, potential presence of gas / potential unacceptable risk / identify further action, if necessary
 - Monitor gas concentrations
 - Assessment of Risk
 - Recommendations / remediation
 - Validation

A7.3 POLLUTANT LINKAGE ASSESSMENT

- A7.3.1 A pollutant linkage assessment is presented in Appendix 3 of the Phase 1 Desk Study Report.
- A7.3.2 Using the risk model in the desk study, the pollutant linkage can be identified and a preliminary estimate of risk undertaken. If there is no relevant pollutant linkage identified there is no risk. If there is a very low risk, it is likely that no further assessment is required. If further assessment is necessary, then gas monitoring is required.

A7.4 SITE MONITORING

- A7.4.1 For sites with low generation potential, giving consistently low concentrations of soil gas under the worst-case conditions, a limited programme of monitoring would be appropriate. Where high or variable concentrations are anticipated or recorded, an extended programme of monitoring would be appropriate. The following guideline has been proposed, ref. 10.45.

Table A7.1

Sensitivity of development		Generation potential of source				
		Very low	Low	Moderate	High	Very high
	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with gardens)	6/3*	9/6	12/6	24/12	24/24

Notes

1. First number is minimum number of readings and second number is minimum period in months, for example 4/1 – Four sets of readings over 1 month.
2. At least two sets of readings must be at low and falling atmospheric pressure (but not restricted to periods below <1000mb) known as worst case conditions (see Boyle and Witherington, 2006).
3. The frequency and period stated are considered to represent typical minimum requirements. Depending on specific circumstances fewer or additional readings may be required (e.g. any such variation subject to site specific justification). * The NHBC guidance is also recommending these periods/frequency of monitoring (Boyle and Witherington, 2006)
4. Historical data can be used as part of the data set.
5. Not all sites will require gas monitoring however, this would need to be confirmed with demonstrable evidence.
6. Placing high sensitivity end use on a high hazard site is not normally acceptable unless the source is removed or treated to reduce its gassing potential. Under such circumstances long-term monitoring may not be appropriate or required.

- A7.4.2 Before taking any readings, zero the instrument, record atmospheric pressure and temperature.

- A7.4.3 Gas flow should be recorded, giving the range of pressures, ensuring positive or negative flow is recorded.

- A7.4.4 Record gas levels, recording peak and steady. Where steady state not obtained within 3 minutes, record change in concentration, where concentrations are decreasing, always record peak value. For very high concentrations, record for longer period of up to 10 minutes.

A7.5 ASSESSMENT OF RISK AND RECOMMENDATIONS

- A7.5.1 The main method of characterising a site is the method described by Wilson and Card, ref. 10.46 and is termed Situation A. This can be used for all types of development except conventional low-rise housing with suspended ground floor and ventilated underfloor void.

- A7.5.2 Low rise housing, Situation B, was developed by Boyle and Witherington, ref. 10.47 and was developed for the NHBC for classifying gassing sites for houses with suspended ground floor slab with ventilated void.

A7.5.3 Although the Code of Practice, ref 10.42, assesses the characteristic gas situation as CIRIA recommend for Situation A, see Table A7.2 below, their solution for gas protection systems is different, see section A7.10.

A7.6 SITUATION A - ASSESSMENT

A7.6.1 This system proposed by Wilson and Card, ref. 10.46 was originally developed in CIRIA Report 149, ref. 10.40.

A7.6.2 The method uses both gas concentrations and borehole flow rate for methane and carbon dioxide to define a Characteristic Situation for a site.

A7.6.3 Gas Screening Value (litre/hr) = borehole flow rate (litre/hr) x gas concentration (%). The GSV is determined for methane and carbon dioxide and the worst case adopted. The Characteristic Situation can then be determined from the table below. The GSV can be exceeded if the conceptual model indicates it is safe to do so, and other factors may lead to a change in the Characteristic Situation.

Table A7.2

Characteristic Situation	Risk Classification	Gas screening value (CH ₄ or CO ₂ (l/hr) ¹	Additional factors	Typical source of generation
1	Very low risk	<0.07	Typically methane ≤1% and/or carbon dioxide ≤5%. Otherwise consider increase to Situation 2	Natural soils with low organic content “Typical” Made Ground
2	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to Characteristic Situation 3	Natural soil, high peat/organic content. “Typical” Made Ground
3	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures	Mineworking – susceptible to flooding, completed landfill (WMP 26B criteria)
5	High risk	<70		Mineworking unflooded inactive with shallow workings near surface
6	Very high risk	>70		Recent landfill site

1. Site characterisation should be based on gas monitoring of concentrations and borehole flow rates for the minimum periods defined in Table A7.1
2. Source of gas and generation potential/performance must be identified.
3. If there is no detectable flow use the limit of detection of the instrument.

A7.7 SITUATION A – SOLUTION

A7.7.1 The Characteristic Situation can be used to define the scope of gas protective measures required.

A7.7.2 The CIRIA approach uses the characteristic situation to define the level of gas protection as follows:

Table A7.3

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
	Number of levels of protection	Typical scope of protective measures	Number of levels of protection	Typical scope of protective measures
1	None	No special precautions	None	No special precautions
2	2	a) Reinforced concrete cast in situ floor slab (suspended non-suspended or raft) with at least 1200g DPM and underfloor venting b) Beam and block or pre-cast concrete and 2000g DPM / reinforced gas membrane and underfloor venting All joints and penetrations sealed	1 to 2	a) Reinforced concrete cast in-situ floor slab (suspended non-suspended or raft) with at least 1200g DPM b) Beam and block or pre-cast concrete slab and minimum 2000g DPM/reinforced gas membrane c) Possibly underfloor venting or pressurisation in combination with a) and b) depending on use All joints and penetrations sealed
3	2	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space	1 to 2	All types of floor slab as above. All joints and penetrations sealed. Minimum 2000g/reinforced gas proof membrane and passively ventilated underfloor sub-space or positively pressurised underfloor sub-space
4	3	All types of floor slab as above. All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated underfloor subspace or positively pressurised underfloor sub-space, oversite capping or blinding and in	2 to 3	All types of floor slab as above. All joints and penetration sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility

Characteristic situation	Residential building (Not low-rise traditional housing)		Office/commercial/industrial development	
		ground venting layer		
5	4	Reinforced concrete cast in situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and ventilated or positively pressurised underfloor sub-space, oversite capping and in ground venting wells or barriers	3 to 4	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and passively ventilated or positively pressurised underfloor sub-space with monitoring facility. In ground venting wells or barriers
6	5	Not suitable unless gas regime is reduced first and quantitative risk assessment carried out to assess design of protection measures in conjunction with foundation design	4 to 5	Reinforced concrete cast in-situ floor slab (suspended, non-suspended or raft). All joints and penetrations sealed. Proprietary gas resistant membrane and actively ventilated or positively pressurised underfloor sub-space with monitoring facility, with monitoring. In ground venting wells and reduction of gas regime.

1. Typical scope of protective measures may be rationalised for specific developments on the basis of quantitative risk assessments.
2. Note the type of protection is given for illustration purposes only. Information on the detailing and construction of passive protection measures is given in BR414, ref. 10.44.
3. In all cases there should be minimum penetration of ground slabs by services and minimum number of confined spaces such as cupboards above the ground slab. Any confined spaces should be ventilated.
4. Foundation design must minimise differential settlement particularly between structural elements and ground-bearing slabs.
5. Commercial buildings with basement car parks, provided with ventilation in accordance with the Building Regulations, may not require gas protection for characteristic situations 3 and 4.
6. Floor slabs should provide an acceptable formation on which to lay the gas membrane. If a block and beam floor is used it should be well detailed so it has no voids in it that membranes have to span, and all holes for service penetrations should be filled. The minimum density of the blocks should be 600kg/m³ and the top surface should have a 4:1 sand cement grout brushed into all joints before placing any membrane (this is also good practice to stabilise the floor and should be carried out regardless of the need for gas membrane).
7. The gas-resistant membrane can also act as the damp-proof membrane.

A7.8 SITUATION B -ASSESSMENT

- A7.8.1 The NHBC has developed a characterisation system that is similar to Situation A but is specific to low-rise housing development with a clear ventilated underfloor void. The gas emission rates are compared to generic ‘Traffic Lights’.
- A7.8.2 The Traffic Lights include a Typical Maximum Concentration that is used for initial screening purposes. Where the Typical Maximum Concentration is exceeded the risk-based Gas Screening Value, GSV, should be adopted. The GSVs are determined for the ‘model’ low rise development and where they differ from this model, the GSV should be reassessed, ref. 10.41.
- A7.8.3 The calculations should be made for both methane and carbon dioxide, and the worst case adopted. The GSV is only a guideline.

Table A7.4

Traffic light	Methane		Carbon dioxide	
	Typical maximum concentration ² (% v/v)	Gas screening value (GSV) ³ (litres per hour)	Typical maximum concentration ² (% v/v)	Gas screening value (GSV) ^{1,2} (litres per hour)
Green	1	0.16	5	0.78
Amber 1				
Amber 2	5	0.63	10	1.56
Red	20	1.56	30	3.13

1. Generic GSVs are based on guidance contained within latest revision of Department of the Environment and the Welsh Office (2004 edition) “The Building Regulations: Approved Document C” and used a sub-floor void of 150mm thickness.
2. The Typical Maximum Concentrations can be exceeded in certain circumstances should the conceptual site model indicate it is safe to do so. This is where professional judgement will be required, based on a thorough understanding of the gas-regime identified at the site where monitoring in the worst temporal conditions has occurred.
3. The GSV thresholds should not generally be exceeded without completion of a detailed gas risk assessment taking into account site-specific conditions.

A7.9 SITUATION B – SOLUTION

- A7.9.1 On the basis of this Traffic Light classification the following protection should be applied to low-rise housing.

Table A7.5

Traffic Light Classification	Protection measures required
Green	Negligible gas regime identified and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.

Traffic Light Classification	Protection measures required
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. A specialist contractor should always fit membranes. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

A7.10 CODE OF PRACTICE – SOLUTIONS

- A7.10.1 The Characteristic Gas Situation is determine in a similar manner to that recommended by CIRIA, see Table A7.2 above.
- A7.10.2 Having selected the Characteristic Gas Situation, the appropriate gas protection could be selected for the building. The tables below give a guide as to the relative performance of the various designs and systems.
- A7.10.3 A guidance value for the required gas protection, in the range 0 to 7 should be obtained from Table A7.6 below. Then, a combination of ventilation and/or barrier system should be chosen from Table A7.7 to meet that requirement.

Table A7.6

Characteristic gas situation, CS	NHBC traffic light	Required gas protection			
		Non-managed property, e.g. private housing	Public building ^{A)}	Commercial buildings	Industrial buildings ^{B)}
1	Green	0	0	0	0
2	Amber 1	3	3	2	1 ^{C)}
3	Amber 2	4	3	2	2
4	Red	6 ^{D)}	5 ^{D)} 6 ^{E)}	4 5 7	3 4 6

NOTE: Traffic light indications are taken from NHBC Report no.: 10627-R01 (04) [3] and are mainly applicable to low-rise residential housing. These are for comparative purposes but the boundaries between the traffic light indications and CS values do not coincide.

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

A7.10.4 Having determined the appropriate guidance value from Table A7.6, an element or combination of elements from a), b), c) or d) in Table A7.7, should be chosen to achieve the required level of protection .

Table A7.7

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
a) Venting/dilution			
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, ref. 10.42
	Good performance	1	If passive ventilation is poor this is generally unacceptable and some form of active system will be required
Subfloor ventilation with active abstraction/pressurization (venting layer can be a clear void or formed using gravel, geocomposites, polystyrene void formers, etc.) ^{A)}		2.5	There have to be robust management systems in place to ensure the continued maintenance of any ventilation system. Active ventilation can always be designed to meet good performance. Mechanically assisted systems come in two main forms: extraction and positive pressurization.

PROTECTION ELEMENT/SYSTEM	SCORE	COMMENTS
Ventilated car park (basement or undercroft)	4	Assumes car park is vented to deal with car exhaust fumes, designed to Building Regulations Document F and IstructE guidance
b) Barriers		
Floor slabs		
Block and beam floor slab	0	It is good practice to install ventilation in all foundation systems to effect pressure relief as a minimum. Breached in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances
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	
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 installation, 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 systems ought to be installed in the underfloor venting/dilution system in the first instance but can also be provided within the occupied space as a fail safe.
Permanent monitoring and alarm system ^{A)}	2	
Installed in the underfloor venting/dilution system	1	
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, ref. 10.42)
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 1200 g DPM material is to function as a gas barrier it should be installed according to BRE 414, ref. 10.44 being taped and sealed to all penetrations.

C) Polymeric Materials >1200g can be used to improve confidence in the barrier. Remember that their gas resistance is little more than the standard 1200g (proportional to thickness) but their physical properties mean that they are more robust and resistant to site damage.

