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REPORT ON GROUND INVESTIGATION

Contract: 52562A

Date: November 2017

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REPORT ON GROUND INVESTIGATION

carried out at

2 PARK LANE,
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Prepared for

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EXECUTIVE SUMMARY

On the instructions of NLD (Rentals) Ltd, an investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with a contamination risk assessment and a review of gas emissions.

The site is situated at 2 Park Lane, approximately 28m to the northwest of Knebworth train station, and may be located by National Grid Reference TL 248 202. It is understood that the revised development plan comprises the demolition of the existing structures on site and the construction of a single three storey block containing nine flats, together with twenty two car parking spaces, hardstanding and landscaping areas.

Geological maps pertaining to the area indicate the site to be underlain by superficial Glaciofluvial Deposits, designated a Secondary A aquifer by the Environment Agency, subsequently underlain by undifferentiated deposits of the Lewes Nodular and Seaford Chalk Formations, designated a Principal aquifer. The site is located within a Zone 1 groundwater Source Protection to a public supply well.

Site works were carried out on the 14 and 15 September 2017 and comprised a single cable percussion borehole to a depth of 20.45m below ground level (bgl) and five percussive window sample boreholes to depths of between 4.85m and 5.29m bgl. Gas and groundwater monitoring standpipes were installed in three of the boreholes.

The sequence of the strata encountered during the investigation generally confirmed the anticipated geology, being superficial Glaciofluvial Deposits to a proven depth in the cable percussion borehole of 12.95m bgl, unproven in the window sample boreholes at depths of between 4.85m and 5.29m bgl. The superficial deposits were underlain in the cable percussion borehole by a void to a depth of 16.50m bgl, over the solid geology of the Chalk to the full depth of the investigation at 20.45m bgl.

The natural strata were overlain by Made Ground to proven depths of between 0.30m and 0.75m bgl.

Hazards associated with the ground conditions identified within the Preliminary Investigation, included a moderate to high risk from ground dissolution subsidence, associated with the underlying chalk, with a series of ten solution pipes recorded some 18m to the northeast. These findings together with the identification of a 3.55m deep void located between the superficial deposits and the top of the chalk, would indicate that measures would need to be implemented within the design of development to mitigate the risk from ground solution hazards. Such options might include the use of shallow spread orthogonal grid or raft foundations, ‘bridging’, or the adoption of a piled foundation able to transfer loads from the structure to below the base of the solution feature.

Ground floor slabs should be suspended and traditional soakaways avoided where possible, and if unavoidable be sited as a minimum some 20m away from foundations and roads.

It would be prudent to construct water pipes, and foul and surface water drains from flexible pipes and joints, wherever possible, and care taken to avoid leaks from water supplies and drainage.

Further investigation would be required across the footprint of the proposed structure to establish the depth to competent ground and soil profiles for piling and it is recommended that the Building Control Officer at the local council is contacted as soon as possible for their advice and as to whether they have any special design requirements in this area.

The results of the soil analyses, with the exception of lead, have been compared to the recently published S4ULs (Suitable 4 Use Levels) determined by LQM and CIEH. As the CLEA SGV for lead was withdrawn in 2014, DEFRA have produced C4SLs (Category 4 Screening Levels) for lead and a number of other contaminants. As no S4UL has been produced for lead, the C4SL has been adopted.

The assessment has identified the presence of elevated lead and PAH concentrations within the Made Ground with potential risks to receptors. Therefore remediation will be required to address the identified pollutant linkages,

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1.0 INTRODUCTION

1.1 It is understood that the revised proposed development comprises the demolition of the existing structures on site and the construction of a single three storey block containing nine flats, together with twenty two car parking spaces, hardstanding and landscaping areas.

1.2 The revised proposed development plan is given in Appendix 1, Figure A1.2.

1.3 On the instructions of NLD (Rentals) Ltd, an investigation was undertaken to determine ground conditions to enable foundation and road/hard standing design to be carried out, together with a contamination risk assessment and a review of gas emissions.

1.4 This report should be read in conjunction with the Preliminary Investigation, which was reported under reference 52562 in November 2016.

1.5 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.

1.6 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.

1.7 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.

1.8 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 2 Park Lane, approximately 28m to the northwest of Knebworth train station, and may be located by National Grid Reference TL 248 202.

2.1.2 Site location plans and an aerial photograph are included in Appendix 1, Figure A1.1.

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. 221, 'Hitchin', solid and drift edition, 1:50 000 scale, published 1995.

2.2.2 The geological map indicates the site to be underlain by superficial Glaciofluvial Deposits - Mid Pleistocene, comprising sand and gravel. Furthermore, the Clay-with-Flints Formation is shown to be present in close proximity to the site, and may be present underlying the site.

2.2.3 The superficial deposits are underlain by undifferentiated deposits of the Lewes Nodular and Seaford Chalk Formations.

2.2.4 A local existing borehole close to the site indicates 1.40m of Made Ground, underlain by superficial deposits to 2.55m below ground level (bgl), subsequently underlain by Chalk to the full depth of the borehole at 15.45m bgl.

2.2.5 This information is based upon records provided by the British Geological Survey.

3.0 SUMMARY DESK STUDY FINDINGS

3.1 A Preliminary Investigation in the form of a desk study and site reconnaissance was carried out in November 2016 in order to assess the potential hazards on and adjacent to the site and prepare a risk assessment for further consideration.

3.2 Historic maps indicated the site to have been first developed by c. 1898 with a structure in the north western corner and a row of structures trending north-south across the centre of the site. Additional development in the form of an extension to the structures in the north western corner of the site and the construction of a small structure in the south western corner were indicated to have occurred by c. 1923. The small structure was demolished by c.1937. The eastern area of the site was developed by c. 1960 with a structure parallel to the northern boundary of the site, and was extended southward by c. 1970. The historic maps indicated the extension to the structure in the northwest corner of the site may have been demolished and rebuilt between c. 1960 and c. 1970. By c. 1970, a tank present on maps from c. 1898 and located some 70m to the north of the site was no longer shown. A coal yard associated with the railway was present approximately 70m to the northeast from c. 1970, as well as an electricity substation 105m to the southeast of the site. The coal yard to the northeast was no longer present from c. 1983, from which time the eastern area of the site was labelled as a builder's yard.

3.3 At the time of the walkover survey, the site was accessed from Park Lane, and was developed with four permanent structures in the west and two temporary timber clad structures in the east, all with associated car parking and areas of hardstanding. Given the age of the structures on site, it was considered that asbestos was likely to be present in some form within the site boundaries. The surrounding area gently sloped toward the southeast at an approximate angle of 6°. A wall retaining some 1.3m of material was present in the south western corner of the site, creating a level parking area. A small depression in the ground was present in the south western area of the site.

3.4 The initial ground model identified the following potential hazards which may impact upon the engineering of the proposed development:

Potential Hazard	Assessed Risk
BGS Recorded Mineral Sites	Low
Other shallow mine workings	Very Low
Man-Made Cavities	Very Low
Collapsible Ground	Very Low
Compressible Ground	Low
Ground Dissolution	Moderate to High
Landslide	Very Low
Running Sand	Very Low
Shrinking or Swelling Clay	Low to Moderate
Unconsolidated Made Ground	Low
Bearing Pressure	Low
Aggressive conditions for construction materials	Very Low
Shallow or high groundwater table	Very Low

3.5 Geotechnical hazards identified by the research include a moderate to high risk associated with the potential for ground dissolution associated with the underlying chalk, largely driven by the presence of ten solution pipes located some 18m to the northeast of the site, and a low to moderate risk of volume change potential associated with the underlying superficial deposits.

3.6 The Initial Conceptual Site Model presented in the Phase I Preliminary Investigation Report is reproduced below:

Source	Potential Contaminants of Concern	Potential Pathways	Receptor Group	Risk
Made Ground and previous builder's yard/joinery	Heavy Metals PAHs TPHs Asbestos	Ingestion of contaminated soil by direct contact Ingestion of vegetables grown in contaminated soil Entry of contaminants by skin or eye contact with contaminated soils or dust Inhalation of contaminated dust Inhalation or migration of toxic/explosive gases/vapours	Humans • Site users • Construction workers • Neighbouring site users Water Environment • Groundwater • Surface Water Buildings, Materials and Services • Concrete • Plastic pipes and services	Low/Moderate Negligible[1,2] Negligible[2] Low/Moderate Negligible Low/Moderate Low/Moderate
Historic tank to the north of the site	TPHs		Humans • Site users • Construction workers • Neighbouring site users Buildings, Materials and Services • Concrete • Plastic pipes and services	Low Negligible[1,2] Negligible[2] Low Low
Railway to the east of the site	Heavy Metals PAHs TPHs		Humans • Site users • Construction workers • Neighbouring site users Buildings, Materials and Services • Concrete • Plastic pipes and services	Low Negligible[1,2] Negligible[2] Low Low

[1] – Assumes that PPE is worn at all times
[2] – Pathway exists only during the construction period

4.0 SITE WORK

4.1 The site work was carried out on the 14 and 15 September 2017. The locations of exploratory holes have been planned, where possible, in general accordance with CLR 4, ref. 10.1, and the site work carried out on the basis of the practices set out in BS 10175:2011, ref. 10.2, BS 5930:2015, ref. 10.3, and ISO 1997:2007, ref. 10.4.

4.2 A single borehole, designated BH1, was sunk by light cable percussion method and five boreholes, designated WS1 to WS5, were undertaken by percussive window sampler at the positions shown on the exploratory hole location plan, Appendix 1, Figure A1.3. The depths of boreholes, descriptions of strata encountered and comments on groundwater conditions are given in the borehole records, Appendix 2, Figure A2.1. A nominal cross section of the strata encountered in the boreholes is provided in Figure A2.2.

4.3 Representative disturbed and undisturbed samples were taken at the depths shown on the borehole records and despatched to the laboratory. Standard (split-barrel and cone) penetration tests, refs. 10.6 and 10.5, 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.

4.4 Samples for environmental purposes were collected in amber glass jars and kept in a cool box.

4.5 Standpipes were installed in selected boreholes as detailed in the table below. A visual representation of the standpipes is presented on the relevant borehole logs.

Borehole N^{o}	Depth To Base (m)	Response Zone (m bgl)	Nominal Pipe Diameter (mm)	Gas Valve/Lockable Cover
BH1	12.0	1.00 – 12.00	50	Yes
WS1	4.50	0.50 – 4.50	50	Yes
WS2	3.50	0.50 – 3.50	50	Yes

4.6 The ground levels at the borehole locations, reported on the records, were interpolated from spot levels on a survey drawing provided by the Client.

4.7 The eastings and northings for each of the exploratory locations, reported on the borehole records, were approximated from mapping provided within proprietary software.

4.8 Groundwater and gas monitoring visits were undertaken on the 29 September, 12 and 26 October, and 2 November 2017, as detailed in Figure A2.3.

5.0 LABORATORY TESTS

5.1 Geotechnical Testing

5.1.1 Geotechnical soil analysis was undertaken of samples obtained during the investigation as follows:

5.1.2 10 No. Water Content Tests

5.1.3 10 No. Plasticity Index Tests

5.1.4 1 No. Particle Size Distribution (by Wet Sieving)

5.1.5 2 No. Particle Size Distributions (by Wet Sieving and Pipette Analysis)

5.1.6 2 No. Quick Undrained Single-stage Triaxial Tests

5.1.7 8 No. pH Values

5.1.8 8 No. Sulphate Contents (Water Soluble)

5.1.9 The laboratory test reports are given in Appendix 3, Figures A3.1 and A3.2, with further values for water soluble sulphate content and pH given in Appendix 4, Figure A4.1.

5.2 Chemical Testing

5.2.1 The suite of chemical analyses has been based upon the findings of the preliminary investigation, along with any on-site observations, to investigate the potential sources of contamination identified in the conceptual model. The chemical analyses were carried out on six samples of soil. The nature of the analyses is detailed below:

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

5.2.3 **Organic Suite -** petroleum hydrocarbons (TPH) –CWG speciated analysis, benzene, toluene, ethylbenzene and xylenes (BTEX), methyl tertiary butyl ether (MTBE) and polycyclic aromatic hydrocarbons (PAH) – USEPA 16 suite.

5.2.4 **Inorganics Suite** - sulphate (water soluble).

5.2.5 **Others** - pH, organic matter content and asbestos.

5.2.6 The results of these tests are shown in Appendix 4, Figure A4.1.

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 Interpolation of strata depths between locations should be undertaken with caution, particularly for depths of Made Ground where structures are still present at the time of the investigation.

6.1.3 The sequence and indicative thicknesses of strata are provided below:

Strata Encountered	Depth Encountered (m bgl)		Strata Thickness (m)
	From	To	
Made Ground	0.00	0.30 to 0.75	0.30 to 0.75
Glaciofluvial Deposits	0.30 to 0.75	12.95	12.45
Void (BH1)	12.95	16.50	3.55
Chalk – Lewes Nodular and Seaford Chalk Formations	16.50	>20.45	>3.95

6.2 Made Ground (MGR)

6.2.1 Made Ground was encountered in all of the exploratory locations to proven depths of between 0.30m and 0.75m below ground level (bgl).

6.2.2 This stratum predominantly comprised dark brown or orange brown slightly clayey fine to coarse sand and angular to rounded fine to coarse gravel of flint or granite, brick and concrete with varying proportions of asphalt/clinker fragments in boreholes 1 and WS2, clay pockets in boreholes WS3 and WS5, occasional glass fragments in borehole WS1, and rare rootlets in boreholes WS1 and WS5.

6.2.3 In borehole WS2 from a depth of 0.20m bgl the Made Ground became cohesive and was described as firm dark brown/dark grey and orange brown gravelly sandy organic clay with occasional brick and asphalt/clinker fragments.

6.2.4 The Made Ground was overlain in borehole WS1 by a 0.14m thick hardstanding of asphalt over concrete, overlain in borehole WS2 by a thin layer of asphalt, and overlain in boreholes WS3, WS4 and WS5 by a concrete slab, between 0.012m and 0.09m thick.

6.3 Glaciofluvial Deposits (GFDU)

6.3.1 Material indicative of the superficial Glaciofluvial Deposits underlay the Made Ground to a proven depth in the cable percussion borehole at 12.95m bgl, unproven in the window sample boreholes at depths of between 4.85m and 5.29m bgl.

6.3.2 These deposits typically consisted of firm to stiff orange brown and light grey mottled, becoming with depth very stiff brown, orange brown and occasionally light grey mottled, gravelly sandy clay with varying proportions of black flecks and rare to occasional decomposing rootlets in borehole WS4 from 2.00m to 3.00m bgl. Gravels were predominantly angular to rounded fine and medium of flint, becoming with depth chalk and rare flint.

6.3.3 In window sample boreholes WS3, WS4 and WS5 from depths of between 4.20m and 4.50m bgl the deposits became granular and were generally recovered as very dense orange brown slightly gravelly, slightly silty very clayey and calcareous in borehole WS3, fine and medium sand . Gravels were typically fine to coarse of orange brown sandstone.

6.3.4 Whereas, in the cable percussion borehole from a depth of 5.50m bgl the granular deposits were generally described as medium dense orange brown gravelly silty clayey, becoming with depth very gravelly silty and slightly clayey, fine and medium sand with varying proportions of clay pockets to 11.00m bgl, over dense orange brown sandy slightly silty slightly clayey fine to coarse gravel of flint and chalk to the full depth of the stratum at 12.95m bgl.

6.4 Void (VOID)

6.4.1 This was encountered below the Glaciofluvial Deposits in the cable percussion borehole to a proven depth of 16.50m bgl and at a thickness of 3.55m bgl.

6.5 Chalk – Lewes Nodular and Seaford Chalk Formations (LESE)

6.5.1 Chalk was proven below the void in the cable percussion borehole to the full depth of the investigation at 20.45m bgl.

6.5.2 The stratum was generally recovered as structureless chalk composed of white and light brown slightly clayey silt and angular to subrounded gravel with occasional angular and subangular medium and coarse flint gravel. Clasts were weak, medium density, white with occasional black specks and rare orange brown staining. Grade Dm.

6.5.3 From a depth of 18.50m bgl the chalk was typically recovered as structureless chalk composed of white, occasionally light brown and orange brown mottled, gravelly slightly clayey silt. Gravels were weak, medium density, white with occasional black specks and rare orange brown staining. Grade Dm.

6.5.4 The description of chalk and references to Chalk Grade under the heading ‘Description’ in the records are based on the guidelines given in CIRIA Report C574, ref. 10.7. Details of the Grades are included in Appendix 2.

6.6 Groundwater

6.6.1 Groundwater was not encountered in any of the exploratory holes during the investigation.

6.6.2 Gas and groundwater monitoring standpipes were installed in the cable percussion borehole and in window sample boreholes WS1 and WS2.

6.6.3 A summary of the groundwater observations on the initial return visits to monitor the standpipes is provided in the table below:

Borehole N^{o}	Date	Response Zone (m)	Water Level (m bgl)	Stratum
BH1 (Standpipe)	29/09/2017	1.00 – 12.00	Dry	Glaciofluvial Deposits
	12/10/2017		Dry	
	26/10/2017		Dry	
	02/11/2017		Dry	
WS1 (Standpipe)	29/09/2017	0.50 – 4.50	Dry	Made Ground/Glaciofluvial Deposits
	12/10/2017		Dry	
	26/10/2017		Dry	
	02/11/2017		Dry	
WS2 (Standpipe)	29/09/2017	0.50 – 3.50	Dry	Made Ground/Glaciofluvial Deposits
	12/10/2017		Dry	
	26/10/2017		Dry	
	02/11/2017		Dry	

7.0 GEOTECHNICAL ASSESSMENT AND RECOMMENDATIONS IN RELATION TO THE PROPOSED DEVELOPMENT

7.1 Structural Details

7.1.1 It is understood that the proposed revised development is to consist of the demolition of the existing structures on site and the construction of a single three storey block containing nine flats, together with twenty two car parking spaces, hardstanding and landscaping areas.

7.1.2 In this report it has been considered that boreholes 1, WS3, WS4 and WS5 are located within the proposed building footprint, and boreholes WS1, WS2 and WS3 situated within the proposed car parking spaces.

7.1.3 The revised proposed development plan is given in Appendix 1, Figure A1.2.

7.1.4 Precise structural details were not available at the time of preparation of this report.

7.2 Assessment of Soil Condition

7.3 Made Ground (MGR)

7.3.1 The results of chemical tests in these deposits indicate a sulphate concentration in the soil of between 41mg/l and 1200mg/l as a 2:1 water/soil extract, with pH values in the range of 8.3 to 10.9.

7.4 Glaciofluvial Deposits - clay (GFDU)

7.4.1 Typically consisting of firm to stiff, becoming with depth very stiff gravelly sandy clay, encountered to depths of some 4.20m and 5.50m bgl.

7.4.2 Laboratory testing undertaken within the cohesive Glaciofluvial Deposits recorded natural moisture contents in the range of 14% and 33%, with an average of 21%, plasticity indices in the range of 12% and 34%, with an average of 29% and modified plasticity indices in the range of 9% and 34%, with an average of 26%. The plastic index test results are presented on the plasticity classification chart, Appendix 3, Figure A3.3.

7.4.3 These results indicate the cohesive Glaciofluvial Deposits is of low to high plasticity and of low to medium volume change potential as defined by the National House Building Council, ref. 10.8 and other published data, refs 10.9 and 10.10.

7.4.4 It is considered that a modified plasticity index value of 26% could be assuemd for this stratum and that for design purposes, medium volume change potential should be adopted. Changes in moisture content will result in moderate changes in volume, seasonal changes being exacerbated by the presence of trees.

7.4.5 Consistency index determinations were between 0.79 and 1.33 suggesting the stratum to be generally stiff to very stiff.

7.4.6 Unconsolidated un-drained triaxial compression tests, undertaken on 'undisturbed' (Class B) samples suggest c_u values of 157kPa and 170kPa.

7.4.7 SPT's were undertaken and where full penetration was achieved, recorded 'N' values of between 8 and 32, with an average of 21.

7.4.8 The results of chemical tests in the cohesive Glaciofluvial Deposits indicate a sulphate concentration in the soil of between 11mg/l and 89mg/l as a 2:1 water/soil extract, with pH values in the range of 8.1 to 8.7.

7.5 Glaciofluvial Deposits - granular (GFDU)

7.5.1 Particle size distributions undertaken on bulk samples from the fine granular bed in the cable percussion borehole indicated a gravel content of 14% and 28%, sand content of 52% and 59%, silt content of 16% and 19%, and clay content of 1% and 11%.

7.5.2 A particle size distribution undertaken on a bulk sample from the coarse granular bed in the cable percussion borehole indicated a gravel content of 71%, sand content of 19% and silt/clay content of 10%.

7.5.3 SPT's undertaken in the cable percussion borehole and where full penetration was achieved, recorded 'N' values of between 28 and 38, with an average of 33, indicating the deposit at this location to be generally of dense compaction. However, it should be noted that the 'N' value of 12 obtained at 12.50m bgl between the junction of the granular Glaciofuvial Deposits and the void was not used within this assessment.

7.5.4 Whilst, SPT's undertaken in the window sample boreholes recorded 'N' values generally of >50, indicating the deposit at this location to be typically of very dense compaction.

7.5.5 The results of chemical tests in the granular Glaciofluvial Deposits indicate a sulphate concentration in the soil of between 13mg/l and 21mg/l as a 2:1 water/soil extract, with pH of 8.5 and 8.6.

7.6 Chalk – Lewes Nodular and Seaford Chalk Formations (LESE)

7.6.1 Chalk was encountered below the void in the cable percussion borehole at a depth of 16.50m bgl and the grades determined by manual tests were of Dm.

7.6.2 SPT's were undertaken and where full penetration was achieved, recorded 'N' values of 21 and 14 at depths of 16.50m and 20.00m bgl respectively. Based on the comparison made by Spink (2001) to the Mundford grading system, ref. 10.7 the SPT 'N' values indicate the chalk to be of grade B2, becoming from a depth of 20.00m bgl grade Dc.

7.6.3 However, it should be noted that only machine excavated trial pits or rotary core drilling can provide samples of suitable quality for the accurate assessment of in-situ chalk and therefore some caution should be used when using these values for design purposes.

7.7 Foundation Options

7.7.1 Geotechnical hazards identified within the Preliminary Investigation, included a moderate to high risk from ground dissolution subsidence at the site, associated with the underlying chalk, with a series of ten solution pipes recorded some 18m to the northeast.

7.7.2 This together with the identification of a 3.55m void located between the superficial deposits and the top of the chalk at a depth of 12.95m to 16.50m bgl, would indicate that measures would need to be implemented within the design of the development to mitigate the risk from ground solution hazards. Reference can be made to the guidance given in CIRA C574, ref 10.7.

7.7.3 Therefore on the assumption that the void encountered is a solution feature, consideration could be given to the adoption of the following treatments, as given in the above guidance.

7.7.4 **Bridging**

7.7.5 For locations where a significant thickness of dense material is present above the void, such as in this case where six exploratory boreholes located across the site have proven the superficial deposits to be generally firm to stiff, becoming very stiff, to a depth of in excess of 4.5m bgl, consideration could be given to shallow spread footings.

7.7.6 These would typically be formed of an orthogonal grid or raft, which is capable of bridging over any potential voids, up to 5m in diameter.

7.7.7 Outside the zone of influence of existing and proposed trees, it is recommended that such footings should be taken through any Made Ground and placed in the cohesive Glaciofluvial Deposits at a minimum depth of 0.90m bgl.

7.7.8 Within the zone of influence of recently removed, existing or proposed trees, foundations should be taken through the Made Ground and placed at depths recommended by the NHBC for soils of medium volume change potential. Compressible material should be placed on the inside faces of foundations as specified by the NHBC.

7.7.9 Such foundations, assuming a 0.60m wide strip foundation at the minimum depth of 0.90m bgl, with a lower bound c_u value of 50kPa, may be designed to an allowable bearing pressure of 110kPa, which would provide an adequate factor of safety against shear failure and reduce settlement to be less than 15mm. Settlement should be checked when the final structural loading is known.

7.7.10 **Piling**

7.7.11 Alternatively consideration could be given to the adoption of a piled foundation, where the load from the structure is transferred below the base of the solution feature. Particular care would be needed to be sure that the piles are of a sufficient length to provide the design capacity below any impacted ground and that the vibration and use of flush during drilling did not result in further disturbance of the ground.

7.7.12 Further investigation would be required across the footprint of the proposed structure to establish the depth to competent ground and soil profiles for piling.

7.7.13 This might include probing of the building footprint on a 3m grid to determine the boundaries of the identified solution feature and the location of any further low strength ground or voids. It is suggested that this be supported by further deep boreholes, preferably at each corner of the structure to provide information for the design of piles.

7.7.14 Pile capacities have not yet been determined for the structure, however it is likely that the additional boreholes would need to extend to a minimum depth of 25m bgl, with the option to extend these as required should low strength chalk be recovered.

7.7.15 Other techniques which may be suitable for gathering of soil parameters could be considered such as conepressuremeter testing and geophysical techniques. A specialist contractor would need to be consulted for the suitability and cost effectiveness of these methods.

7.7.16 It is recommended that the Building Control Officer at the local council is contacted as soon as possible for their advice and whether they have any special design requirements in this area.

7.8 Ground Floor Slabs

7.8.1 It is recommended that the floor slab be suspended, and when within the zone of influence of trees incorporate a void in accordance with NHBC guidelines.

7.9 Drainage and Services

7.9.1 It would be prudent to construct waterpipes, and foul and surface water drains from flexible pipes and joints, wherever possible, and care taken to avoid leaks from water supplies and drainage.

7.9.2 Soakaways should be avoided however where avoidance is not possible, proposed soakaways should be sited away from foundations and roads at a distance of some 20m.

7.10 Excavations

7.10.1 The safety of all excavations should be assessed and managed in accordance with Regulation 22 of CDM 2015 Managing Health and Safety in Construction, ref 10.11.

7.10.2 On the basis of observations on site together with the results of in-situ and laboratory tests, it is considered that shallow excavations for foundations and services encountering the Made Ground are unlikely to be stable in the short term. Excavations encountering the shallow cohesive Glaciofluvial Deposits are likely to be stable in the short term.

7.10.3 However due to the risk from ground solution it may be prudent to manage the safety of the excavations by measures such as trench support or reducing side angles to ensure that no excavation or part of an excavation collapses, no material adjacent to any excavation is dislodged or falls and no person is buried or trapped in an excavation by material which is dislodged or falls.

7.10.4 Groundwater should not be expected in shallow excavations for foundations or services. However, it is possible that perched groundwater could be present in the Made Ground and Glaciofluvial Deposits overlying the Chalk during periods of high rainfall. It is considered that this could be dealt with by the use of a small pump.

7.11 Road and Hard Standing Design

7.11.1 The structural design of a road or hard standing is based on the strength of the subgrade, which is assessed on the California Bearing Ratio, CBR, scale from which the subgrade surface modulus can be estimated. Experience has indicated that the measurement of the in-situ CBR value tends to give unreliable results because of the influence of the moisture content of the materials. In practice, the correlation given by the Highways Agency, ref. 10.12, is usually more appropriate than direct determination of the CBR.

7.11.2 The process of design given in the guidance notes requires an estimate of CBR and subgrade stiffness modulus to be made at the design stage and in-situ measurement prior to construction.

7.11.3 On the basis of laboratory classification tests it is recommended that for formation prepared in the cohesive Glaciofluvial Deposits, with an average modified characteristic plastic index value of 26%, a subgrade CBR value of 5% be adopted for design purposes. The assessment assumes there to be a low water table, good construction conditions and a thin pavement construction. Any areas of soft or deleterious material in the Made Ground should be excavated and replaced with a properly compacted granular fill.

7.11.4 For routine cases, all material within 450mm of the road surface should be non frost-susceptible.

7.12 Chemical Attack on Buried Concrete

7.12.1 The site has been classified in accordance with BRE Special Digest 1, ref. 10.13, as Made Ground and as natural ground without the presence of pyrite. It is recommended that the guidelines given in BRE Special Digest 1, ref. 10.13, be adopted.

7.12.2 Characteristic values for each strata have been derived from laboratory results for pH and 2:1 water/soil extract (WS), and are presented in the table below with Design Sulphate Class and the ACEC Class: -

Stratum	pH	WS (mg/l)	AS (%)	TPS (%)	OS (%)	Groundwater Condition	DS	AC
Made Ground	8.5	1095	N/a	N/a	N/a	Mobile	2	2
Glaciofluvial Deposits	8.1	60	N/a	N/a	N/a	Mobile	1	1

7.12.3 On the basis of the laboratory test results it is considered that a Design Sulphate Class for concrete located in the Made Ground may be taken as DS-2. The site conditions would suggest that an ACEC class for the site of AC-2 would be appropriate, with DS-1 and AC-1 appropriate for the Glaciofluvial Deposits.

7.12.4 Chalk strata are not known to contain significant concentrations of sulphates or sulphides.

8.0 ENVIRONMENTAL RISK ASSESSMENT IN RELATION TO PROPOSED DEVELOPMENT

8.1 Contaminated Land

8.1.1 The statutory definition of contaminated land is defined in the Environmental Protection Act 1990, ref. 10.14, which was introduced by the Environment Act 1995, ref. 10.15, as;

8.1.2 '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 –

- significant harm is being caused or there is a significant possibility of such harm being caused; or
- significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.'

8.2 Risk Assessment

8.2.1 The definition of contaminated land is based on the principles of risk assessment. Risk is defined as a combination of:

- The probability, or frequency of exposure to a substance with the potential to cause harm, and:
- The seriousness of the consequence.

8.3 Pollutant Linkage

8.3.1 The basis of an environmental risk assessment involves identifying a 'source' of contamination, a 'pathway' along which the contamination may migrate and a 'receptor' at risk from the contamination.

8.3.2 Current legislation defines the various elements of the pollution linkage as:

- A contaminant is a substance, which is in or under the ground and which has the potential to cause harm or to cause pollution of controlled waters.
- A pathway is one or more routes through which a receptor is being exposed to, or affected by, a contaminant, or could be so affected.
- A receptor is either a living organism, an ecological system, a piece of land or property, or controlled water.

8.3.3 A pollutant linkage indicates that all three elements have been identified. The site can only be defined as 'Contaminated Land' if a pollutant linkage exists and the contamination meets the criteria in Section 8.1 above.

8.3.4 The guidance proposes a four-stage approach for the assessment of contamination and the associated risks. The four stages are listed below:

- Hazard Identification
- Hazard Assessment
- Risk Assessment
- Risk Evaluation

8.3.5 The hazard identification and hazard assessment have been based upon the Preliminary Investigation and formed the conceptual site model, detailed in our report, reference 52562, dated November 2016.

8.3.6 The risk assessment and evaluation stages are presented in this phase 2 interpretive report, after an intrusive ground investigation has taken place.

8.4 Risk Assessment – Human Health

8.4.1 The proposed development consists of a single three storey block containing nine flats, together with twenty two car parking spaces, hardstanding and landscaping areas. The risk assessment has therefore been based on guidelines for a residential end use without homegrown produce. Should the proposed development be changed in the future then further risk assessment may be required, particularly should a more sensitive end-use be envisaged, such as the inclusion of private gardens or allotments.

8.4.2 The results of the soil analyses, with the exception of lead, have been compared to the recently published S4ULs (Suitable 4 Use Levels) determined by LQM and CIEH, ref. 10.18. As the CLEA SGV for lead was withdrawn in 2014, DEFRA have produced C4SLs (Category 4 Screening Levels) for lead and a number of other contaminants. As no S4UL has been produced for lead, the C4SL has been adopted.

8.4.3 The Generic Assessment Criteria (GAC) used within this contamination assessment have been tabulated and are detailed within Appendix 6.

8.4.4 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. 10.20. Where the concentrations determined on site are at or below the respective Generic Assessment Criteria, they are considered not to pose a risk and are removed from further consideration, unless otherwise stated.

8.4.5 Those contaminants with observed concentrations above the GAC are detailed below:

Location	Depth (m bgl)	Contaminant	Concentration (mg/kg)	Guidance Level (mg/kg)
BH1	0.30	Benzo(b)anthracene	9	4
		Benzo(a)pyrene	7.3	3.2
		Dibenzo(ah)anthracene	0.96	0.32
WS1	0.30	Lead	450	310
		Benzo(b)anthracene	11	4
		Benzo(a)pyrene	9.8	3.2
		Dibenzo(ah)anthracene	1.2	0.32

8.5 Risk Assessment - Asbestos

8.5.1 Asbestos including Asbestos Containing Soils (ACS) only presents a risk to health if fibres are released into the air. It is generally assumed that only near surface ACS would contribute airborne fibres. However, in instances where gardens are proposed, then there is a risk that ACS could be exposed to the atmosphere through the action of digging.

8.5.2 Although no assessment criteria (AC) has been proposed in the new CIRIA C733, ref. 10.23, Ian Farmer Associates have adopted the view that if asbestos is identified within soil then further sampling and testing will be required; specifically to quantify the amount and type of asbestos present. This information should then be used in Detailed Quantitative Risk Assessment (DQRA) as outline in CIRIA C733.

8.5.3 None of the samples tested at this site contained asbestos.

8.6 Risk Assessment - Controlled Waters

8.6.1 The site is situated above a Secondary A aquifer, relating to the variably permeable Glaciofluvial Deposits, which is further underlain by a Principal aquifer relating to the highly permeable Chalk bedrock, and is within a zone 1 source protection zone to a public supply well.

8.6.2 There are no licensed groundwater abstractions within 500m of the site. There are six licensed abstractions from 606m to the east of the site, all for public potable supply.

8.6.3 There are no major surface watercourses within 1km of the site, though there is a pond located approximately 367m to the northeast of the site.

8.6.4 The concentrations of contaminants identified in the shallow soils are considered unlikely to represent a risk to controlled waters receptors, particularly considering the absence of groundwater encountered within the depth of the investigation and the distance to off-site receptors. Consequently, no further risk assessment is deemed necessary in relation to controlled waters.

8.7 Gas Generation

8.7.1 Gas monitoring visits were undertaken on the 29 September, 12 and 26 October, and 2 November 2017, with an atmospheric pressure ranging between 1003mb and 1013mb. The results of the gas monitoring are included within Appendix 2, Figure A2.3.

8.7.2 Methane concentrations up to 0.2% by volume were recorded during the monitoring, together with a carbon dioxide concentration of between 0.1% and 2.1% v/v. Variable oxygen concentrations were recorded ranging from near atmospheric to marginally depleted, 20.8% to 17.8% v/v.

8.7.3 Negligible concentrations of up to 0.6ppm total volatile compounds (VOCs) were recorded using a photo ionisation detector (PID).

8.7.4 Negligible concentrations of up to 1ppm carbon monoxide were also recorded in the standpipes, whilst concentrations of hydrogen sulphide were recorded at below the detection limit.

8.7.5 Flow rates were recorded over a three minute period during the monitoring. The maximum of the three minute average flows was recorded at less than 0.1l/hr (limit of detection).

8.7.6 In accordance with the methodology published in CIRIA Document C665, ref. 10.37, the maximum recorded values were taken to calculate a Gas Screening Value for the site of 0.002l/hr. This value indicates the site to be Characteristic Situation (CS) 1 (Appendix 7, Table A7.2).

8.7.7 On the basis of these results, gas protection measures should not be required for the proposed development.

8.7.8 Radon - The BRE guidance on Radon producing areas within the UK, (BR211:2007), indicates that the site lies within an area where radon protective measures are not required.

8.8 Protection of Services

8.8.1 Due to the increasing number of developments being undertaken on potentially contaminated land, the Water Supply Industry has identified the need to protect newly laid water supply pipes. They are likely to impose constraints on the nature of water supply pipes that are to be laid in contaminated land. Current guidance on the selection of materials for water pipes is provided by the UK Water Industry Research Limited, ref. 10.24, which superseded the previous guidance provided by Water Regulations Advisory Scheme, ref. 10.25.

8.8.2 The House Builders Federation, in collaboration with Water UK, ref. 10.26, have subsequently provided guidance, part of which includes a basic risk assessment which is tabulated in Appendix 6, Figure A6.1, and based on the contamination test results reviewed above. This assessment indicates no risks to plastic water supply pipes from the concentrations of organic contaminants observed in the shallow soils.

8.9 Risk Evaluation

8.9.1 The conceptual model formed within the Preliminary Investigation 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 Contaminants of Concern	Potential Pathways	Receptor Group	Risk
Made Ground and previous builder's yard/joinery	Heavy Metals PAHs TPHs Asbestos	Ingestion of contaminated soil by direct contact Ingestion of vegetables grown in contaminated soil Entry of contaminants by skin or eye contact with contaminated soils or dust Inhalation of contaminated dust Inhalation or migration of toxic/explosive gases/vapours	Humans • Site users • Construction workers • Neighbouring site users Water Environment • Groundwater • Surface Water Buildings, Materials and Services • Concrete • Plastic pipes and services	Low/Moderate Negligible[1,2] Negligible[2] Very Low Negligible Very Low Very Low
Historic tank to the north of the site	TPHs		Humans • Site users • Construction workers • Neighbouring site users Buildings, Materials and Services • Concrete • Plastic pipes and services	Very Low Negligible[1,2] Negligible[2] Very Low Very Low
Railway to the east of the site	Heavy Metals PAHs TPHs		Humans • Site users • Construction workers • Neighbouring site users Buildings, Materials and Services • Concrete • Plastic pipes and services	Very Low Negligible[1,2] Negligible[2] Very Low Very Low

[1] – Assumes that PPE is worn at all times
[2] – Pathway exists only during the construction period

8.10 Summary of Risk Evaluation

8.10.1 The above assessment identifies that the 'source – pathway – receptor' linkage potentially occurs with lead and PAH 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.

8.11 Waste

8.11.1 An initial assessment of the likely waste classification for any material to be disposed of has been conducted on the basis of the chemical test results obtained as part of the contamination risk assessment.

Made Ground

8.11.2 This assessment has been conducted using the HazWasteOnline[tm] tool, ref. 10.27, the summary output sheets from which are included within Appendix 4, Figure A4.2.

8.11.3 None of the samples were indicated likely to be classified as hazardous.

8.11.4 A number of samples were initially classified as potentially hazardous due to Hazard Property HP3(i): Flammable. However, maximum TPH concentrations were measured at less than 0.1% and it is unlikely that at these levels materials would be flammable. Therefore, the criteria has been altered to indicate total TPH concentrations less than 500mg/kg in solid samples as non-hazardous.

8.11.5 It should be noted that individual tips might require further analysis prior to the disposal of any material from the site. Any such requirements should be clarified with the tip prior to any further analysis being undertaken.

Natural Ground

8.11.6 Natural arisings which are not contaminated can be disposed of at an inert landfill based on being classified as a natural soil and a listed waste with no requirement for WAC testing.

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. 10.28, 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 This initial risk assessment has identified the presence of elevated lead and PAH concentrations within the Made Ground. Relevant pollutant linkages have been identified, as demonstrated in the updated conceptual model.

9.1.4 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 Investigation report and this Phase 2 Ground Investigation report in order to enable liaison to be undertaken with them.

9.1.5 Following liaison with the relevant regulatory bodies, a remediation strategy could 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.

9.1.6 The remediation strategy will need to review methods of reducing or controlling the identified unacceptable risks. This could be done by removing or treating the sources of contamination, removing or modifying the pathways or removing or modifying the behaviour of the receptors, to ensure there is no significant risk of significant harm to either human health or controlled waters from the identified contamination, in relation to the proposed end use.

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 In areas that are to be covered by buildings or hard standing, no pathway is likely to exist between any source of contamination and the human receptors by ingestion or dermal contact, therefore no further remedial action is likely to be required.

9.1.9 In gardens, landscaped areas or areas likely to be used for the growing of vegetables/fruit for consumption, a capping layer of 'inert' material could be provided to break the pathway between the identified contamination and end users of the site. The required thickness of the capping layer could be determined using guidance provided by the BRE, ref. 10.29.

9.2 Management of Unidentified Sources of Contamination

9.2.1 There is the possibility that 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 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 situated above an aquifer, 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 any known or previously unidentified 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.

10.0 REFERENCES

10.1 CLR 4, 'Sampling strategies for contaminated land'. Report by The Centre for Research into the Built Environment, the Nottingham Trent University, DoE, 1994.

10.2 British Standards Institute: BS 10175:2011+A1:2013 Investigation of potentially contaminated sites – Code of practice', BSI 2011.

10.3 British Standards Institute: BS 5930:2015 'Code of practice for ground investigations', BSI 2015.

10.4 British Standards Institute: BS EN 1997-2:2007 Incorporating corrigendum June 2010, 'Eurocode 7 - Geotechnical Design – Part 2: Ground investigation and testing.'

10.5 BS EN ISO 22476-3:2005+A1:2011 Incorporating corrigendum February 2007: 'Geotechnical investigation and testing – Field Testing - Part 3: Standard penetration test'.

10.6 British Standard 1377:1990, Part 9, 'Methods of Test for Soils for Civil Engineering Purposes'.

10.7 CIRIA Report C574, 'Engineering in Chalk' London 2002.

10.8 National House-Building Council, Standards, Chapter 4.2, 2014 'Building Near Trees'.

10.9 BRE Digest 240, 'Low-rise buildings on shrinkable clay soils: Part 1'. September 1993.

10.10 Geotechnique, June 1983.

10.11 HSE, Managing Health and Safety in Construction - 2015, Construction (Design and Management) Regulation 22, Excavations.

10.12 Design Guidance for Road Pavement Foundations, Interim Advice Note 73/06, Revision 1 (2009).

10.13 Building Research Establishment, Special Digest 1, 'Concrete in Aggressive Ground', 2005.

10.14 The Environmental Protection Act, Part IIA, Section 78, 1990.

10.15 Environment Act 1995, Section 57, DoE 1995.

10.16 Environment Agency Science Report SC050021/SR3, 2008, 'Updated technical background to the CLEA model'.

10.17 Environment Agency Science Report SC050021, 2009, 'Contaminants in Soil: Updated Collation of Toxicological Data and Intake Values for Humans'.

10.18 The LQM/S4ULs for Human Health Risk Assessment, Nathanail P, McCaffery C, Gillett A, Ogden R, and Nathanail J, Land Quality Press, Nottingham, published 2015.

10.19 DEFRA SP1010: Development of Category 4 Screening Levels for the Assessment of Land Affected by Contamination, published March 2014.

10.20 'Guidance on Comparing Soil Contamination Data with a Critical Concentration', Chartered Institute of Environmental Health (CIEH) and Contaminated Land: Applications in Real Environments (CL:AIRE) May 2008.

10.21 Environment Agency Science Report SC050021/SR2 'Human health toxicological assessment of contaminants in soil'.

10.22 Generic Assessment Criteria for Human Health Risk Assessment, Nathanial CP, McCaffery C, Ashmore M, Cheng Y, Gillett A, Hooker P and Ogden RC, Land Quality Press, Nottingham, published November 2006.

10.23 CIRIA C733, 'Asbestos in Soil and Made Ground: a guide to understanding and managing risk, 2014.

10.24 UK Water Industry Research Limited, 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites', report reference Number 10/WM/03/21, 2010.

10.25 Water Regulations Advisory Scheme, Information and Guidance Note, October 2002, 'The Selection of Materials for Water Supply Pipes to be Laid in Contaminated Land'.

10.26 Water UK, Contaminated Land Assessment Guidance: Protocols published by agreement between Water UK and the Home Builders Federation, January 2014.

10.27 HazWasteOnline^{tm}, http://www.hazwasteonline.co.uk.

10.28 CLR 11, 'Model Procedures for the Management of Land Contamination', DEFRA and Environment Agency, 2004.

10.29 BRE Digest 465, 'Cover Systems for Land Regeneration – Thickness Cover Systems for Contaminated Land', 2004.

10.30 ISO 22475-1:2006, 'Geotechnical Investigation and Testing – Sampling Methods and Groundwater Measurements' Part 1: Technical Principles for Execution.

10.31 ISO 14688 Part 1:2002 and Part 2:2004, 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

10.32 CLR 2, 'Guidance on preliminary site inspection of contaminated land', Report by Applied Environmental, DoE 1994.

10.33 CLR 3 'Documentary Research on Industrial Sites', Report by RPS Consultants Ltd., DOE, 1994.

10.34 CLR 8, 'Potential contaminants for the assessment of contaminated land'. DEFRA/EA, March 2002.

10.35 Environment Agency, 2003, 'Review of the Fate and Transport of Selected Contaminants in the Soil Environment'. Draft Technical Report P5-079/TR1. Bristol: Environment Agency.

10.36 CLR 10, 'The Contaminated Land Exposure Assessment Model (CLEA): Technical basis and algorithms'. DEFRA/EA, March 2002.

10.37 CIRIA C665, 'Assessing Risks Posed by Hazardous Ground Gases in Buildings', 2007.

10.38 British Standards Institute: BS 8485:2015, 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings', BSI 2015.

10.39 Office of the Deputy Prime Minister, 'The Building Regulations 2000, Approved Document C, Site Preparation and Resistance to Contaminants and Moisture', 2004.

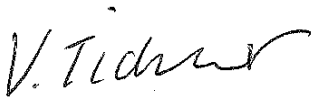
10.40 Building Research Establishment, Report 414, 'Protective Measures for Housing on Gas Contaminated Land', 2004.

10.41 Wilson, S A and Haines, S, 'Site Investigation and Monitoring for Soil Gas Assessment – Back to Basics', Land Contamination and Reclamation, 2005.

10.42 Wilson S A and Card G B, 'Reliability and Risk in Gas Protection Design', 2004.

10.43 Boyle and Witherington, 'Guidance on Evaluation on Development Proposals on Sites where Methane and Carbon Dioxide are present, incorporating 'Traffic Lights''. Report 10627-R01-(02) for NHBC, 2006.

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





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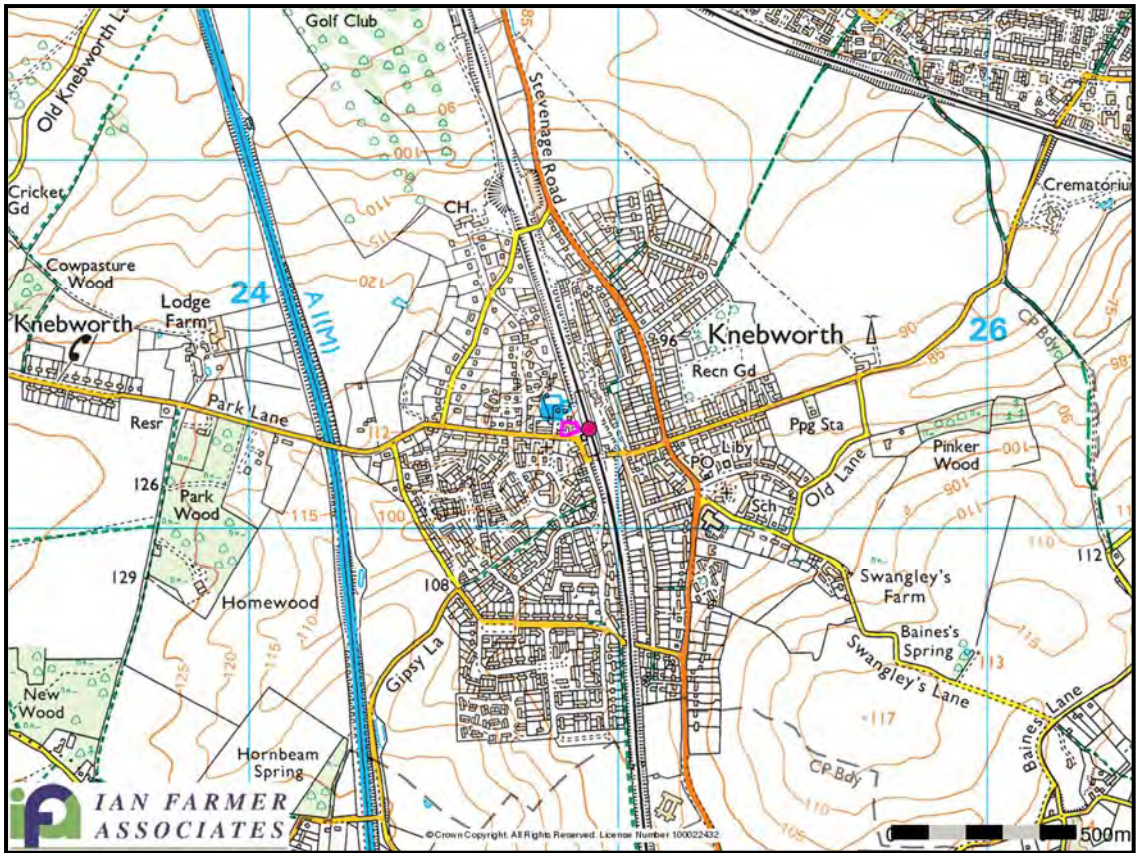
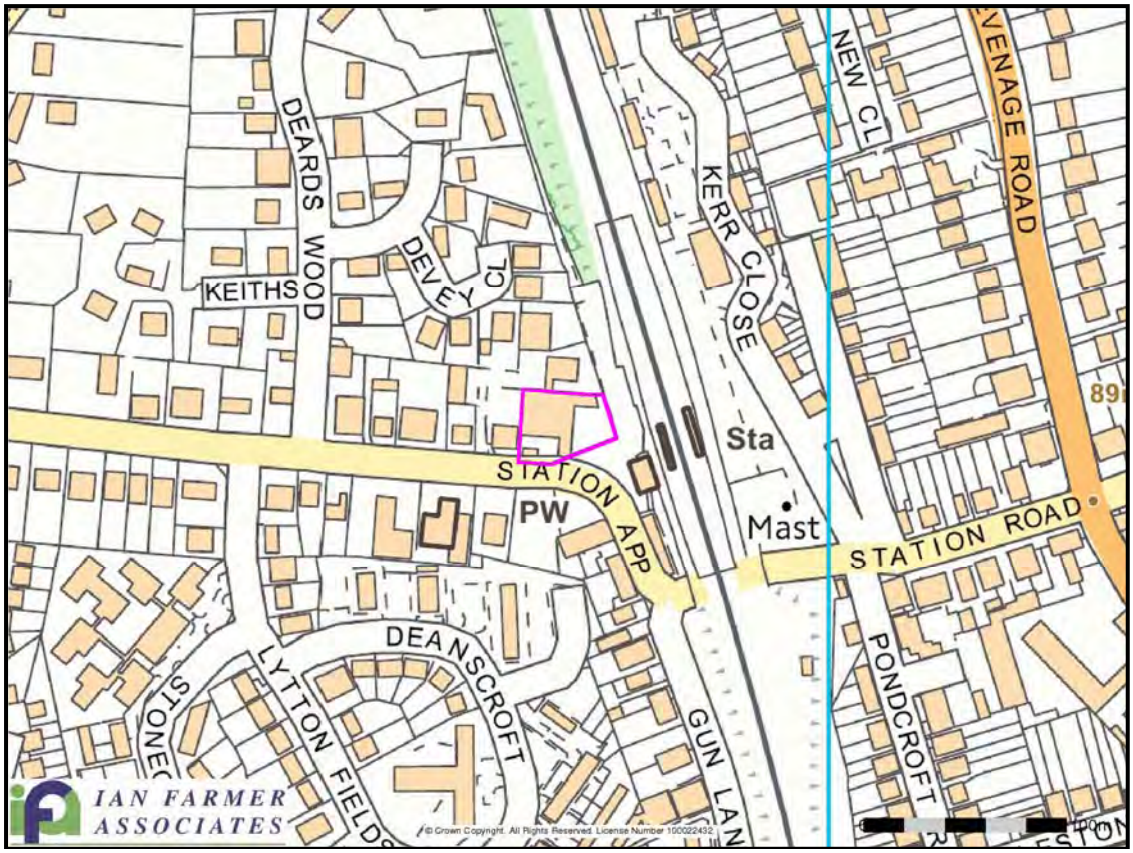
APPENDIX 1

DRAWINGS





IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**SITE LOCATION PLANS**	Job no. 52562A
	2 Park Lane, Knebworth, Hertfordshire, SG3 6PJ	Fig. A1.1



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**AERIAL PHOTOGRAPH**	Job no. 52562A
	2 Park Lane, Knebworth, Hertfordshire, SG3 6PJ	Fig. A1.1



Wastell &Porter

Figure A1.2

JOB No.	1815
DWG No	PL13F
SCALE	1:100 @ A1
DATE	MARCH 2017
DRAWN	MS
CLIENT	NLD LONDON

2 PARK LANE
KNEBWORTH
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PROPOSED
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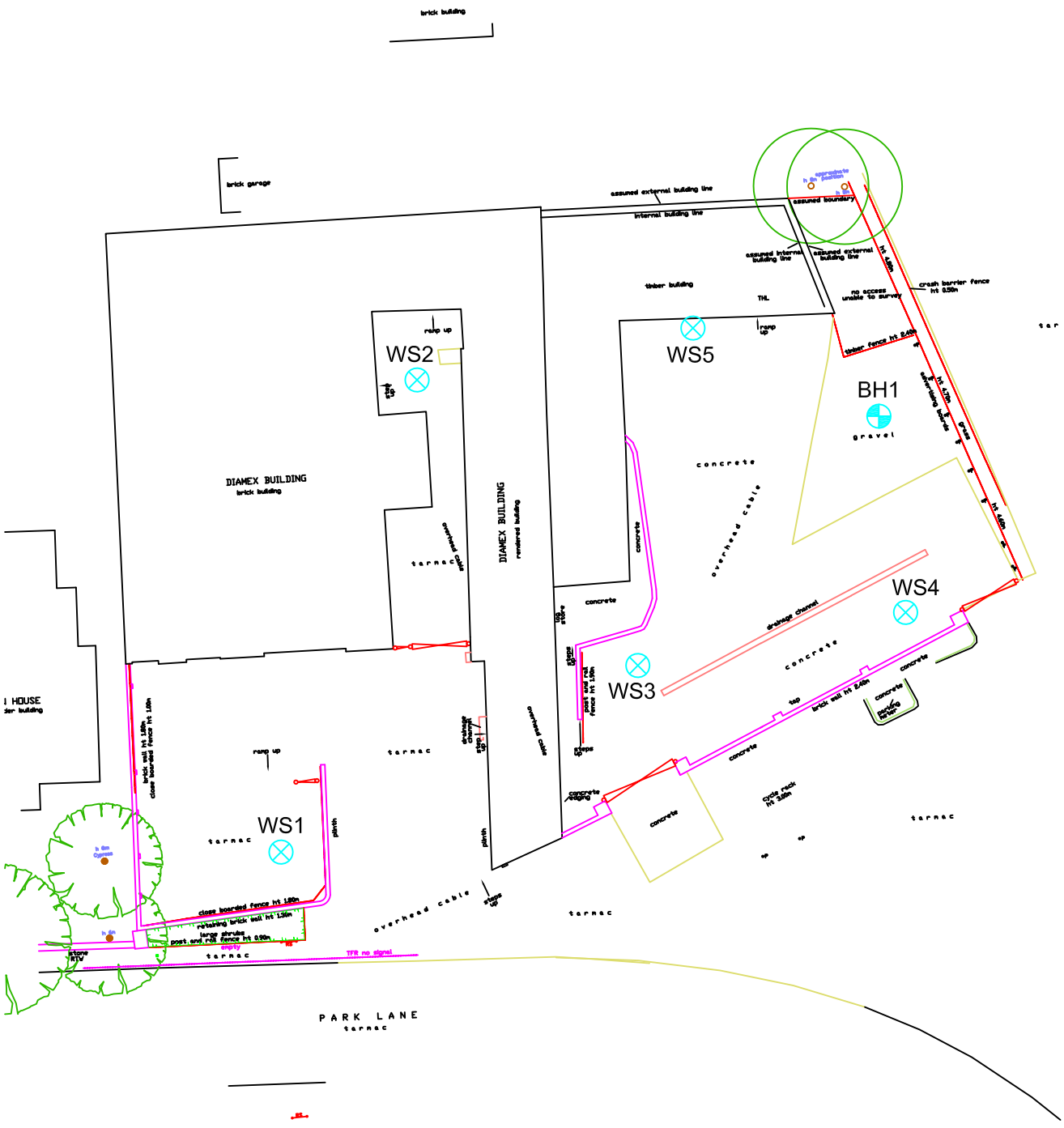


Scale :	N.T.S.
Drawn By :	P.L.E.
Job No:	52562A
Fig:	A1.3

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

EXPLORATORY HOLE LOCATION PLAN

2 Park Lane, Knebworth, Hertfordshire, SG3 6PJ.

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 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.

A2.1.3 Percussive Window Sampling Rig

The percussive sampler consists of a track mounted window sampler, ref. 10.30, with tube sizes varying in diameter from 98mm to 86mm. The sample tube is driven by a drop weight, which can also be used for dynamic probing and standard SPT tests. A cutting shoe is fitted to the bottom of each tube, whilst the sample is collected in a plastic sleeve.

The borehole is extended by using progressively smaller diameter tubes.

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. 10.6 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

A2.3 SAMPLES

A2.3.1 General

Samples have been recovered and stored in accordance with the guidelines given in ISO 22475-1:2006, ref. 10.30 and BS 5930, ref. 10.3.

The undisturbed samples recovered from the percussive sampler were of varying diameters depending upon the depth taken and the ground conditions encountered.

In accordance with EN ISO 22475, ref. 10.30, and BS 5930, 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. A similar assumption can be made from samples tested from the percussive window sample probing.

Laboratory strength and consolidation testing can only be carried out on Class 1 quality samples, which can be obtained from a Class A sampling technique, ref. 10.4. This is due to possible disturbance during sampling, giving a weaker strength in testing.

Therefore values for c_u and mv derived for use in this report can only be used as guidance and not used to determine the shear strength properties of the clay and is not used to give a descriptive strength in the borehole records.

UT represents undisturbed 100mm diameter samples taken in thin walled sample tubes, the number of blows to obtain the sample also recorded.

U represents undisturbed 100mm diameter sample, the number of blows to obtain the sample also recorded.

U fail indicates undisturbed sample not recovered

E represents sample recovered in an amber jar, generally for environmental analysis

HV represents Hand Vane test with equivalent undrained shear strength in kPa.

PP represents Pocket Penetrometer test with equivalent undrained shear strength in kPa.

CBR represents California Bearing Ratio test

B represents large bulk disturbed samples

D represents small disturbed sample

W represents water sample

$\underline{\nabla}$ represents water strike

$\underline{\blacktriangledown}$ represents level to which water rose

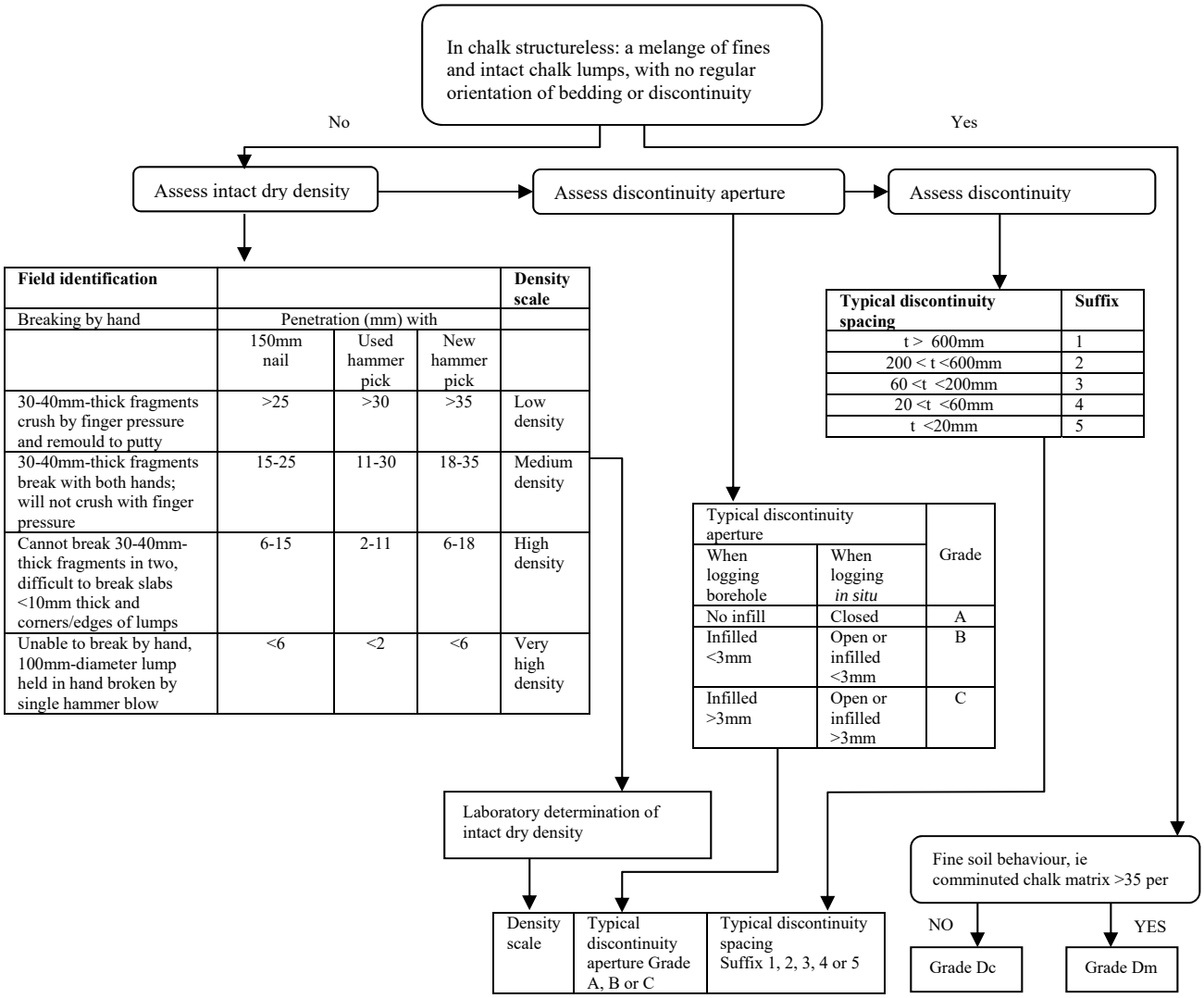
A2.4 DESCRIPTION OF SOILS

A2.4.1 General

The procedures and principles given in ISO 14688 Parts 1 and 2, ref. 10.31, supplemented by section 6 of BS 5930, ref. 10.3 have been used in the soil descriptions contained within this report.

A2.4.2 Chalk

The descriptions and Grades of Chalk are based on guidelines given in CIRIA Report C574, ref. 10.7. The principal details are as follows.



Field identification				Density scale
Breaking by hand	Penetration (mm) with			
	150mm nail	Used hammer pick	New hammer pick	
30-40mm-thick fragments crush by finger pressure and remould to putty	>25	>30	>35	Low density
30-40mm-thick fragments break with both hands; will not crush with finger pressure	15-25	11-30	18-35	Medium density
Cannot break 30-40mm-thick fragments in two, difficult to break slabs <10mm thick and corners/edges of lumps	6-15	2-11	6-18	High density
Unable to break by hand, 100mm-diameter lump held in hand broken by single hammer blow	<6	<2	<6	Very high density

Typical discontinuity spacing	Suffix
t > 600mm	1
200 < t <600mm	2
60 <t <200mm	3
20 <t <60mm	4
t <20mm	5

Typical discontinuity aperture		Grade
When logging borehole	When logging *in situ*	
No infill	Closed	A
Infilled <3mm	Open or infilled <3mm	B
Infilled >3mm	Open or infilled >3mm	C

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Contract Name:		Client:			Borehole ID:
2 Park Lane, Knebworth, SG3 6PJ		NLD (Rentals) Ltd			BH1
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 3
52562A	15/09/2017	EM	EM	FINAL	
Cable Percussion Borehole Log	Easting: 524892.0	Northing: 220278.0	Ground Level: 97.64	Plant Used:	Print Date: 11/10/2017	Scale: 1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.00 - 0.50	D1					MADE GROUND comprising sub-base composed of orange brown and red slightly gravelly fine and medium SAND and angular and subangular fine to coarse GRAVEL of granite with occasional brick and rare clinker fragments. Gravel is angular to subrounded fine and medium of flint. (MGR)		
0.30	ES1			(0.50)				
0.50 - 1.00	D2		97.14	0.50				
0.75	ES2					Firm orange brown occasionally light grey mottled slightly gravelly to gravelly sandy CLAY with occasional black flecks. Gravel is subangular and rounded fine and medium of chalk and rare flint. Sand is fine and medium (GFDU)		
1.20 - 1.65	SPTLS1	SPT(S) 1.20m, N=18 (2,3/4,4,5,5)				*From 1.20m; Becoming brown, orange brown and gravelly.*		
1.75 - 2.00	D3					*From 1.75m; Becoming stiff to very stiff.*		
2.00 - 2.45	U1	60 blows		(3.00)				
2.50	D4					*From 2.50m; Becoming very stiff with rare black flecks.*		
3.00 - 3.45	SPTLS2	SPT(S) 3.00m, N=22 (2,3/4,5,6,7)						
3.50 - 4.00	D5		94.14	3.50		Stiff dark brown occasionally dark grey mottled gravelly sandy CLAY. Gravel is subangular to rounded fine and medium of chalk and rare flint. Sand is fine and medium. (GFDU)		
4.00 - 4.45	U2	60 blows						
4.50	D6			(2.00)		*From 4.50m; Becoming firm brown, orange brown with frequent black flecks.*		
5.00 - 5.45	SPTLS3	SPT(S) 5.00m, N=25 (4,4/5,6,7,7)				*From 5.00m; Becoming very stiff dark brown, brown occasionally dark grey and orange brown mottled. No black flecks.*		
5.50 - 6.00	B1		92.14	5.50		Medium dense orange brown gravelly silty clayey fine and and medium SAND with frequent pockets of very soft brown gravelly sandy clay. Gravel is angular to rounded fine and medium of flint and chalk. (GFDU)		
6.00 - 6.50	B2							
6.50 - 6.95	SPTLS4	SPT(S) 6.50m, N=30 (5,5/7,7,7,9)				*From 6.00m; With rare pockets of clay.*		
7.00 - 8.00	B3					*From 7.00m; Becoming slightly gravelly. No clay pockets.*		
				(5.50)				
8.00 - 8.45	SPTLS5	SPT(S) 8.00m, N=28 (7,6/6,6,7,9)				*From 8.00m; Becoming very gravelly and slightly clayey. Gravel becomes fine to coarse.*		
8.50 - 9.50	B4					*From 8.50m; With occasional pockets of soft dark grey slightly gravelly to gravelly sandy clay.*		
9.50 - 9.95	SPTLS6	SPT(S) 9.50m, N=38 (5,7/7,9,11,11)				*From 9.50m; Becoming dense. No clay pockets.*		
						Continued next sheet		

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
15-09-2017	08:00	0.00		
15-09-2017	16:00	12.00	10.50	
16-09-2017	08:00	12.00	10.50	
16-09-2017	16:00	20.45	16.50	

Borehole Diameter

Depth (m)	Dia (mm)
20.45	150

Casing Diameter

Depth (m)	Dia (mm)
16.50	150

Chiselling

From (m)	To (m)	Duration	Remarks

Installation

Top (m)	Base (m)	Type	Dia (mm)
0.00	1.00	PLAIN	19
1.00	12.00	SLOTTED	19

Remarks:

Groundwater not observed. On 15/09/2017 - 1 hour hand digging service pit. On 16/09/2017 - Water added from 12.00m to 12.50m to assist with drilling the borehole. Installation of standpipe. *Drillers description

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

HBSI CP Template Issue Number: 3 Issue Date: 27/04/16

IAN FARMER ASSOCIATES	Contract Name: 2 Park Lane, Knebworth, SG3 6PJ		Client: NLD (Rentals) Ltd			Borehole ID: BH1
	Contract Number: 52562A	Date Started: 15/09/2017	Logged By: EM	Checked By: EM	Status: FINAL	Sheet 2 of 3
Cable Percussion Borehole Log	Easting: 524892.0	Northing: 220278.0	Ground Level: 97.64	Plant Used:	Print Date: 11/10/2017	Scale: 1:50
Weather:		Termination:		SPT Hammer: N/R, Energy Ratio: N/R		

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
10.00 - 11.00	B5					*From 10.00m; Becoming clayey with occasional pockets of stiff clay.*		
11.00 - 11.45	B6	SPT(C) 11.00m, N=36 (7,7/7,9,9,11)	86.64	11.00		Dense orange brown sandy slightly silty slightly clayey angular to rounded fine to coarse GRAVEL of flint and chalk. Sand is fine to coarse. (GFDU)		
11.50 - 12.50	B7					*From 11.50m; Becoming creamy white.*		
12.50 - 12.95	SPTLS7	SPT(S) 12.50m, N=12 (3,2/3,3,3,3)		(1.95)				
12.50 - 16.50	B8		84.69	12.95		*VOID, no sample recovery. (VOID)		
16.50 - 16.95	SPTLS8	SPT(S) 16.50m, N=21 (3,3/3,5,5,8)	81.14	16.50		Recovered as structureless CHALK composed of a white and light brown, slightly clayey SILT and angular to subrounded GRAVEL. Clasts are weak, medium density, white with rare becoming occasional black specks and rare orange brown staining. Occasional angular and subangular medium and coarse flint gravel. Grade Dm (SPT indicates a grade B2) (LESE)		
17.50	D7			(2.00)		*From 17.50m; No flint gravel.*		
18.00 - 18.45	B9	65 blows						
18.00 - 18.45	U3							
18.50	D8		79.14	18.50		Recovered as structureless CHALK composed of a white occasionally light and orange brown mottled, gravelly slightly clayey SILT. Gravel is weak, medium density, white with occasional black specks and rare orange brown staining. Grade Dm (SPT indicates a grade Dc) (LESE)		
				(1.95)				
						Continued next sheet		

Start & End of Shift Observations				
Date	Time	Depth (m)	Casing (m)	Water (m)
15-09-2017	08:00	0.00		
15-09-2017	16:00	12.00	10.50	
16-09-2017	08:00	12.00	10.50	
16-09-2017	16:00	20.45	16.50	

Borehole Diameter		Casing Diameter	
Depth (m)	Dia (mm)	Depth (m)	Dia (mm)
20.45	150	16.50	150

Remarks:

Groundwater not observed. On 15/09/2017 - 1 hour hand digging service pit. On 16/09/2017 - Water added from 12.00m to 12.50m to assist with drilling the borehole. Installation of standpipe. *Drillers description

Chiselling			
From (m)	To (m)	Duration	Remarks

Installation			
Top (m)	Base (m)	Type	Dia (mm)
0.00	1.00	PLAIN	19
1.00	12.00	SLOTTED	19

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

HBSI CP Template Issue Number: 3 Issue Date: 27/04/16

IAN FARMER ASSOCIATES

Contract Name:	Client:	Borehole ID:
2 Park Lane, Knebworth, SG3 6PJ	NLD (Rentals) Ltd	BH1

Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 3 of 3
52562A	15/09/2017	EM	EM	FINAL	

Cable Percussion Borehole Log	Easting:	Northing:	Ground Level:	Plant Used:	Print Date:	Scale:
	524892.0	220278.0	97.64		11/10/2017	1:50

Weather: | Termination: | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
20.00 - 20.45	SPTLS9	SPT(S) 20.00m, N=14 (5,4/4,2,4,4)	77.19	20.45		*From 20.00m; Rare pockets of brown clay and flint gravel.* End of Borehole at 20.450m		

21 22 23 24 25 26 27 28 29 30

Start & End of Shift Observations

Date	Time	Depth (m)	Casing (m)	Water (m)
15-09-2017	08:00	0.00		
15-09-2017	16:00	12.00	10.50	
16-09-2017	08:00	12.00	10.50	
16-09-2017	16:00	20.45	16.50	

Borehole Diameter

Depth (m)	Dia (mm)
20.45	150

Casing Diameter

Depth (m)	Dia (mm)
16.50	150

Chiselling

From (m)	To (m)	Duration	Remarks

Installation

Top (m)	Base (m)	Type	Dia (mm)
0.00	1.00	PLAIN	19
1.00	12.00	SLOTTED	19

Remarks:

Groundwater not observed. On 15/09/2017 - 1 hour hand digging service pit. On 16/09/2017 - Water added from 12.00m to 12.50m to assist with drilling the borehole. Installation of standpipe. *Drillers description

Water Strikes

Strike (m)	Casing (m)	Sealed (m)	Time (mins)	Rose to (m)	Remarks

HBSI CP Template Issue Number: 3 Issue Date: 27/04/16

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
2 Park Lane, Knebworth, SG3 6PJ		NLD (Rentals) Ltd			WS1
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
52562A	14/09/2017	EM	EM	FINAL	
Dynamic Sample Borehole Log	Easting: 524859.0	Northing: 220258.0	Ground Level: 99.28mOD	Plant Used:	Print Date: 11/10/2017 — Scale: 1:40

Weather: | Termination: Terminated at 5.25m due to dense stratum. | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.20	D1		99.14	0.14		*MADE GROUND comprising ASPHALT over CONCRETE. (MGR)		
0.30	ES1		98.98	0.30		MADE GROUND comprising orange brown slightly gravelly fine to coarse SAND and fine to coarse GRAVEL of brick and concrete. Gravel is subangular to rounded fine and medium of flint. (MGR)		
0.50	D2			(0.35)				
0.70	ES2		98.63	0.65		MADE GROUND comprising dark brown slightly silty clayey fine to coarse SAND and angular to rounded fine to coarse GRAVEL of flint with frequent brick, occasional concrete and glass fragments, and rare rootlets. (MGR)		
0.80	D3			(0.65)				
1.20	D4							
1.20 - 1.65	SPTLS1		97.98	1.30		Dry friable orange brown slightly gravelly sandy very silty CLAY with rare rootlets. Gravel is angular to subrounded fine to coarse of flint. Sand is fine and medium. (GFDU) *From 1.20m; Becoming very stiff friable.*		
1.20		SPT(S) N=10 (2,3/2,3,3,2)						
1.40	D5							
2.00	D6			(1.30)				
2.00 - 2.45	SPTLS2					Stiff to very stiff orange brown and light grey mottled slightly gravelly sandy CLAY. Gravel is angular to rounded fine and medium of flint. Sand is fine to coarse becoming fine and medium. (GFDU) *From 2.40m; Becoming very stiff brown, orange brown and occasional light grey mottled with frequent black flecks.*		
2.00		SPT(S) N=11 (2,2/2,2,3,4)						
2.50	D7		96.68	2.60		Very stiff brown, orange brown and occasionally light grey mottled gravelly sandy CLAY with occasional black flecks. Gravel is subangular to rounded predominantly fine and medium of chalk and rare flint. Sand is fine and medium. (GFDU)		
3.00	D8							
3.00 - 3.45	SPTLS3							
3.00		SPT(S) N=25 (3,5/5,5,7,8)						
3.50	D9							
4.00	D10			(2.65)				
4.00 - 4.45	SPTLS4							
4.00		SPT(S) N=27 (4,4/5,6,7,9)						
4.50	D11							
4.80 - 5.25	SPTLS5							
4.80		SPT(S) N=32 (4,7/7,8,8,9)						
			94.03	5.25		End of Borehole at 5.25m		

1 2 3 4 5 6 7 8

Borehole Diameter		Installation			
Depth (m)	Dia (mm)	Depth Top	Base (m)	Dia (mm)	Pipe Type
		0.00	0.50		PLAIN
		0.50	4.50		SLOTTED

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Groundwater not observed. *Drillers description

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
2 Park Lane, Knebworth, SG3 6PJ		NLD (Rentals) Ltd			WS2
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
52562A	14/09/2017	EM	EM	FINAL	
Dynamic Sample Borehole Log	Easting: 524867.0	Northing: 220282.0	Ground Level: 99.18mOD	Plant Used:	Print Date: 11/10/2017	Scale: 1:40

Weather:

Termination: Terminated at 5.15m due to dense stratum.

SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.10	D1		98.98	0.20		MADE GROUND comprising *ASPHALT over dark brown slightly clayey to clayey fine to coarse SAND and angular to rounded fine to coarse GRAVEL of flint and asphalt/clinker. (MGR)		
0.30	ES1							
0.50	D2			(0.55)		MADE GROUND comprising firm dark brown/dark grey and orange brown gravelly sandy organic CLAY with occasional brick and asphalt/clinker fragments. Gravel is angular to subrounded fine and medium of flint. Sand is fine to coarse. (MGR)		
0.80	ES2		98.43	0.75				
1.00	D3					Firm becoming stiff orange brown and light grey mottled slightly gravelly sandy CLAY. Gravel is angular to rounded fine and medium of flint. Sand is fine to coarse. (GFDU)		
1.20	D4							
1.20 - 1.65	SPTLS1			(1.25)				
1.20		SPT(S) N=10 (1,2/2,3,2,3)						
1.50	D5					*From 1.50m; With frequent black flecks. Sand is fine and medium.*		
2.00	D6		97.18	2.00		Very stiff brown, orange brown and occasionally light grey mottled gravelly sandy CLAY. Gravel is subangular to rounded predominantly fine and medium of chalk and occasional flint. Sand is fine and medium. (GFDU)		
2.00 - 2.45	SPTLS2							
2.00		SPT(S) N=19 (2,4/4,4,5,6)						
2.50	D7							
3.00	D8							
3.00 - 3.45	SPTLS3							
3.00		SPT(S) N=24 (3,4/5,6,6,7)						
3.50	D9			(3.15)				
4.00	D10							
4.00 - 4.45	SPTLS4							
4.00		SPT(S) N=30 (4,5/6,7,9,8)						
4.50	D11							
4.70 - 5.15	SPTLS5					*From 4.70m; Gravel is angular to subrounded fine to coarse of orange brown sandstone.*		
4.70		SPT(S) N=66 (4,5/7,20,16,23)						
			94.03	5.15		End of Borehole at 5.15m		

Borehole Diameter		Installation			
Depth (m)	Dia (mm)	Depth Top	Base (m)	Dia (mm)	Pipe Type
		0.00	0.50		PLAIN
		0.50	3.50		SLOTTED

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks
			0	0.00	

Remarks:

Groundwater not observed. *Drillers description

IFA DS Template Issue Number: 3 Issue Date: 30-01-16

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
2 Park Lane, Knebworth, SG3 6PJ		NLD (Rentals) Ltd			WS3
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
52562A	14/09/2017	EM	EM	FINAL	
Dynamic Sample Borehole Log	Easting: 524880.0	Northing: 220266.0	Ground Level: 97.16mOD	Plant Used:	Print Date: 11/10/2017
					Scale: 1:40

Weather:

Termination: Terminated at 5.285m due to dense stratum.

SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.20	D1			(0.36)		MADE GROUND comprising *CONCRETE slab to 0.012m over brown fine to coarse SAND and fine to coarse GRAVEL of brick and concrete with rare pockets of very soft orange brown clay. (MGR)		
0.40	D2		96.80	0.36				
0.50	ES1					Firm to stiff becoming stiff orange brown occasionally light grey mottled slightly gravelly sandy CLAY. Gravel is angular to subrounded fine and medium of flint. Sand is fine to coarse. (GFDU)		
0.70	D3							
0.80	ES2			(0.84)				
1.20	D4		95.96	1.20				
1.20 - 1.65	SPTLS1					Very stiff brown, orange brown and occasionally light grey mottled gravelly sandy CLAY with occasional black flecks. Gravel is subangular to rounded predominantly fine and medium of chalk and rare flint. Sand is fine and medium. (GFDU)		
1.20		SPT(S) N=18 (2,3/4,4,5,5)						
1.50	D5							
2.00	D6							
2.00 - 2.45	SPTLS2							
2.00		SPT(S) N=22 (2,3/4,5,6,7)						
2.50	D7			(2.80)				
3.00	D8							
3.00 - 3.45	SPTLS3							
3.00		SPT(S) N=28 (4,5/6,6,7,9)						
3.50	D9							
4.00 - 4.20	D10		93.16	4.00				
4.00 - 4.45	SPTLS4					Recovered as soft and firm to stiff orange brown occasionally brown sandy becoming very sandy slightly silty slightly calcareous CLAY. Sand is fine and medium (GFDU)		
4.00		SPT(S) N=35 (6,8/9,9,8,9)	92.96	4.20				
4.50	11					Recovered as very dense orange brown slightly gravelly slightly silty very clayey slightly calcareous fine and medium SAND. Gravel is fine and medium becoming fine to coarse of orange brown sandstone. (GFDU)		
				(1.08)				
5.00 - 5.28	SPTLS5							
5.00		SPT(S) 50 (22,27/50 for 135mm)						
			91.88	5.29		End of Borehole at 5.28m		

Borehole Diameter		Installation			
Depth (m)	Dia (mm)	Depth Top	Base (m)	Dia (mm)	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Groundwater not observed. *Drillers description

IFA DS Template Issue Number: 3 Issue Date: 30-01-16

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
2 Park Lane, Knebworth, SG3 6PJ		NLD (Rentals) Ltd			WS4
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
52562A	14/09/2017	EM	EM	FINAL	
Dynamic Sample Borehole Log	Easting: 524893.0	Northing: 220270.0	Ground Level: 97.10mOD	Plant Used:	Print Date: 11/10/2017 — Scale: 1:40

Weather: | Termination: Terminated at 4.875m due to dense stratum. | SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.10	D1		96.85	0.25		MADE GROUND comprising *reinforced CONCRETE slab to 0.075m over orange brown fine to coarse SAND and angular to rounded fine to coarse GRAVEL of flint and concrete. (MGR)		
0.30	ES1			(0.35)				
0.40	D2		96.50	0.60		MADE GROUND comprising firm orange brown occasionally light grey mottled slightly gravelly to gravelly sandy CLAY with occasional black flecks. Gravel is subangular to rounded predominantly fine and medium of flint. Sand is fine and medium. (MGR)		
0.70	ES2							
0.80	D3							
1.20	D4					Firm to stiff becoming very stiff orange brown occasionally light grey mottled slightly gravelly to gravelly sandy CLAY. Gravel is subangular to rounded predominantly fine and medium of flint and chalk. Sand is fine and medium. (GFDU)		
1.20 - 1.65	SPTLS1							
1.20		SPT(S) N=14 (1,2/3,3,4,4)						
1.50	D5					*From 1.20m; Gravel is chalk and rare flint.* *From 1.50m; Becoming brown, orange brown and light grey mottled.*		
2.00	D6					*From 2.00m; With rare to occasional decomposing rootlets.*		
2.00 - 2.45	SPTLS2							
2.00		SPT(S) N=20 (3,3/4,5,5,6)						
2.50	D7			(3.80)				
3.00	D8					*From 3.00m; No decomposing rootlets.*		
3.00 - 3.45	SPTLS3							
3.00		SPT(S) N=25 (3,4/5,6,7,7)						
3.50	D9					*From 3.50m; Becoming dark brown and occasionally dark grey mottled.*		
4.00	D10					*From 4.00m; Becoming orange brown occasionally brown mottled.*		
4.00 - 4.45	SPTLS4							
4.00		SPT(S) N=32 (5,6/6,8,8,10)						
4.40	D11		92.70	4.40				
4.50 - 4.88	SPTLS5		92.60	4.50		Recovered as firm orange brown gravelly sandy CLAY. Gravel is subangular to rounded fine and medium of flint and chalk. Sand is fine to coarse. (GFDU)		
4.50		SPT(S) 55 (14,13/55 for 225mm)		(0.38)				
			92.22	4.88		Recovered as very dense orange brown slightly gravelly fine and medium SAND. Gravel is fine and medium of orange brown sandstone. (GFDU)		
						End of Borehole at 4.88m		

Borehole Diameter		Installation			
Depth (m)	Dia (mm)	Depth Top	Base (m)	Dia (mm)	Pipe Type

Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:
Groundwater not observed. *Drillers description

IAN FARMER ASSOCIATES

Contract Name:		Client:			Borehole ID:
2 Park Lane, Knebworth, SG3 6PJ		NLD (Rentals) Ltd			WS5
Contract Number:	Date Started:	Logged By:	Checked By:	Status:	Sheet 1 of 1
52562A	14/09/2017	EM	EM	FINAL	
Dynamic Sample Borehole Log	Easting: 524883.0	Northing: 220282.0	Ground Level: 98.39mOD	Plant Used:	Print Date: 11/10/2017	Scale: 1:40

Weather:

Termination: Terminated at 4.85m due to dense stratum.

SPT Hammer: N/R, Energy Ratio: N/R

Samples & In Situ Testing			Strata Details				Groundwater	
Depth	Sample ID	Test Result	Level (mAOD)	Depth (m) (Thickness)	Legend	Strata Description	Water Strike	Backfill/ Installation
0.10	D1			(0.30)		MADE GROUND comprising *reinforced CONCRETE slab to 0.09m over black, dark brown clayey fine to coarse SAND and angular to rounded fine to coarse GRAVEL of flint with frequent concrete fragments and pockets of firm orange brown slightly gravelly sandy clay, and rare rootlets. (MGR)		
0.20	ES1		98.09	0.30				
0.40	D2					Firm becoming firm to stiff orange brown occasionally light grey mottled slightly gravelly slightly sandy becoming sandy CLAY with occasional black flecks, rare to occasional rootlets and rare roots. Gravel is subangular to rounded fine and medium of flint. Sand is fine and medium. (GFDU)		
0.40	ES2					*From 0.70m; No roots or rootlets.*		
0.70	D3			(1.20)		*From 1.00m; Becoming stiff. Gravel is fine to coarse.*		
1.00	D4					*From 1.20m; Becoming very stiff. Gravel is angular to rounded.*		
1.20	D5							
1.20 - 1.65	SPTLS1							
1.20		SPT(S) N=10 (1,2/2,2,3,3)						
1.50	D6		96.89	1.50		Very stiff orange brown occasionally light grey mottled gravelly sandy CLAY. Gravel is angular to rounded predominantly fine and medium of chalk and occasional flint. (GFDU)		
2.00	D7							
2.00 - 2.45	SPTLS2							
2.00		SPT(S) N=21 (2,4/4,5,6,6)						
2.50	D8							
3.00	D9			(2.90)				
3.00 - 3.45	SPTLS3							
3.00		SPT(S) N=25 (3,4/5,5,7,8)						
3.50	D10							
4.00	D11							
4.00 - 4.45	SPTLS4							
4.00		SPT(S) N=31 (4,5/7,7,8,9)						
4.30	D12					*From 4.30m; Recovered as firm and slightly gravelly.*		
4.40 - 4.85	SPTLS5		93.99	4.40		Recovered as very dense orange brown slightly gravelly slightly clayey fine and medium SAND with rare pockets of clay. Gravel is fine to coarse of orange brown sandstone. (GFDU)		
4.40		SPT(S) N=61 (7,10/13,15,16,17)		(0.45)				
			93.54	4.85		End of Borehole at 4.85m		

Borehole Diameter		Installation			
Depth (m)	Dia (mm)	Depth Top	Base (m)	Dia (mm)	Pipe Type

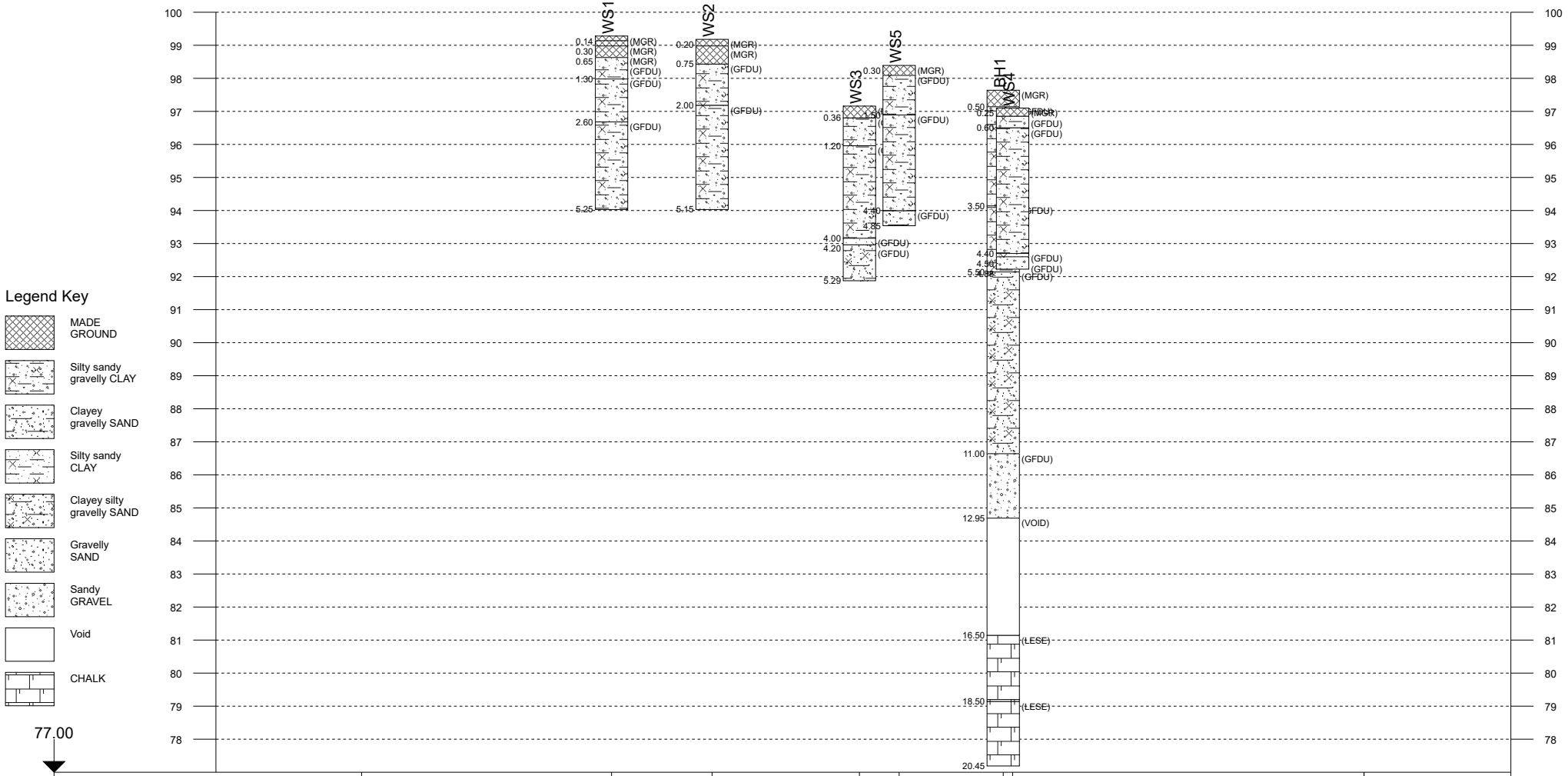
Water Strikes					
Depth Strike	Depth Casing	Depth Sealed	Time (mins)	Rose to (m)	Remarks

Remarks:

Groundwater not observed. *Drillers description

Project Id: 52562A	Title: Section line 1
Project Title: 2 Park Lane, Knebworth, SG3 6PJ	Vertical Scale: 1:176
Location: OS Grid Reference - TL 248 202	Horizontal Scale: 1:497
Client: NLD (Rentals) Ltd	Engineer: BL

IAN FARMER ASSOCIATES



| | | |

Project Id: 52562A	Title: Section line 1
Project Title: 2 Park Lane, Knebworth, SG3 6PJ	Vertical Scale: 1:176
Location: OS Grid Reference - TL 248 202	Horizontal Scale: 1:323
Client: NLD (Rentals) Ltd	Engineer: BL

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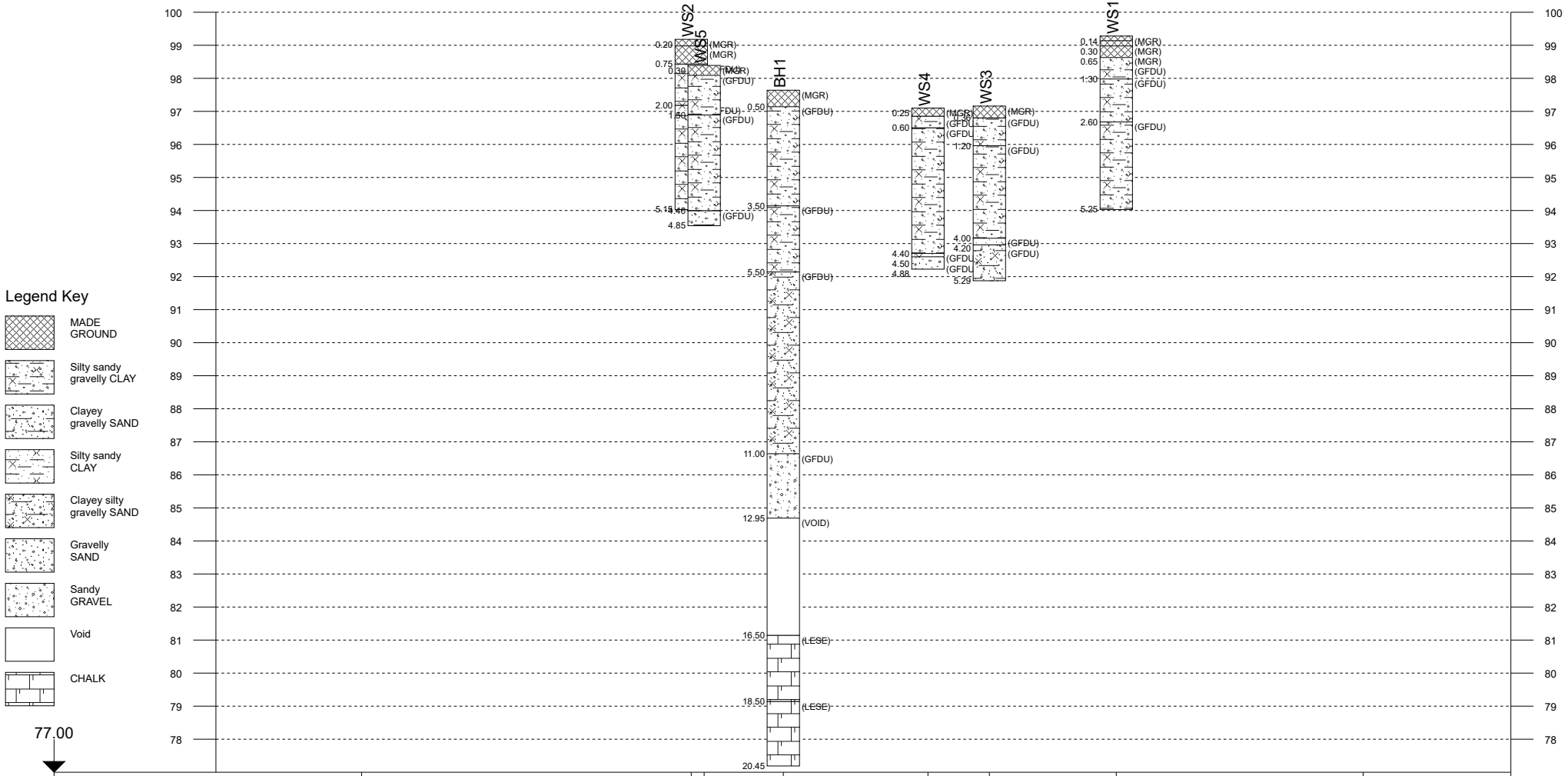

Figure A2.2

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Background Readings:	**Date of Visit**	**29/09/2017**			
CH_4%v/v	**CO_2%v/v**	**O_2%v/v**	**H_2Sppm**	**COppm**	**VOC ppm**
0.2	**0.1**	**20.8**	**ND**	**ND**	**ND**
Weather Conditions		Overcast			
Ground Conditions (dry/wet etc.)		Wet			
Atmospheric Pressure (mb)		1003			

2 Park Lane, Knebworth, Hertfordshire, SG3 6PJ

RESULTS OF GAS AND GROUNDWATER MONITORING

Hole No:	**Time (hh:mm)**	**Atmos. Pressure (mb)**	**Gas Flow Rate (l/hr)**	**CH_4% v/v**		**CO_2% v/v**		**O_2% v/v**		**H_2S ppm**		**CO ppm**		**VOC ppm**		**Water Level**	**Depth of Well**	**Water Sample Y / N**
				Peak	**Steady**	**Peak**	**Steady**	**Peak**	**Steady**	**Peak**	**Steady**	**Peak**	**Steady**	**Peak**	**Steady**	**mBGL**	**mBGL**	
BH1	14:30	1003	ND	0.2	0.2	0.1	0.1	20.8	20.7	ND	ND	ND	ND	ND	ND	DRY	10.42	N
WS1	13:45	1003	ND	0.2	0.2	1.9	1.9	18.4	18.4	ND	ND	ND	ND	ND	ND	DRY	4.37	N
WS2	14:20	1003	ND	0.2	0.2	1.1	1.0	17.8	17.8	ND	ND	1	1	0.6	0.3	DRY	3.51	N

BH1 = 19mm Pipe

ND = Below detection limit of instrument. NR = Not Read.

Readings Taken By: **SG** Checked By: **VT**

Job No: 52562A

Figure No: A2.3

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Background Readings:	Date of Visit	12/10/2017				
	CH_4%v/v	CO_2%v/v	O_2%v/v	H_2Sppm	COppm	VOC ppm
	ND	0.1	21.1	ND	ND	ND
	Weather Conditions		Sunny			
	Ground Conditions (dry/wet etc.)		Damp			
	Atmospheric Pressure (mb)		1009			

2 Park Lane, Knebworth, Hertfordshire, SG3 6PJ

RESULTS OF GAS AND GROUNDWATER MONITORING

Hole No:	Time (hh:mm)	Atmos. Pressure (mb)	Gas Flow Rate (l/hr)	CH_4% v/v		CO_2% v/v		O_2% v/v		H_2S ppm		CO ppm		VOC ppm		Water Level	Depth of Well	Water Sample Y / N
				Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	mBGL	mBGL	
BH1	10:10	1009	ND	ND	ND	0.1	0.1	20.8	20.8	ND	ND	ND	ND	ND	ND	DRY	10.44	N
WS1	10:00	1009	ND	ND	ND	2.0	2.0	20.0	19.4	ND	ND	ND	ND	ND	ND	DRY	4.37	N
WS2	10:20	1009	ND	ND	ND	0.9	0.8	19.1	19.0	ND	ND	ND	ND	0.4	0.2	DRY	3.51	N

BH1 = 19mm Pipe

ND = Below detection limit of instrument. NR = Not Read.

Readings Taken By: **SG** Checked By: **VT**

Figure No: A2.3

Job No: 52562A

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

Background Readings:	Date of Visit	26/10/2017				
	CH_4%v/v	CO_2%v/v	O_2%v/v	H_2Sppm	COppm	VOC ppm
	ND	0.1	20.9	ND	ND	ND
	Weather Conditions		Overcast			
	Ground Conditions (dry/wet etc.)		Damp			
	Atmospheric Pressure (mb)		1013			

2 Park Lane, Knebworth, Hertfordshire, SG3 6PJ

RESULTS OF GAS AND GROUNDWATER MONITORING

Hole No:	Time (hh:mm)	Atmos. Pressure (mb)	Gas Flow Rate (l/hr)	CH_4% v/v		CO_2% v/v		O_2% v/v		H_2S ppm		CO ppm		VOC ppm		Water Level	Depth of Well	Water Sample Y / N
				Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	mBGL	mBGL	
BH1	11:05	1013	ND	ND	ND	0.1	0.1	20.6	20.6	ND	ND	ND	ND	ND	ND	DRY	10.43	N
WS1	10:45	1013	ND	ND	ND	2.1	2.1	19.3	18.7	ND	ND	ND	ND	ND	ND	DRY	4.37	N
WS2	10:55	1013	ND	ND	ND	1.6	1.2	18.1	18.1	ND	ND	ND	ND	0.1	0.1	DRY	3.51	N

BH1 = 19mm Pipe

ND = Below detection limit of instrument. NR = Not Read.

Readings Taken By: **SG** Checked By: **VT**

Figure No: A2.3

Job No: 52562A

IAN FARMER ASSOCIATES
Geotechnical & Environmental Specialists

2 Park Lane, Knebworth, Hertfordshire, SG3 6PJ

RESULTS OF GAS AND GROUNDWATER MONITORING

Job No: 52562A

Figure No: A2.3

Background Readings:	Date of Visit	02/11/2017				
	CH_4%v/v	CO_2%v/v	O_2%v/v	H_2Sppm	COppm	VOC ppm
	ND	0.1	20.8	ND	ND	ND
	Weather Conditions		Overcast			
	Ground Conditions (dry/wet etc.)		Damp			
	Atmospheric Pressure (mb)		1004			

Hole No:	Time (hh:mm)	Atmos. Pressure (mb)	Gas Flow Rate (l/hr)	CH_4% v/v		CO_2% v/v		O_2% v/v		H_2S ppm		CO ppm		VOC ppm		Water Level	Depth of Well	Water Sample Y / N
				Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	Peak	Steady	mBGL	mBGL	
BH1	11:05	1004	ND	ND	ND	0.3	0.3	20.4	20.4	ND	ND	ND	ND	ND	ND	DRY	10.44	N
WS1	10:45	1004	ND	ND	ND	2.1	2.1	19.9	18.7	ND	ND	ND	ND	ND	ND	DRY	4.37	N
WS2	10:55	1004	ND	ND	ND	1.3	1.2	18.5	18.3	ND	ND	ND	ND	0.2	0.1	DRY	3.50	N

BH1 = 19mm Pipe

ND = Below detection limit of instrument. NR = Not Read.

Readings Taken By: **SG** Checked By: **VT**

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 given in the laboratory test reports.

A3.1.2 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 SOIL CLASSIFICATION

A3.2.1 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).

A3.2.2 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.

A3.2.3 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

A3.2.4 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.

IAN FARMER ASSOCIATES

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F.A.O.

Test Report - 52562A / 1

Site:	2 Park Lane, Knebworth, SG3 6PJ
Job Number:	52562A
Originating Client:	NLD London Ltd
Originating Reference:	52562
Date Sampled:	Not Given
Date Scheduled:	20/09/2017
Date Testing Started:	25/09/2017
Date Testing Finished:	06/10/2017
Remarks:	

Authorised By:

Paul Cathcart
Laboratory Manager

Date: 06/10/2017

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Motherwell (01698) 230 231. Newcastle upon Tyne (0191) 482 8500. Truro (01827) 261 775.
Warrington (01925) 855 440.

Figure A3.1

IAN FARMER ASSOCIATES

Laboratory Test Report 52562A / 1

Site: 2 Park Lane, Knebworth, SG3 6PJ **Job Number:** 52562A

Client: NLD London Ltd **Page:** 2

Determination of Water Content, Liquid Limit and Plastic Limit and Derivation of Plasticity and Liquidity Index

Borehole / Trial Pit	Depth (m)	Sample	Natural / Sieved	Natural Water Content %	Sample Passing 425 µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Class	Description / Remarks
					Percentage %	Water Content %						
BH1	0.50	D2	Sieved	20.9	94	22.0	54	21	33	0.03	CH	Brown CLAY
BH1	2.00	U1	Sieved	15.2	75	19.0	50	20	30	-0.05	CI/CH	Brown slightly gravelly CLAY
BH1	3.50	D5	Sieved	19.9	87	22.0	46	21	25	0.04	CI	Brown/Grey slightly gravelly CLAY
WS1	0.80	D3	Sieved	13.9	78	16.0	30	18	12	-0.14	CL	Brown slightly gravelly CLAY
WS1	1.40	D5	Sieved	23.7	90	26.0	62	24	38	0.04	CH	Brown CLAY
WS2	1.00	D3	Natural	33.1	97	34.0	60	26	34	0.24	CH	Brown CLAY
WS2	2.00	D6	Natural	17.6	97	18.0	40	19	21	-0.05	CI	Brown slightly gravelly CLAY
WS3	0.70	D3	Natural	22.3	97	23.0	55	24	31	-0.04	CH	Brown CLAY
WS4	1.20	D4	Natural	17.9	86	20.0	50	18	32	0.06	CI/CH	Brown slightly gravelly CLAY
WS5	1.20	D5	Natural	22	99	22.0	54	20	34	0.07	CH	Brown slightly gravelly CLAY

Method of Preparation: BS EN ISO 17892 : Part 1 : 2014 : Clause 5.1 Water content test preparation
BS 1377 : Part 1 : 2016 : Clause 8.4.3 Preparation of samples for plasticity tests
BS 1377 : Part 2 : 1990 : Clause 4.2 Preparation of samples for plastic limit tests

Method of Test: BS EN ISO 17892 : Part 1 : 2014 : Clause 5.2 Water content test execution
BS 1377 : Part 2 : 1990 : Clause 4.3 or 4.4 Determination of the liquid limit
BS 1377 : Part 2 : 1990 : Clause 5.3 Determination of the plastic limit and plasticity index

UKAS TESTING 1464

Figure A3.1

IAN FARMER ASSOCIATES

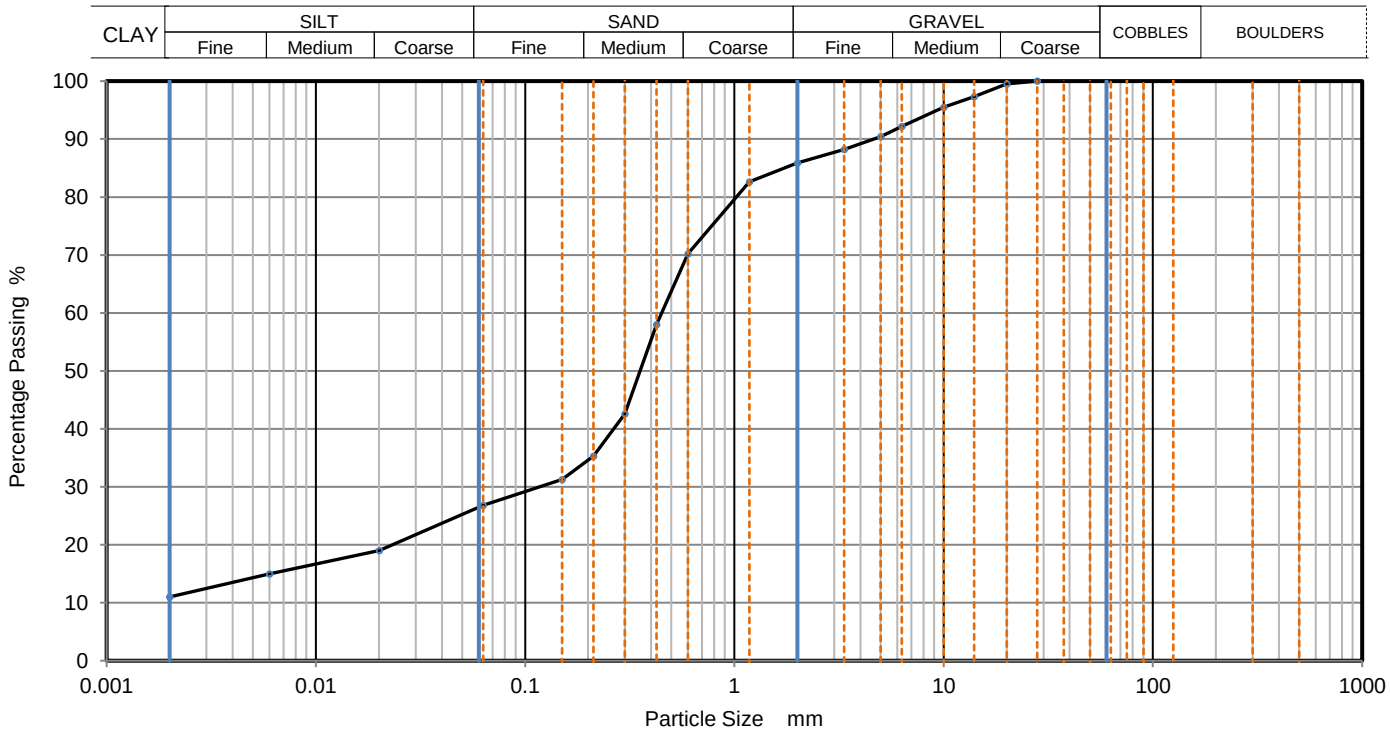
Laboratory Test Report	52562A / 1

Site: 2 Park Lane, Knebworth, SG3 6PJ **Job Number:** 52562A

Client: NLD London Ltd **Page:** 3

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
BH1	5.50	B1	Wet Sieve + Pipette	Brown clayey, gravelly, silty SAND



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
		0.0201	19
		0.0060	15
		0.0020	11
28	100		
20	100		
14	97		
10	96		
6.3	92		
5	90		
3.35	88		
2	86	Particle density (assumed)	
1.18	83	2.65	Mg/m3
0.6	70		
0.425	58		
0.3	43		
0.212	35		
0.15	31		
0.063	27		

Dry Mass of sample, g: 2433

Sample Proportions	% dry mass
Very coarse	0
Gravel	14
Sand	59
Silt	16
Clay	11

Grading Analysis		
D100	mm	28
D60	mm	0.449
D30	mm	0.117
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Method of Preparation: BS 1377:Part 1:1990, clause 7 3 Initial preparation
BS 1377:Part 1:1990, clause 7.4.5 Preparation of particle size tests

Method of Test: BS1377:Part 2:1990, clause 9.2 Determination of particle size distribution by wet sieving method
BS1377:Part 2:1990, clause 9.4 Determination of sedimentation by pipette method

UKAS TESTING
1464

Figure A3.1

IAN FARMER ASSOCIATES

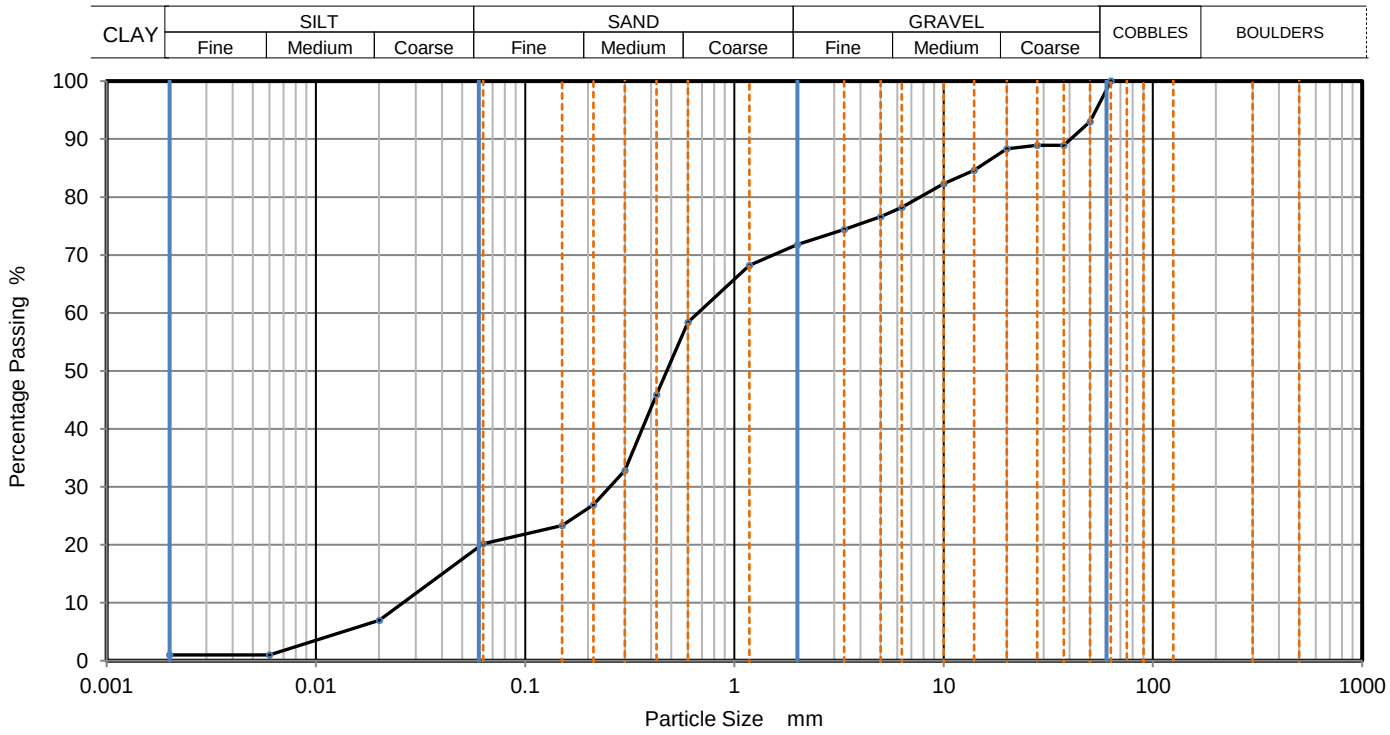
Laboratory Test Report | 52562A / 1

Site: 2 Park Lane, Knebworth, SG3 6PJ **Job Number:** 52562A

Client: NLD London Ltd **Page:** 4

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
BH1	8.50	B4	Wet Sieve + Pipette	Brown silty, gravelly SAND



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
		0.0201	7
		0.0060	1
		0.0020	1
63	100		
50	93		
37.5	89		
28	89		
20	88		
14	85		
10	82		
6.3	78		
5	77		
3.35	74		
2	72	Particle density (assumed)	
1.18	68	2.65	Mg/m3
0.6	58		
0.425	46		
0.3	33		
0.212	27		
0.15	23		
0.063	20		

Dry Mass of sample, g: 2511

Sample Proportions	% dry mass
Very coarse	0
Gravel	28
Sand	52
Silt	19
Clay	1

Grading Analysis		
D100	mm	63
D60	mm	0.668
D30	mm	0.255
D10	mm	0.0262
Uniformity Coefficient		26
Curvature Coefficient		3.7

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Method of Preparation: BS 1377:Part 1:1990, clause 7 3 Initial preparation
BS 1377:Part 1:1990, clause 7.4.5 Preparation of particle size tests

Method of Test: BS1377:Part 2:1990, clause 9.2 Determination of particle size distribution by wet sieving method
BS1377:Part 2:1990, clause 9.4 Determination of sedimentation by pipette method

UKAS TESTING
1464

Figure A3.1

IAN FARMER ASSOCIATES

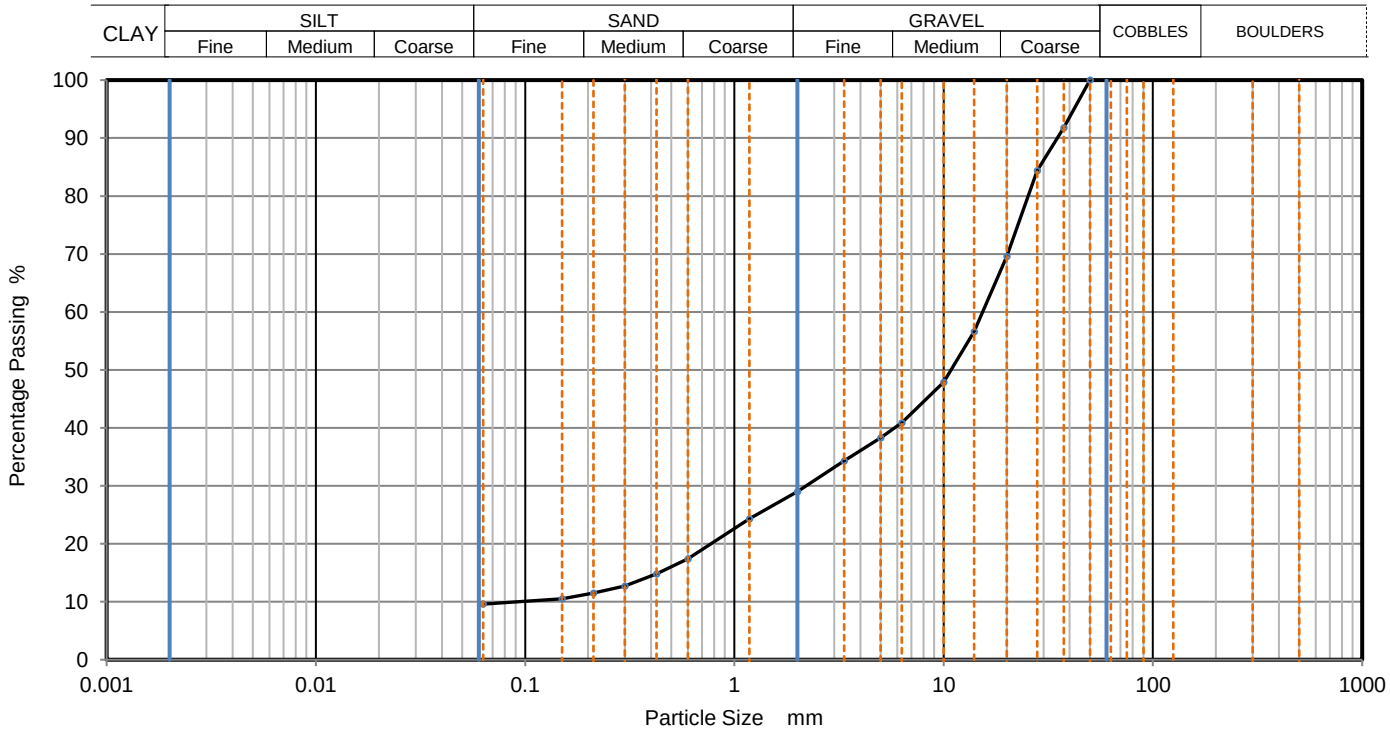
Laboratory Test Report	52562A / 1

Site: 2 Park Lane, Knebworth, SG3 6PJ **Job Number:** 52562A

Client: NLD London Ltd **Page:** 5

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

Borehole / Trial Pit	Depth (m)	Sample	Testing Type	Description
BH1	11.00	B6	Wet Sieve	Brown clayey, sandy GRAVEL



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
50	100		
37.5	92		
28	84		
20	70		
14	57		
10	48		
6.3	41		
5	38		
3.35	34		
2	29		
1.18	24		
0.6	17		
0.425	15		
0.3	13		
0.212	12		
0.15	11		
0.063	10		

Dry Mass of sample, g	4037

Sample Proportions	% dry mass
Very coarse	0
Gravel	71
Sand	19
Fines <0.063mm	10

Grading Analysis		
D100	mm	50
D60	mm	15.4
D30	mm	2.2
D10	mm	0.0916
Uniformity Coefficient		170
Curvature Coefficient		3.4

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Method of Preparation: BS 1377:Part 1:1990, clause 7 3 Initial preparation
BS 1377:Part 1:1990, clause 7.4.5 Preparation of particle size tests

Method of Test: BS1377:Part 2:1990, clause 9.2 Determination of particle size distribution by wet sieving method

UKAS TESTING
1464

Figure A3.1

IAN FARMER ASSOCIATES	Laboratory Test Report	52562A / 1

Site: 2 Park Lane, Knebworth, SG3 6PJ **Job Number:** 52562A

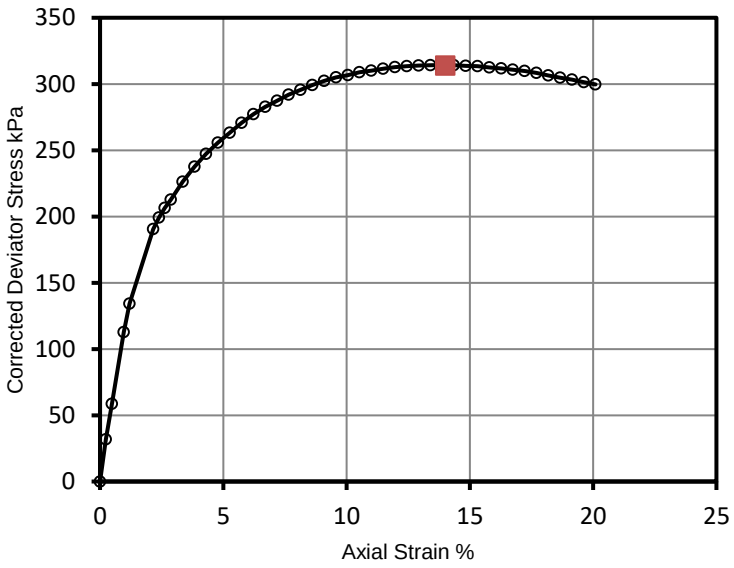
Client: NLD London Ltd **Page:** 6

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen (Definitive Method)

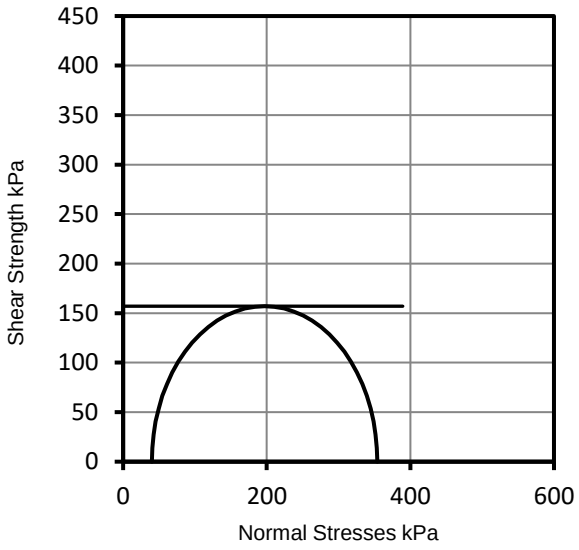
Borehole / Trial Pit	Depth (m)	Sample	Description
BH1	2.00	U1	**Brown slightly gravelly CLAY**

Initial Sample	Test Number	1
	Original Length (mm)	400.00
	Depth from Top (mm)	50.00
	Condition	Undisturbed
	Orientation	Vertical
Length (mm)		209.00
Diameter (mm)		104.33
Moisture Content (%)		15.20
Bulk Density (Mg/m3)		2.07
Dry Density (Mg/m3)		1.80
Membrane Thickness (mm)		0.3
Membrane Type		Latex
Rate of Strain (%/min)		1.9
Test Results	Cell Pressure (kPa)	40
	Axial Strain (%)	14
	Membrane Corr. (kPa)	0.82
	Deviator Stress, (σ1 - σ3)f (kPa)	314
	Undrained Shear Strength, cu = ½(σ1 - σ3)f (kPa)	157
	Mode of Failure	Compound

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Method of Preparation: 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:PT2:1990:7.2 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)

UKAS TESTING
1464

Figure A3.1

IAN FARMER ASSOCIATES	Laboratory Test Report	52562A / 1

Site: 2 Park Lane, Knebworth, SG3 6PJ **Job Number:** 52562A

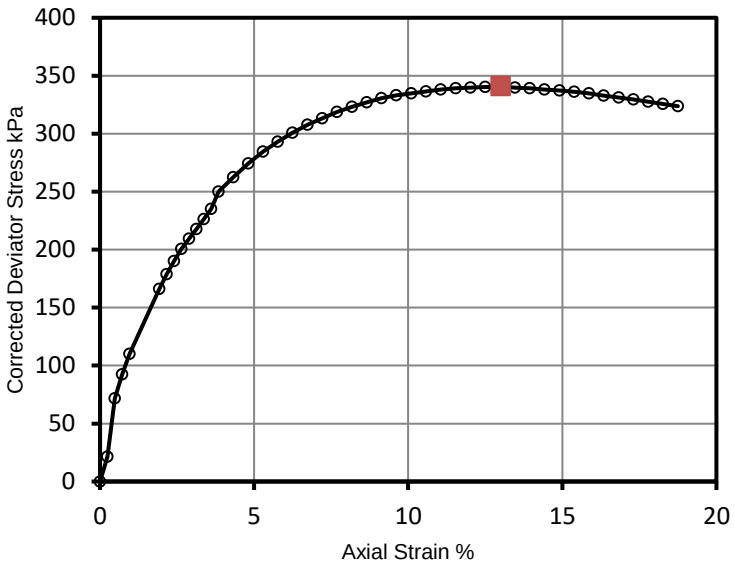
Client: NLD London Ltd **Page:** 7

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen (Definitive Method)

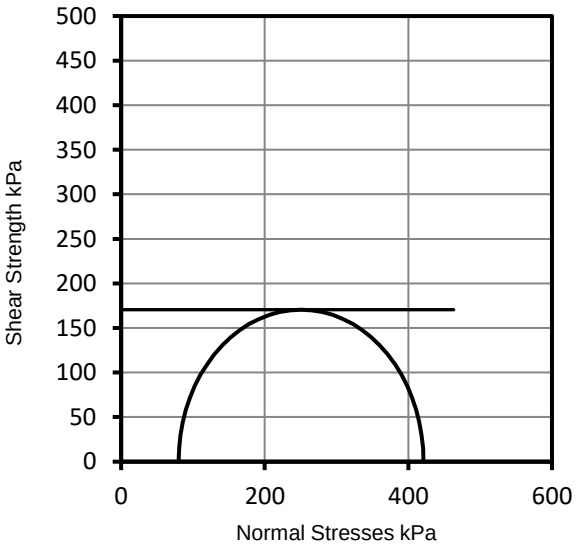
Borehole / Trial Pit	Depth (m)	Sample	Description
BH1	4.00	U2	**Brown slightly gravelly CLAY**

Initial Sample	Test Number	1
	Original Length (mm)	400.00
	Depth from Top (mm)	50.00
	Condition	Undisturbed
	Orientation	Vertical
Length (mm)		208.00
Diameter (mm)		103.33
Moisture Content (%)		17.50
Bulk Density (Mg/m3)		2.11
Dry Density (Mg/m3)		1.80
Membrane Thickness (mm)		0.3
Membrane Type		Latex
Rate of Strain (%/min)		1.9
Test Results	Cell Pressure (kPa)	80
	Axial Strain (%)	13
	Membrane Corr. (kPa)	0.79
	Deviator Stress, (σ1 - σ3)f (kPa)	341
	Undrained Shear Strength, cu = ½(σ1 - σ3)f (kPa)	170
	Mode of Failure	Brittle

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

Mohr circles and their interpretation is not covered by BS1377.
This is provided for information only.

Method of Preparation: 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:PT2:1990:7.2 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)

UKAS TESTING
1464

Figure A3.1

IAN FARMER ASSOCIATES

Test Report - 52562A / 1

Site:	2 Park Lane, Knebworth, SG3 6PJ
Job Number:	52562A
Originating Client:	NLD London Ltd

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

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Date: 06/10/2017

Figure A3.1

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e: reception@i2analytical.com

Analytical Report Number : 17-60807

Project / Site name:	Park Lane, Knebworth	**Samples received on:**	19/09/2017
Your job number:	52562A	**Samples instructed on:**	19/09/2017
Your order number:	54786	**Analysis completed by:**	26/09/2017
Report Issue Number:	1	**Report issued on:**	26/09/2017
Samples Analysed:	1 soil sample		

Signed:

Emma Winter
Assistant Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 17-60807

Project / Site name: Park Lane, Knebworth
Your Order No: 54786

Lab Sample Number				819690				
Sample Reference				WS1				
Sample Number				None Supplied				
Depth (m)				0.70				
Date Sampled				14/09/2017				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1				
Moisture Content	%	N/A	NONE	8.9				
Total mass of sample received	kg	0.001	NONE	1.3				
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.1				
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	60				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.030				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	30.1				

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 17-60807

Project / Site name: Park Lane, Knebworth

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
819690	WS1	None Supplied	0.70	Brown sand with gravel and vegetation.

Figure A3.2

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Analytical Report Number : 17-60807

Project / Site name: Park Lane, Knebworth

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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The results included within the report are representative of the samples submitted for analysis.

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Analytical Report Number : 17-60966

Project / Site name:	2 Park Lane, Knebworth	**Samples received on:**	20/09/2017
Your job number:	52562A	**Samples instructed on:**	20/09/2017
Your order number:	54801	**Analysis completed by:**	27/09/2017
Report Issue Number:	1	**Report issued on:**	27/09/2017
Samples Analysed:	7 soil samples		

Signed:

Emma Winter
Assistant Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Analytical Report Number: 17-60966

Project / Site name: 2 Park Lane, Knebworth
Your Order No: 54801

Lab Sample Number				820371	820372	820373	820374	820375
Sample Reference				BH1	BH1	BH1	BH1	WS1
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				1.75	5.00	6.50	8.00	4.00
Date Sampled				15/09/2017	15/09/2017	15/09/2017	15/09/2017	14/09/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	13	12	4.6	6.5	12
Total mass of sample received	kg	0.001	NONE	0.89	0.64	0.66	0.71	1.7
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.1	8.2	8.6	8.5	8.4
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	62	24	27	42	21
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.031	0.012	0.013	0.021	0.011
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	30.9	12.0	13.4	21.2	10.6

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 17-60966

Project / Site name: 2 Park Lane, Knebworth
Your Order No: 54801

Lab Sample Number				820376	820377			
Sample Reference				WS2	WS3			
Sample Number				None Supplied	None Supplied			
Depth (m)				2.00	4.50			
Date Sampled				14/09/2017	14/09/2017			
Time Taken				None Supplied	None Supplied			
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1			
Moisture Content	%	N/A	NONE	12	10			
Total mass of sample received	kg	0.001	NONE	0.32	0.57			
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	8.3	8.5			
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	57	40			
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.028	0.020			
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	28.4	20.2			

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Analytical Report Number : 17-60966

Project / Site name: 2 Park Lane, Knebworth

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
820371	BH1	None Supplied	1.75	Light brown clay with gravel.
820372	BH1	None Supplied	5.00	Brown clay with gravel.
820373	BH1	None Supplied	6.50	Light brown sand with gravel.
820374	BH1	None Supplied	8.00	Brown sand with gravel.
820375	WS1	None Supplied	4.00	Brown clay with gravel and chalk.
820376	WS2	None Supplied	2.00	Light brown clay with gravel and chalk.
820377	WS3	None Supplied	4.50	Brown sand.

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number : 17-60966

Project / Site name: 2 Park Lane, Knebworth

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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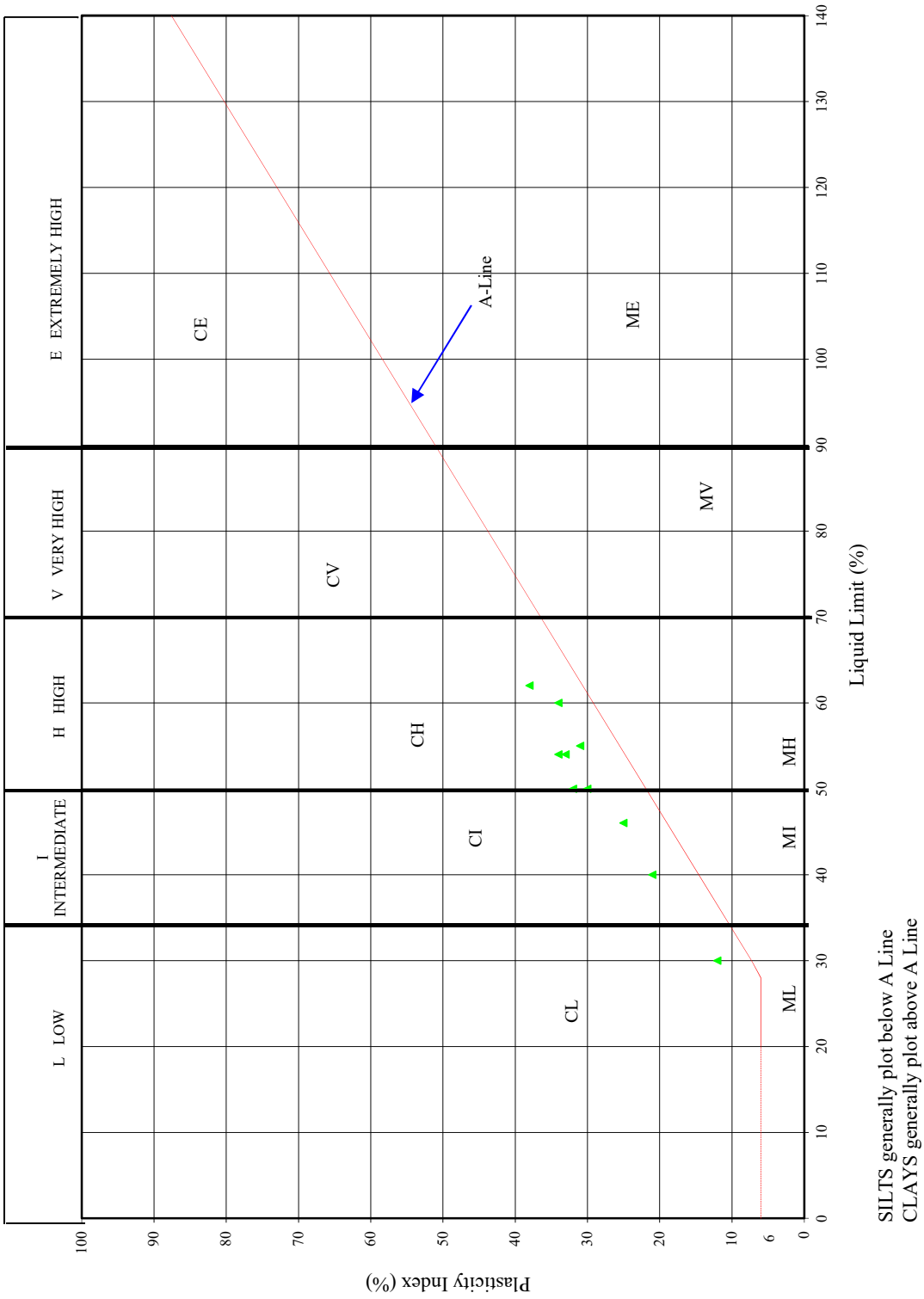

IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**PLASTICITY CLASSIFICATION CHART**	Job no. 52562A
	2 Park Lane, Knebworth, Hertfordshire, SG3 6PJ	Fig no. A3.3

APPENDIX 4

CHEMICAL TESTS

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Analytical Report Number : 17-60529

Project / Site name:	Park Lane, Knebworth	**Samples received on:**	15/09/2017
Your job number:	52562A	**Samples instructed on:**	15/09/2017
Your order number:	54786	**Analysis completed by:**	22/09/2017
Report Issue Number:	1	**Report issued on:**	22/09/2017
Samples Analysed:	5 soil samples		

Signed:

Rexona Rahman
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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Figure A4.1

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 17-60529

Project / Site name: Park Lane, Knebworth
Your Order No: 54786

Lab Sample Number				817989	817990	817991	817992	817993
Sample Reference				WS1	WS2	WS3	WS4	WS5
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.30	0.30	0.50	0.30	0.20
Date Sampled				14/09/2017	14/09/2017	14/09/2017	14/09/2017	14/09/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	8.1	13	18	15	10
Total mass of sample received	kg	0.001	NONE	1.2	1.2	1.1	1.1	1.1
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	9.6	8.3	8.7	8.7	10.9
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	170	200	180	-	-
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.083	0.10	0.089	1.2	0.99
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	82.7	100	89.0	-	-
Organic Matter	%	0.1	MCERTS	1.8	1.4	0.2	0.4	1.1
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	3.2	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.05	MCERTS	0.50	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthene	mg/kg	0.05	MCERTS	1.7	0.17	< 0.05	< 0.05	< 0.05
Fluorene	mg/kg	0.05	MCERTS	1.4	0.14	< 0.05	< 0.05	< 0.05
Phenanthrene	mg/kg	0.05	MCERTS	16	1.7	0.65	< 0.05	1.1
Anthracene	mg/kg	0.05	MCERTS	3.2	0.32	0.12	< 0.05	0.29
Fluoranthene	mg/kg	0.05	MCERTS	23	2.7	1.2	< 0.05	2.1
Pyrene	mg/kg	0.05	MCERTS	20	2.7	1.1	< 0.05	2.1
Benzo(a)anthracene	mg/kg	0.05	MCERTS	10	1.2	0.47	< 0.05	0.99
Chrysene	mg/kg	0.05	MCERTS	8.1	1.1	0.46	< 0.05	0.94
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	11	1.4	0.54	< 0.05	0.94
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	7.4	0.61	0.38	< 0.05	0.79
Benzo(a)pyrene	mg/kg	0.05	MCERTS	9.8	1.2	0.58	< 0.05	1.1
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	4.5	0.58	0.23	< 0.05	0.47
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	1.2	0.14	< 0.05	< 0.05	< 0.05
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	5.1	0.72	0.30	< 0.05	0.58
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	126	14.7	6.06	< 0.80	11.4

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Analytical Report Number: 17-60529

Project / Site name: Park Lane, Knebworth
Your Order No: 54786

Lab Sample Number				817989	817990	817991	817992	817993
Sample Reference				WS1	WS2	WS3	WS4	WS5
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.30	0.30	0.50	0.30	0.20
Date Sampled				14/09/2017	14/09/2017	14/09/2017	14/09/2017	14/09/2017
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	22	21	27	20	23
Boron (water soluble)	mg/kg	0.2	MCERTS	1.1	1.6	0.5	1.1	0.8
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	0.9	< 0.2	< 0.2	< 0.2	< 0.2
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	23	25	38	32	22
Copper (aqua regia extractable)	mg/kg	1	MCERTS	35	23	25	17	31
Lead (aqua regia extractable)	mg/kg	1	MCERTS	450	42	22	21	170
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	37	25	29	23	19
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	1.5	< 1.0	< 1.0	< 1.0	1.2
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	780	74	86	74	100
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	3.6	< 2.0	< 2.0	< 2.0	< 2.0
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0	< 8.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	24	9.0	< 8.0	< 8.0	< 8.0
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	33	13	< 10	< 10	< 10
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	5.4	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	16	< 2.0	< 2.0	< 2.0	3.9
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	91	15	< 10	< 10	< 10
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	210	19	16	< 10	20
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	320	36	22	12	33

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Analytical Report Number : 17-60529

Project / Site name: Park Lane, Knebworth

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
817989	WS1	None Supplied	0.30	Brown loam and sand with gravel and rubble.
817990	WS2	None Supplied	0.30	Brown clay and sand with gravel and brick.
817991	WS3	None Supplied	0.50	Light brown clay and sand with gravel.
817992	WS4	None Supplied	0.30	Light brown clay and sand with gravel.
817993	WS5	None Supplied	0.20	Light brown clay and sand with gravel and rubble.

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Analytical Report Number : 17-60529

Project / Site name: Park Lane, Knebworth

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Analytical Report Number : 17-60808

Project / Site name:	Park Lane, Knebworth	**Samples received on:**	19/09/2017
Your job number:	52562A	**Samples instructed on:**	19/09/2017
Your order number:	54796	**Analysis completed by:**	26/09/2017
Report Issue Number:	1	**Report issued on:**	26/09/2017
Samples Analysed:	1 soil sample		

Signed:

Rexona Rahman
Reporting Manager
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils	- 4 weeks from reporting
leachates	- 2 weeks from reporting
waters	- 2 weeks from reporting
asbestos	- 6 months from reporting

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The results included within the report are representative of the samples submitted for analysis.

Analytical Report Number: 17-60808

Project / Site name: Park Lane, Knebworth
Your Order No: 54796

Lab Sample Number				819691				
Sample Reference				BH1				
Sample Number				None Supplied				
Depth (m)				0.30				
Date Sampled				14/09/2017				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1				
Moisture Content	%	N/A	NONE	9.6				
Total mass of sample received	kg	0.001	NONE	1.9				
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected				
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	9.1				
Water Soluble Sulphate as SO_4 16hr extraction (2:1)	mg/kg	2.5	MCERTS	83				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.041				
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	mg/l	1.25	MCERTS	41.4				
Organic Matter	%	0.1	MCERTS	0.8				
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthylene	mg/kg	0.05	MCERTS	< 0.05				
Acenaphthene	mg/kg	0.05	MCERTS	1.8				
Fluorene	mg/kg	0.05	MCERTS	1.1				
Phenanthrene	mg/kg	0.05	MCERTS	15				
Anthracene	mg/kg	0.05	MCERTS	4.3				
Fluoranthene	mg/kg	0.05	MCERTS	19				
Pyrene	mg/kg	0.05	MCERTS	17				
Benzo(a)anthracene	mg/kg	0.05	MCERTS	8.2				
Chrysene	mg/kg	0.05	MCERTS	7.6				
Benzo(b)fluoranthene	mg/kg	0.05	MCERTS	9.0				
Benzo(k)fluoranthene	mg/kg	0.05	MCERTS	3.6				
Benzo(a)pyrene	mg/kg	0.05	MCERTS	7.3				
Indeno(1,2,3-cd)pyrene	mg/kg	0.05	MCERTS	3.8				
Dibenz(a,h)anthracene	mg/kg	0.05	MCERTS	0.96				
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	3.9				
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	0.8	MCERTS	103				

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Analytical Report Number: 17-60808

Project / Site name: Park Lane, Knebworth
Your Order No: 54796

Lab Sample Number				819691				
Sample Reference				BH1				
Sample Number				None Supplied				
Depth (m)				0.30				
Date Sampled				14/09/2017				
Time Taken				None Supplied				
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	2.9				
Boron (water soluble)	mg/kg	0.2	MCERTS	0.4				
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2				
Chromium (hexavalent)	mg/kg	4	MCERTS	< 4.0				
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	15				
Copper (aqua regia extractable)	mg/kg	1	MCERTS	27				
Lead (aqua regia extractable)	mg/kg	1	MCERTS	82				
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3				
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	10				
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0				
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	51				
Monoaromatics								
Benzene	ug/kg	1	MCERTS	< 1.0				
Toluene	µg/kg	1	MCERTS	< 1.0				
Ethylbenzene	µg/kg	1	MCERTS	< 1.0				
p & m-xylene	µg/kg	1	MCERTS	< 1.0				
o-xylene	µg/kg	1	MCERTS	< 1.0				
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0				
Petroleum Hydrocarbons								
TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0				
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	< 2.0				
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	< 8.0				
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	16				
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	21				
TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001				
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	2.3				
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	22				
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	140				
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	240				
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	400				

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Analytical Report Number : 17-60808

Project / Site name: Park Lane, Knebworth

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Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
819691	BH1	None Supplied	0.30	Brown clay and sand with gravel.

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Analytical Report Number : 17-60808

Project / Site name: Park Lane, Knebworth

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW) Process Water (PrW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Asbestos identification in soil	Asbestos Identification with the use of polarised light microscopy in conjunction with disperion staining techniques.	In house method based on HSG 248	A001-PL	D	ISO 17025
Boron, water soluble, in soil	Determination of water soluble boron in soil by hot water extract followed by ICP-OES.	In-house method based on Second Site Properties version 3	L038-PL	D	MCERTS
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
Hexavalent chromium in soil	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry.	In-house method	L080-PL	W	MCERTS
Metals in soil by ICP-OES	Determination of metals in soil by aqua-regia digestion followed by ICP-OES.	In-house method based on MEWAM 2006 Methods for the Determination of Metals in Soil.	L038-PL	D	MCERTS
Moisture Content	Moisture content, determined gravimetrically.	In-house method based on BS1377 Part 2, 1990, Chemical and Electrochemical Tests	L019-UK/PL	W	NONE
Organic matter (Automated) in soil	Determination of organic matter in soil by oxidising with potassium dichromate followed by titration with iron (II) sulphate.	BS1377 Part 3, 1990, Chemical and Electrochemical Tests""	L009-PL	D	MCERTS
pH in soil (automated)	Determination of pH in soil by addition of water followed by automated electrometric measurement.	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests	L099-PL	D	MCERTS
Speciated EPA-16 PAHs in soil	Determination of PAH compounds in soil by extraction in dichloromethane and hexane followed by GC-MS with the use of surrogate and internal standards.	In-house method based on USEPA 8270	L064-PL	D	MCERTS
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
Sulphate, water soluble, in soil (16hr extraction)	Determination of water soluble sulphate by ICP-OES. Results reported directly (leachate equivalent) and corrected for extraction ratio (soil equivalent).	In-house method based on BS1377 Part 3, 1990, Chemical and Electrochemical Tests, 2:1 water:soil extraction, analysis by ICP-OES.	L038-PL	D	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.
For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.
Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

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Waste Classification Report

8E3N5-7326W-KWEVM

Job name

52562A Park Lane, Knebworth

Description/Comments

Project

Site

Waste Stream Template

Example waste stream template for contaminated soils

Classified by

Name:
Victoria Tickner
Date:
05/10/2017 15:22:53 UTC
Telephone:
01582 460018

Company:
Ian Farmer Associates
1A Baford Mill
Lower Luton Road
Harpenden
AL5 5BZ

Report

Created by: Victoria Tickner
Created date: 05/10/2017 15:22 UTC

Job summary

#	Sample Name	Depth [m]	Classification Result	Hazard properties	Page
1	WS1	0.30	Non Hazardous		2
2	WS2	0.30	Non Hazardous		5
3	WS3	0.50	Non Hazardous		8
4	WS4	0.30	Non Hazardous		11
5	WS5	0.20	Non Hazardous		14
6	BH1	0.30	Non Hazardous		17

Appendices	Page
Appendix A: Classifier defined and non CLP determinands	20
Appendix B: Rationale for selection of metal species	21
Appendix C: Version	22

Figure A4.2

Classification of sample: WS1

Non Hazardous Waste
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:
WS1
Sample Depth:
0.30 m
Moisture content:
8.1%
(no correction)

LoW Code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

Hazard properties

None identified

Determinands

Moisture content: 8.1% No Moisture Correction applied (MC)

#	Determinand	CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	CLP index number / EC Number / CAS Number							
1	arsenic { arsenic trioxide }		22 mg/kg	1.32	29.047 mg/kg	0.0029 %		
	033-003-00-0 / 215-481-4 / 1327-53-3							
2	boron { diboron trioxide; boric oxide }		1.1 mg/kg	3.22	3.542 mg/kg	0.000354 %		
	005-008-00-8 / 215-125-8 / 1303-86-2							
3	cadmium { cadmium oxide }		0.9 mg/kg	1.142	1.028 mg/kg	0.000103 %		
	048-002-00-0 / 231-152-8 [1] 215-146-2 [2] / 7440-43-9 [1] 1306-19-0 [2]							
4	chromium in chromium(III) compounds { chromium(III) oxide }		23 mg/kg	1.462	33.616 mg/kg	0.00336 %		
	/ 215-160-9 / 1308-38-9							
5	chromium in chromium(VI) compounds { chromium(VI) oxide }		<4 mg/kg	1.923	<7.692 mg/kg	<0.000769 %		<LOD
	024-001-00-0 / 215-607-8 / 1333-82-0							
6	copper { dicopper oxide; copper (I) oxide }		35 mg/kg	1.126	39.406 mg/kg	0.00394 %		
	029-002-00-X / 215-270-7 / 1317-39-1							
7	lead { lead chromate }	1	450 mg/kg	1.56	701.917 mg/kg	0.045 %		
	082-004-00-2 / 231-846-0 / 7758-97-6							
8	mercury { mercury dichloride }		<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %		<LOD
	080-010-00-X / 231-299-8 / 7487-94-7							
9	nickel { nickel chromate }		37 mg/kg	2.976	110.122 mg/kg	0.011 %		
	028-035-00-7 / 238-766-5 / 14721-18-7							
10	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }		1.5 mg/kg	2.554	3.83 mg/kg	0.000383 %		
	034-002-00-8 / /							
11	zinc { zinc sulphate }		780 mg/kg	2.469	1926.051 mg/kg	0.193 %		
	030-006-00-9 / 231-793-3 [1] 231-793-3 [2] / 7446-19-7 [1] 7733-02-0 [2]							
12	TPH (C6 to C40) petroleum group		353 mg/kg		353 mg/kg	0.0353 %		
	/ / TPH							
13	confirm TPH has NOT arisen from diesel or petrol		☑					
	/ /							

Figure A4.2

#		Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
14		tert-butyl methyl ether; MTBE; 2-methoxy-2-methylpropane				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<**LOD**
		603-181-00-X	216-653-1	1634-04-4									
15		benzene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<**LOD**
		601-020-00-8	200-753-7	71-43-2									
16		toluene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<**LOD**
		601-021-00-3	203-625-9	108-88-3									
17		ethylbenzene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<**LOD**
		601-023-00-4	202-849-4	100-41-4									
18		xylene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<**LOD**
		601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]									
19		pH				9.6	pH		9.6	pH	9.6 pH		
				PH									
20		naphthalene				3.2	mg/kg		3.2	mg/kg	0.00032 %		
		601-052-00-2	202-049-5	91-20-3									
21		acenaphthylene				0.5	mg/kg		0.5	mg/kg	0.00005 %		
			205-917-1	208-96-8									
22		acenaphthene				1.7	mg/kg		1.7	mg/kg	0.00017 %		
			201-469-6	83-32-9									
23		fluorene				1.4	mg/kg		1.4	mg/kg	0.00014 %		
			201-695-5	86-73-7									
24		phenanthrene				16	mg/kg		16	mg/kg	0.0016 %		
			201-581-5	85-01-8									
25		anthracene				3.2	mg/kg		3.2	mg/kg	0.00032 %		
			204-371-1	120-12-7									
26		fluoranthene				23	mg/kg		23	mg/kg	0.0023 %		
			205-912-4	206-44-0									
27		pyrene				20	mg/kg		20	mg/kg	0.002 %		
			204-927-3	129-00-0									
28		benzo[a]anthracene				10	mg/kg		10	mg/kg	0.001 %		
		601-033-00-9	200-280-6	56-55-3									
29		chrysene				8.1	mg/kg		8.1	mg/kg	0.00081 %		
		601-048-00-0	205-923-4	218-01-9									
30		benzo[b]fluoranthene				11	mg/kg		11	mg/kg	0.0011 %		
		601-034-00-4	205-911-9	205-99-2									
31		benzo[k]fluoranthene				7.4	mg/kg		7.4	mg/kg	0.00074 %		
		601-036-00-5	205-916-6	207-08-9									
32		benzo[a]pyrene; benzo[def]chrysene				9.8	mg/kg		9.8	mg/kg	0.00098 %		
		601-032-00-3	200-028-5	50-32-8									
33		indeno[123-cd]pyrene				4.5	mg/kg		4.5	mg/kg	0.00045 %		
			205-893-2	193-39-5									
34		dibenz[a,h]anthracene				1.2	mg/kg		1.2	mg/kg	0.00012 %		
		601-041-00-2	200-181-8	53-70-3									
35		benzo[ghi]perylene				5.1	mg/kg		5.1	mg/kg	0.00051 %		
			205-883-8	191-24-2									
										Total:	0.308 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Figure A4.2

Supplementary Hazardous Property Information

HP 3(i) on Flam. Liq. 1; H224, Flam. Liq. 2; H225, Flam. Liq. 3; H226: Force this Hazardous property to non hazardous because Solid, not liquid. Not deemed flammable at concentrations observed. Inert soil threshold adopted.

Figure A4.2

Classification of sample: WS2

Non Hazardous Waste
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:
WS2
Sample Depth:
0.30 m
Moisture content:
13%
(no correction)

LoW Code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

Hazard properties

None identified

Determinands

Moisture content: 13% No Moisture Correction applied (MC)

#	Determinand	CLP index number	EC Number	CAS Number	CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
1	arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3		21 mg/kg	1.32	27.727 mg/kg	0.00277 %		
2	boron { diboron trioxide; boric oxide }	005-008-00-8	215-125-8	1303-86-2		1.6 mg/kg	3.22	5.152 mg/kg	0.000515 %		
3	cadmium { cadmium oxide }	048-002-00-0	231-152-8 [1] 215-146-2 [2]	7440-43-9 [1] 1306-19-0 [2]		<0.2 mg/kg	1.142	<0.228 mg/kg	<0.0000228 %		<**LOD**
4	chromium in chromium(III) compounds { chromium(III) oxide }		215-160-9	1308-38-9		25 mg/kg	1.462	36.539 mg/kg	0.00365 %		
5	chromium in chromium(VI) compounds { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0		<4 mg/kg	1.923	<7.692 mg/kg	<0.000769 %		<**LOD**
6	copper { dicopper oxide; copper (I) oxide }	029-002-00-X	215-270-7	1317-39-1		23 mg/kg	1.126	25.895 mg/kg	0.00259 %		
7	lead { lead chromate }	082-004-00-2	231-846-0	7758-97-6	1	42 mg/kg	1.56	65.512 mg/kg	0.0042 %		
8	mercury { mercury dichloride }	080-010-00-X	231-299-8	7487-94-7		<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %		<**LOD**
9	nickel { nickel chromate }	028-035-00-7	238-766-5	14721-18-7		25 mg/kg	2.976	74.407 mg/kg	0.00744 %		
10	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }	034-002-00-8				<1 mg/kg	2.554	<2.554 mg/kg	<0.000255 %		<**LOD**
11	zinc { zinc sulphate }	030-006-00-9	231-793-3 [1] 231-793-3 [2]	7446-19-7 [1] 7733-02-0 [2]		74 mg/kg	2.469	182.728 mg/kg	0.0183 %		
12	TPH (C6 to C40) petroleum group			TPH		49 mg/kg		49 mg/kg	0.0049 %		
13	confirm TPH has NOT arisen from diesel or petrol					☑					

Figure A4.2

#		Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
14		tert-butyl methyl ether; MTBE; 2-methoxy-2-methylpropane				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		603-181-00-X	216-653-1	1634-04-4									
15		benzene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-020-00-8	200-753-7	71-43-2									
16		toluene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-021-00-3	203-625-9	108-88-3									
17	•	ethylbenzene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-023-00-4	202-849-4	100-41-4									
18		xylene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]									
19	•	pH				8.3	pH		8.3	pH	8.3 pH		
				PH									
20		naphthalene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
		601-052-00-2	202-049-5	91-20-3									
21	•	acenaphthylene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
			205-917-1	208-96-8									
22	•	acenaphthene				0.17	mg/kg		0.17	mg/kg	0.000017 %		
			201-469-6	83-32-9									
23	•	fluorene				0.14	mg/kg		0.14	mg/kg	0.000014 %		
			201-695-5	86-73-7									
24	•	phenanthrene				1.7	mg/kg		1.7	mg/kg	0.00017 %		
			201-581-5	85-01-8									
25	•	anthracene				0.32	mg/kg		0.32	mg/kg	0.000032 %		
			204-371-1	120-12-7									
26	•	fluoranthene				2.7	mg/kg		2.7	mg/kg	0.00027 %		
			205-912-4	206-44-0									
27	•	pyrene				2.7	mg/kg		2.7	mg/kg	0.00027 %		
			204-927-3	129-00-0									
28		benzo[a]anthracene				1.2	mg/kg		1.2	mg/kg	0.00012 %		
		601-033-00-9	200-280-6	56-55-3									
29		chrysene				1.1	mg/kg		1.1	mg/kg	0.00011 %		
		601-048-00-0	205-923-4	218-01-9									
30		benzo[b]fluoranthene				1.4	mg/kg		1.4	mg/kg	0.00014 %		
		601-034-00-4	205-911-9	205-99-2									
31		benzo[k]fluoranthene				0.61	mg/kg		0.61	mg/kg	0.000061 %		
		601-036-00-5	205-916-6	207-08-9									
32		benzo[a]pyrene; benzo[def]chrysene				1.2	mg/kg		1.2	mg/kg	0.00012 %		
		601-032-00-3	200-028-5	50-32-8									
33	•	indeno[123-cd]pyrene				0.58	mg/kg		0.58	mg/kg	0.000058 %		
			205-893-2	193-39-5									
34		dibenz[a,h]anthracene				0.14	mg/kg		0.14	mg/kg	0.000014 %		
		601-041-00-2	200-181-8	53-70-3									
35	•	benzo[ghi]perylene				0.72	mg/kg		0.72	mg/kg	0.000072 %		
			205-883-8	191-24-2									
										Total:	0.0469 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
•	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Figure A4.2

Supplementary Hazardous Property Information

HP 3(i) on Flam. Liq. 1; H224, Flam. Liq. 2; H225, Flam. Liq. 3; H226: Force this Hazardous property to non hazardous because Solid, not liquid. Not deemed flammable at concentrations observed. Inert soil threshold adopted.

Figure A4.2

Classification of sample: WS3

Non Hazardous Waste
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:
WS3
Sample Depth:
0.50 m
Moisture content:
18%
(no correction)

LoW Code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

Hazard properties

None identified

Determinands

Moisture content: 18% No Moisture Correction applied (MC)

#	Determinand	CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
	CLP index number / EC Number / CAS Number							
1	arsenic { arsenic trioxide }		27 mg/kg	1.32	35.649 mg/kg	0.00356 %		
	033-003-00-0 / 215-481-4 / 1327-53-3							
2	boron { diboron trioxide; boric oxide }		0.5 mg/kg	3.22	1.61 mg/kg	0.000161 %		
	005-008-00-8 / 215-125-8 / 1303-86-2							
3	cadmium { cadmium oxide }		<0.2 mg/kg	1.142	<0.228 mg/kg	<0.0000228 %		<LOD
	048-002-00-0 / 231-152-8 [1] 215-146-2 [2] / 7440-43-9 [1] 1306-19-0 [2]							
4	chromium in chromium(III) compounds { chromium(III) oxide }		38 mg/kg	1.462	55.539 mg/kg	0.00555 %		
	/ 215-160-9 / 1308-38-9							
5	chromium in chromium(VI) compounds { chromium(VI) oxide }		<4 mg/kg	1.923	<7.692 mg/kg	<0.000769 %		<LOD
	024-001-00-0 / 215-607-8 / 1333-82-0							
6	copper { dicopper oxide; copper (I) oxide }		25 mg/kg	1.126	28.147 mg/kg	0.00281 %		
	029-002-00-X / 215-270-7 / 1317-39-1							
7	lead { lead chromate }	1	22 mg/kg	1.56	34.316 mg/kg	0.0022 %		
	082-004-00-2 / 231-846-0 / 7758-97-6							
8	mercury { mercury dichloride }		<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %		<LOD
	080-010-00-X / 231-299-8 / 7487-94-7							
9	nickel { nickel chromate }		29 mg/kg	2.976	86.312 mg/kg	0.00863 %		
	028-035-00-7 / 238-766-5 / 14721-18-7							
10	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }		<1 mg/kg	2.554	<2.554 mg/kg	<0.000255 %		<LOD
	034-002-00-8 / /							
11	zinc { zinc sulphate }		86 mg/kg	2.469	212.359 mg/kg	0.0212 %		
	030-006-00-9 / 231-793-3 [1] 231-793-3 [2] / 7446-19-7 [1] 7733-02-0 [2]							
12	TPH (C6 to C40) petroleum group		22 mg/kg		22 mg/kg	0.0022 %		
	/ / TPH							
13	confirm TPH has NOT arisen from diesel or petrol		☑					
	/ /							

Figure A4.2

#		Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
14		tert-butyl methyl ether; MTBE; 2-methoxy-2-methylpropane				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		603-181-00-X	216-653-1	1634-04-4									
15		benzene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-020-00-8	200-753-7	71-43-2									
16		toluene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-021-00-3	203-625-9	108-88-3									
17		ethylbenzene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-023-00-4	202-849-4	100-41-4									
18		xylene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]									
19		pH				8.7	pH		8.7	pH	8.7 pH		
				PH									
20		naphthalene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
		601-052-00-2	202-049-5	91-20-3									
21		acenaphthylene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
			205-917-1	208-96-8									
22		acenaphthene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
			201-469-6	83-32-9									
23		fluorene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
			201-695-5	86-73-7									
24		phenanthrene				0.65	mg/kg		0.65	mg/kg	0.000065 %		
			201-581-5	85-01-8									
25		anthracene				0.12	mg/kg		0.12	mg/kg	0.000012 %		
			204-371-1	120-12-7									
26		fluoranthene				1.2	mg/kg		1.2	mg/kg	0.00012 %		
			205-912-4	206-44-0									
27		pyrene				1.1	mg/kg		1.1	mg/kg	0.00011 %		
			204-927-3	129-00-0									
28		benzo[a]anthracene				0.47	mg/kg		0.47	mg/kg	0.000047 %		
		601-033-00-9	200-280-6	56-55-3									
29		chrysene				0.46	mg/kg		0.46	mg/kg	0.000046 %		
		601-048-00-0	205-923-4	218-01-9									
30		benzo[b]fluoranthene				0.54	mg/kg		0.54	mg/kg	0.000054 %		
		601-034-00-4	205-911-9	205-99-2									
31		benzo[k]fluoranthene				0.38	mg/kg		0.38	mg/kg	0.000038 %		
		601-036-00-5	205-916-6	207-08-9									
32		benzo[a]pyrene; benzo[def]chrysene				0.58	mg/kg		0.58	mg/kg	0.000058 %		
		601-032-00-3	200-028-5	50-32-8									
33		indeno[123-cd]pyrene				0.23	mg/kg		0.23	mg/kg	0.000023 %		
			205-893-2	193-39-5									
34		dibenz[a,h]anthracene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
		601-041-00-2	200-181-8	53-70-3									
35		benzo[ghi]perylene				0.3	mg/kg		0.3	mg/kg	0.00003 %		
			205-883-8	191-24-2									
										Total:	0.0481 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Figure A4.2

Supplementary Hazardous Property Information

HP 3(i) on Flam. Liq. 1; H224, Flam. Liq. 2; H225, Flam. Liq. 3; H226: Force this Hazardous property to non hazardous because Solid, not liquid. Not deemed flammable at concentrations observed. Inert soil threshold adopted.

Figure A4.2

Classification of sample: WS4

Non Hazardous Waste
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:
WS4
Sample Depth:
0.30 m
Moisture content:
15%
(no correction)

LoW Code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

Hazard properties

None identified

Determinands

Moisture content: 15% No Moisture Correction applied (MC)

#	Determinand	CLP index number	EC Number	CAS Number	CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
1	arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3		20 mg/kg	1.32	26.407 mg/kg	0.00264 %		
2	boron { diboron trioxide; boric oxide }	005-008-00-8	215-125-8	1303-86-2		1.1 mg/kg	3.22	3.542 mg/kg	0.000354 %		
3	cadmium { cadmium oxide }	048-002-00-0	231-152-8 [1] 215-146-2 [2]	7440-43-9 [1] 1306-19-0 [2]		<0.2 mg/kg	1.142	<0.228 mg/kg	<0.0000228 %		**<LOD**
4	chromium in chromium(III) compounds { chromium(III) oxide }		215-160-9	1308-38-9		32 mg/kg	1.462	46.77 mg/kg	0.00468 %		
5	chromium in chromium(VI) compounds { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0		<4 mg/kg	1.923	<7.692 mg/kg	<0.000769 %		**<LOD**
6	copper { dicopper oxide; copper (I) oxide }	029-002-00-X	215-270-7	1317-39-1		17 mg/kg	1.126	19.14 mg/kg	0.00191 %		
7	lead { lead chromate }	082-004-00-2	231-846-0	7758-97-6	1	21 mg/kg	1.56	32.756 mg/kg	0.0021 %		
8	mercury { mercury dichloride }	080-010-00-X	231-299-8	7487-94-7		<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %		**<LOD**
9	nickel { nickel chromate }	028-035-00-7	238-766-5	14721-18-7		23 mg/kg	2.976	68.454 mg/kg	0.00685 %		
10	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }	034-002-00-8				<1 mg/kg	2.554	<2.554 mg/kg	<0.000255 %		**<LOD**
11	zinc { zinc sulphate }	030-006-00-9	231-793-3 [1] 231-793-3 [2]	7446-19-7 [1] 7733-02-0 [2]		74 mg/kg	2.469	182.728 mg/kg	0.0183 %		
12	TPH (C6 to C40) petroleum group			TPH		12 mg/kg		12 mg/kg	0.0012 %		
13	confirm TPH has NOT arisen from diesel or petrol					☑					

Figure A4.2

#		Determinand	CLP index number	EC Number	CAS Number	CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
14		tert-butyl methyl ether; MTBE; 2-methoxy-2-methylpropane	603-181-00-X	216-653-1	1634-04-4		<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
15		benzene	601-020-00-8	200-753-7	71-43-2		<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
16		toluene	601-021-00-3	203-625-9	108-88-3		<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
17	•	ethylbenzene	601-023-00-4	202-849-4	100-41-4		<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
18		xylene	601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]		<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
19	•	pH			PH		8.7	pH		8.7	pH	8.7 pH		
20		naphthalene	601-052-00-2	202-049-5	91-20-3		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
21	•	acenaphthylene		205-917-1	208-96-8		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
22	•	acenaphthene		201-469-6	83-32-9		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
23	•	fluorene		201-695-5	86-73-7		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
24	•	phenanthrene		201-581-5	85-01-8		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
25	•	anthracene		204-371-1	120-12-7		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
26	•	fluoranthene		205-912-4	206-44-0		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
27	•	pyrene		204-927-3	129-00-0		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
28		benzo[a]anthracene	601-033-00-9	200-280-6	56-55-3		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
29		chrysene	601-048-00-0	205-923-4	218-01-9		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
30		benzo[b]fluoranthene	601-034-00-4	205-911-9	205-99-2		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
31		benzo[k]fluoranthene	601-036-00-5	205-916-6	207-08-9		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
32		benzo[a]pyrene; benzo[def]chrysene	601-032-00-3	200-028-5	50-32-8		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
33	•	indeno[123-cd]pyrene		205-893-2	193-39-5		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
34		dibenz[a,h]anthracene	601-041-00-2	200-181-8	53-70-3		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
35	•	benzo[ghi]perylene		205-883-8	191-24-2		<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
											Total:	0.0392 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
•	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Figure A4.2

Supplementary Hazardous Property Information

HP 3(i) on Flam. Liq. 1; H224, Flam. Liq. 2; H225, Flam. Liq. 3; H226: Force this Hazardous property to non hazardous because Solid, not liquid. Not deemed flammable at concentrations observed. Inert soil threshold adopted.

Figure A4.2

Classification of sample: WS5

Non Hazardous Waste
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:
WS5
Sample Depth:
0.20 m
Moisture content:
10%
(no correction)

LoW Code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

Hazard properties

None identified

Determinands

Moisture content: 10% No Moisture Correction applied (MC)

#	Determinand	CLP index number	EC Number	CAS Number	CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
1	arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3		23 mg/kg	1.32	30.367 mg/kg	0.00304 %		
2	boron { diboron trioxide; boric oxide }	005-008-00-8	215-125-8	1303-86-2		0.8 mg/kg	3.22	2.576 mg/kg	0.000258 %		
3	cadmium { cadmium oxide }	048-002-00-0	231-152-8 [1] 215-146-2 [2]	7440-43-9 [1] 1306-19-0 [2]		<0.2 mg/kg	1.142	<0.228 mg/kg	<0.0000228 %		<LOD
4	chromium in chromium(III) compounds { chromium(III) oxide }		215-160-9	1308-38-9		22 mg/kg	1.462	32.154 mg/kg	0.00322 %		
5	chromium in chromium(VI) compounds { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0		<4 mg/kg	1.923	<7.692 mg/kg	<0.000769 %		<LOD
6	copper { dicopper oxide; copper (I) oxide }	029-002-00-X	215-270-7	1317-39-1		31 mg/kg	1.126	34.903 mg/kg	0.00349 %		
7	lead { lead chromate }	082-004-00-2	231-846-0	7758-97-6	1	170 mg/kg	1.56	265.169 mg/kg	0.017 %		
8	mercury { mercury dichloride }	080-010-00-X	231-299-8	7487-94-7		<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %		<LOD
9	nickel { nickel chromate }	028-035-00-7	238-766-5	14721-18-7		19 mg/kg	2.976	56.549 mg/kg	0.00565 %		
10	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }	034-002-00-8				1.2 mg/kg	2.554	3.064 mg/kg	0.000306 %		
11	zinc { zinc sulphate }	030-006-00-9	231-793-3 [1] 231-793-3 [2]	7446-19-7 [1] 7733-02-0 [2]		100 mg/kg	2.469	246.93 mg/kg	0.0247 %		
12	TPH (C6 to C40) petroleum group			TPH		33 mg/kg		33 mg/kg	0.0033 %		
13	confirm TPH has NOT arisen from diesel or petrol					☑					

Figure A4.2

#		Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
14		tert-butyl methyl ether; MTBE; 2-methoxy-2-methylpropane				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		603-181-00-X	216-653-1	1634-04-4									
15		benzene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-020-00-8	200-753-7	71-43-2									
16		toluene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-021-00-3	203-625-9	108-88-3									
17		ethylbenzene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-023-00-4	202-849-4	100-41-4									
18		xylene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]									
19		pH				10.9	pH		10.9	pH	10.9 pH		
				PH									
20		naphthalene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
		601-052-00-2	202-049-5	91-20-3									
21		acenaphthylene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
			205-917-1	208-96-8									
22		acenaphthene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
			201-469-6	83-32-9									
23		fluorene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
			201-695-5	86-73-7									
24		phenanthrene				1.1	mg/kg		1.1	mg/kg	0.00011 %		
			201-581-5	85-01-8									
25		anthracene				0.29	mg/kg		0.29	mg/kg	0.000029 %		
			204-371-1	120-12-7									
26		fluoranthene				2.1	mg/kg		2.1	mg/kg	0.00021 %		
			205-912-4	206-44-0									
27		pyrene				2.1	mg/kg		2.1	mg/kg	0.00021 %		
			204-927-3	129-00-0									
28		benzo[a]anthracene				0.99	mg/kg		0.99	mg/kg	0.000099 %		
		601-033-00-9	200-280-6	56-55-3									
29		chrysene				0.94	mg/kg		0.94	mg/kg	0.000094 %		
		601-048-00-0	205-923-4	218-01-9									
30		benzo[b]fluoranthene				0.94	mg/kg		0.94	mg/kg	0.000094 %		
		601-034-00-4	205-911-9	205-99-2									
31		benzo[k]fluoranthene				0.79	mg/kg		0.79	mg/kg	0.000079 %		
		601-036-00-5	205-916-6	207-08-9									
32		benzo[a]pyrene; benzo[def]chrysene				1.1	mg/kg		1.1	mg/kg	0.00011 %		
		601-032-00-3	200-028-5	50-32-8									
33		indeno[123-cd]pyrene				0.47	mg/kg		0.47	mg/kg	0.000047 %		
			205-893-2	193-39-5									
34		dibenz[a,h]anthracene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
		601-041-00-2	200-181-8	53-70-3									
35		benzo[ghi]perylene				0.58	mg/kg		0.58	mg/kg	0.000058 %		
			205-883-8	191-24-2									
										Total:	0.063 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Figure A4.2

Supplementary Hazardous Property Information

HP 3(i) on Flam. Liq. 1; H224, Flam. Liq. 2; H225, Flam. Liq. 3; H226: Force this Hazardous property to non hazardous because Solid, not liquid. Not deemed flammable at concentrations observed. Inert soil threshold adopted.

Figure A4.2

Classification of sample: BH1

Non Hazardous Waste
Classified as **17 05 04**
in the List of Waste

Sample details

Sample Name:
BH1
Sample Depth:
0.30 m
Moisture content:
9.6%
(no correction)

LoW Code:
Chapter: 17: Construction and Demolition Wastes (including excavated soil from contaminated sites)
Entry: 17 05 04 (Soil and stones other than those mentioned in 17 05 03)

Hazard properties

None identified

Determinands

Moisture content: 9.6% No Moisture Correction applied (MC)

#	Determinand	CLP index number	EC Number	CAS Number	CLP Note	User entered data	Conv. Factor	Compound conc.	Classification value	MC Applied	Conc. Not Used
1	arsenic { arsenic trioxide }	033-003-00-0	215-481-4	1327-53-3		2.9 mg/kg	1.32	3.829 mg/kg	0.000383 %		
2	boron { diboron trioxide; boric oxide }	005-008-00-8	215-125-8	1303-86-2		0.4 mg/kg	3.22	1.288 mg/kg	0.000129 %		
3	cadmium { cadmium oxide }	048-002-00-0	231-152-8 [1] 215-146-2 [2]	7440-43-9 [1] 1306-19-0 [2]		<0.2 mg/kg	1.142	<0.228 mg/kg	<0.0000228 %		**<LOD**
4	chromium in chromium(III) compounds { chromium(III) oxide }		215-160-9	1308-38-9		15 mg/kg	1.462	21.923 mg/kg	0.00219 %		
5	chromium in chromium(VI) compounds { chromium(VI) oxide }	024-001-00-0	215-607-8	1333-82-0		<4 mg/kg	1.923	<7.692 mg/kg	<0.000769 %		**<LOD**
6	copper { dicopper oxide; copper (I) oxide }	029-002-00-X	215-270-7	1317-39-1		27 mg/kg	1.126	30.399 mg/kg	0.00304 %		
7	lead { lead chromate }	082-004-00-2	231-846-0	7758-97-6	1	82 mg/kg	1.56	127.905 mg/kg	0.0082 %		
8	mercury { mercury dichloride }	080-010-00-X	231-299-8	7487-94-7		<0.3 mg/kg	1.353	<0.406 mg/kg	<0.0000406 %		**<LOD**
9	nickel { nickel chromate }	028-035-00-7	238-766-5	14721-18-7		10 mg/kg	2.976	29.763 mg/kg	0.00298 %		
10	selenium { selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex }	034-002-00-8				<1 mg/kg	2.554	<2.554 mg/kg	<0.000255 %		**<LOD**
11	zinc { zinc sulphate }	030-006-00-9	231-793-3 [1] 231-793-3 [2]	7446-19-7 [1] 7733-02-0 [2]		51 mg/kg	2.469	125.934 mg/kg	0.0126 %		
12	TPH (C6 to C40) petroleum group			TPH		421 mg/kg		421 mg/kg	0.0421 %		
13	confirm TPH has NOT arisen from diesel or petrol					☑					

Figure A4.2

#		Determinand			CLP Note	User entered data		Conv. Factor	Compound conc.		Classification value	MC Applied	Conc. Not Used
		CLP index number	EC Number	CAS Number									
14		tert-butyl methyl ether; MTBE; 2-methoxy-2-methylpropane				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		603-181-00-X	216-653-1	1634-04-4									
15		benzene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-020-00-8	200-753-7	71-43-2									
16		toluene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-021-00-3	203-625-9	108-88-3									
17	•	ethylbenzene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-023-00-4	202-849-4	100-41-4									
18		xylene				<0.001	mg/kg		<0.001	mg/kg	<0.0000001 %		<LOD
		601-022-00-9	202-422-2 [1] 203-396-5 [2] 203-576-3 [3] 215-535-7 [4]	95-47-6 [1] 106-42-3 [2] 108-38-3 [3] 1330-20-7 [4]									
19	•	pH				9.1	pH		9.1	pH	9.1 pH		
				PH									
20		naphthalene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
		601-052-00-2	202-049-5	91-20-3									
21	•	acenaphthylene				<0.05	mg/kg		<0.05	mg/kg	<0.000005 %		<LOD
			205-917-1	208-96-8									
22	•	acenaphthene				1.8	mg/kg		1.8	mg/kg	0.00018 %		
			201-469-6	83-32-9									
23	•	fluorene				1.1	mg/kg		1.1	mg/kg	0.00011 %		
			201-695-5	86-73-7									
24	•	phenanthrene				15	mg/kg		15	mg/kg	0.0015 %		
			201-581-5	85-01-8									
25	•	anthracene				4.3	mg/kg		4.3	mg/kg	0.00043 %		
			204-371-1	120-12-7									
26	•	fluoranthene				19	mg/kg		19	mg/kg	0.0019 %		
			205-912-4	206-44-0									
27	•	pyrene				17	mg/kg		17	mg/kg	0.0017 %		
			204-927-3	129-00-0									
28		benzo[a]anthracene				8.2	mg/kg		8.2	mg/kg	0.00082 %		
		601-033-00-9	200-280-6	56-55-3									
29		chrysene				7.6	mg/kg		7.6	mg/kg	0.00076 %		
		601-048-00-0	205-923-4	218-01-9									
30		benzo[b]fluoranthene				9	mg/kg		9	mg/kg	0.0009 %		
		601-034-00-4	205-911-9	205-99-2									
31		benzo[k]fluoranthene				3.6	mg/kg		3.6	mg/kg	0.00036 %		
		601-036-00-5	205-916-6	207-08-9									
32		benzo[a]pyrene; benzo[def]chrysene				7.3	mg/kg		7.3	mg/kg	0.00073 %		
		601-032-00-3	200-028-5	50-32-8									
33	•	indeno[123-cd]pyrene				3.8	mg/kg		3.8	mg/kg	0.00038 %		
			205-893-2	193-39-5									
34		dibenz[a,h]anthracene				0.96	mg/kg		0.96	mg/kg	0.000096 %		
		601-041-00-2	200-181-8	53-70-3									
35	•	benzo[ghi]perylene				3.9	mg/kg		3.9	mg/kg	0.00039 %		
			205-883-8	191-24-2									
										Total:	0.083 %		

Key

	User supplied data
	Determinand values ignored for classification, see column 'Conc. Not Used' for reason
•	Determinand defined or amended by HazWasteOnline (see Appendix A)
	Speciated Deteminand - Unless the Determinand is Note 1, the Conversion Factor is used to calculate the compound concentration
<LOD	Below limit of detection
CLP: Note 1	Only the metal concentration has been used for classification

Figure A4.2

Supplementary Hazardous Property Information

HP 3(i) on Flam. Liq. 1; H224, Flam. Liq. 2; H225, Flam. Liq. 3; H226: Force this Hazardous property to non hazardous because Solid, not liquid. Not deemed flammable at concentrations observed. Inert soil threshold adopted.

Figure A4.2

Appendix A: Classifier defined and non CLP determinands

- **chromium(III) oxide** (EC Number: 215-160-9, CAS Number: 1308-38-9)

Conversion factor: 1.462
Description/Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 17/07/2015
Risk Phrases: R20 , R22 , R36 , R37 , R38 , R42 , R43 , R50/53 , R60 , R61
Hazard Statements: Acute Tox. 4 H332 , Acute Tox. 4 H302 , Eye Irrit. 2 H319 , STOT SE 3 H335 , Skin Irrit. 2 H315 , Resp. Sens. 1 H334 , Skin Sens. 1 H317 , Repr. 1B H360FD , Aquatic Acute 1 H400 , Aquatic Chronic 1 H410

- **dicopper oxide; copper (I) oxide** (EC Number: 215-270-7, CAS Number: 1317-39-1)

CLP index number: 029-002-00-X
Data source: Regulation (EU) 2016/1179 of 19 July 2016 (ATP9)
Additional Risk Phrases: N R50/53 , N R50/53 >= 0.25 %
Additional Hazard Statement(s): None.
Reason for additional Hazards Statement(s)/Risk Phrase(s):
10/10/2016 - N R50/53 risk phrase sourced from: WM3 v1 still uses ecotoxic risk phrases
10/10/2016 - N R50/53 >= 0.25 % risk phrase sourced from: WM3 v1 still uses ecotoxic risk phrases

- **TPH (C6 to C40) petroleum group** (CAS Number: TPH)

Description/Comments: Hazard statements taken from WM3 1st Edition 2015; Risk phrases: WM2 3rd Edition 2013
Data source: WM3 1st Edition 2015
Data source date: 25/05/2015
Risk Phrases: R10 , R45 , R46 , R51/53 , R63 , R65
Hazard Statements: Flam. Liq. 3 H226 , Asp. Tox. 1 H304 , STOT RE 2 H373 , Muta. 1B H340 , Carc. 1B H350 , Repr. 2 H361d , Aquatic Chronic 2 H411

- **confirm TPH has NOT arisen from diesel or petrol**

Description/Comments: Chapter 3, section 4b requires a positive confirmation for benzo[a]pyrene to be used as a marker in evaluating Carc. 1B; H350 (HP 7) and Muta. 1B; H340 (HP 11)
Data source: WM3 1st Edition 2015
Data source date: 25/05/2015
Risk Phrases: None.
Hazard Statements: None.

- **ethylbenzene** (EC Number: 202-849-4, CAS Number: 100-41-4)

CLP index number: 601-023-00-4
Data source: Commission Regulation (EU) No 605/2014 – 6th Adaptation to Technical Progress for Regulation (EC) No 1272/2008. (ATP6)
Additional Risk Phrases: None.
Additional Hazard Statement(s): Carc. 2 H351
Reason for additional Hazards Statement(s)/Risk Phrase(s):
03/06/2015 - Carc. 2 H351 hazard statement sourced from: IARC Group 2B (77) 2000

- **pH** (CAS Number: PH)

Description/Comments: Appendix C4
Data source: WM3 1st Edition 2015
Data source date: 25/05/2015
Risk Phrases: None.
Hazard Statements: None.

- **acenaphthylene** (EC Number: 205-917-1, CAS Number: 208-96-8)

Description/Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 17/07/2015
Risk Phrases: R22 , R26 , R27 , R36 , R37 , R38
Hazard Statements: Acute Tox. 4 H302 , Acute Tox. 1 H330 , Acute Tox. 1 H310 , Eye Irrit. 2 H319 , STOT SE 3 H335 , Skin Irrit. 2 H315

- **acenaphthene** (EC Number: 201-469-6, CAS Number: 83-32-9)

Description/Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 17/07/2015
Risk Phrases: R36 , R37 , R38 , N R50/53 , N R51/53
Hazard Statements: Eye Irrit. 2 H319 , STOT SE 3 H335 , Skin Irrit. 2 H315 , Aquatic Acute 1 H400 , Aquatic Chronic 1 H410 , Aquatic Chronic 2 H411

Figure A4.2

fluorene (EC Number: 201-695-5, CAS Number: 86-73-7)

Description/Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 06/08/2015
Risk Phrases: N R50/53
Hazard Statements: Aquatic Acute 1 H400 , Aquatic Chronic 1 H410

phenanthrene (EC Number: 201-581-5, CAS Number: 85-01-8)

Description/Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 06/08/2015
Risk Phrases: R22 , R36 , R37 , R38 , R40 , R43 , N R50/53
Hazard Statements: Acute Tox. 4 H302 , Eye Irrit. 2 H319 , STOT SE 3 H335 , Carc. 2 H351 , Skin Sens. 1 H317 , Aquatic Acute 1 H400 , Aquatic Chronic 1 H410 , Skin Irrit. 2 H315

anthracene (EC Number: 204-371-1, CAS Number: 120-12-7)

Description/Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 17/07/2015
Risk Phrases: R36 , R37 , R38 , R43 , N R50/53
Hazard Statements: Eye Irrit. 2 H319 , STOT SE 3 H335 , Skin Irrit. 2 H315 , Skin Sens. 1 H317 , Aquatic Acute 1 H400 , Aquatic Chronic 1 H410

fluoranthene (EC Number: 205-912-4, CAS Number: 206-44-0)

Description/Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 21/08/2015
Risk Phrases: Xn R22 , N R50/53
Hazard Statements: Acute Tox. 4 H302 , Aquatic Acute 1 H400 , Aquatic Chronic 1 H410

pyrene (EC Number: 204-927-3, CAS Number: 129-00-0)

Description/Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 2014
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 21/08/2015
Risk Phrases: Xi R36/37/38 , N R50/53
Hazard Statements: Skin Irrit. 2 H315 , Eye Irrit. 2 H319 , STOT SE 3 H335 , Aquatic Acute 1 H400 , Aquatic Chronic 1 H410

indeno[123-cd]pyrene (EC Number: 205-893-2, CAS Number: 193-39-5)

Description/Comments: Data from C&L Inventory Database
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 06/08/2015
Risk Phrases: R40
Hazard Statements: Carc. 2 H351

benzo[ghi]perylene (EC Number: 205-883-8, CAS Number: 191-24-2)

Description/Comments: Data from C&L Inventory Database; SDS Sigma Aldrich 28/02/2015
Data source: http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database
Data source date: 23/07/2015
Risk Phrases: N R50/53
Hazard Statements: Aquatic Acute 1 H400 , Aquatic Chronic 1 H410

Appendix B: Rationale for selection of metal species

arsenic {arsenic trioxide}

Reasonable case CLP species based on hazard statements/molecular weight and most common (stable) oxide of arsenic. Industrial sources include: smelting; main precursor to other arsenic compounds (edit as required)

boron {diboron trioxide; boric oxide}

Reasonable case CLP species based on hazard statements/ molecular weight, physical form and low solubility. Industrial sources include: fluxing agent for glass/enamels; additive for fibre optics, borosilicate glass (edit as required)

cadmium {cadmium oxide}

Reasonable case CLP species based on hazard statements/molecular weight, very low solubility in water. Industrial sources include: electroplating baths, electrodes for storage batteries, catalysts, ceramic glazes, phosphors, pigments and nematocides. (edit as required) Worst case compounds in CLP: cadmium sulphate, chloride, fluoride & iodide not expected as either very soluble and/or compound's industrial usage not related to site history (edit as required)

Figure A4.2

chromium in chromium(III) compounds {chromium(III) oxide}

Reasonable case species based on hazard statements/molecular weight. Industrial sources include: tanning, pigment in paint, inks and glass (edit as required)

chromium in chromium(VI) compounds {chromium(VI) oxide}

Worst case CLP species based on hazard statements/molecular weight. Industrial sources include: production stainless steel, electroplating, wood preservation, anti-corrosion agents or coatings, pigments (edit as required)

copper {dicopper oxide; copper (I) oxide}

Reasonable case CLP species based on hazard statements/molecular weight and insolubility in water. Industrial sources include: oxidised copper metal, brake pads, pigments, antifouling paints, fungicide. (edit as required) Worse case copper sulphate is very soluble and likely to have been leached away if ever present and/or not enough soluble sulphate detected. (edit as required)

lead {lead chromate}

Worst case CLP species based on hazard statements/molecular weight (edit as required)

mercury {mercury dichloride}

Worst case CLP species based on hazard statements/molecular weight (edit as required)

nickel {nickel chromate}

Worst case CLP species based on hazard statements/molecular weight (edit as required)

selenium {selenium compounds with the exception of cadmium sulphoselenide and those specified elsewhere in this Annex}

Harmonised group entry used as most reasonable case. Pigment cadmium sulphoselenide not likely to be present in this soil. No evidence for the other CLP entries: sodium selenite, nickel II selenite and nickel selenide, to be present in this soil. (edit as required)

zinc {zinc sulphate}

No Cr IV present to form compounds.

Appendix C: Version

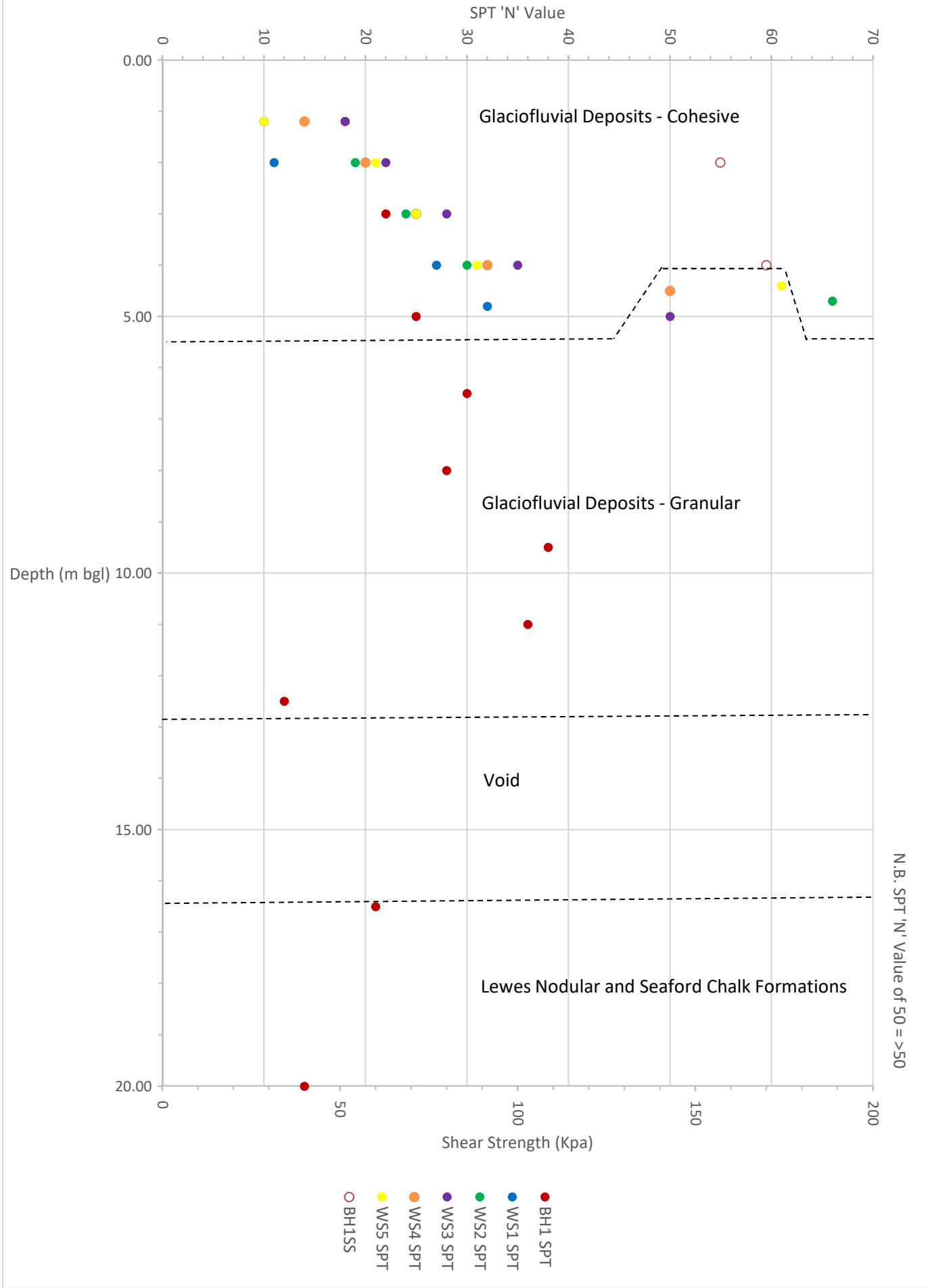
HazWasteOnline Classification Engine: WM3 1st Edition, May 2015
HazWasteOnline Classification Engine Version: 2017.269.3405.6897 (26 Sep 2017)
HazWasteOnline Database: 2017.270.3406.6898 (28 Sep 2017)

This classification utilises the following guidance and legislation:
WM3 - Waste Classification - May 2015
CLP Regulation - Regulation 1272/2008/EC of 16 December 2008
1st ATP - Regulation 790/2009/EC of 10 August 2009
2nd ATP - Regulation 286/2011/EC of 10 March 2011
3rd ATP - Regulation 618/2012/EU of 10 July 2012
4th ATP - Regulation 487/2013/EU of 8 May 2013
Correction to 1st ATP - Regulation 758/2013/EU of 7 August 2013
5th ATP - Regulation 944/2013/EU of 2 October 2013
6th ATP - Regulation 605/2014/EU of 5 June 2014
WFD Annex III replacement - Regulation 1357/2014/EU of 18 December 2014
Revised List of Wastes 2014 - Decision 2014/955/EU of 18 December 2014
7th ATP - Regulation 2015/1221/EU of 24 July 2015
8th ATP - Regulation (EU) 2016/918 of 19 May 2016
9th ATP - Regulation (EU) 2016/1179 of 19 July 2016
10th ATP - Regulation (EU) 2017/776 of 4 May 2017
POPs Regulation 2004 - Regulation 850/2004/EC of 29 April 2004
1st ATP to POPs Regulation - Regulation 756/2010/EU of 24 August 2010
2nd ATP to POPs Regulation - Regulation 757/2010/EU of 24 August 2010

Figure A4.2

APPENDIX 5

DESIGN CONSIDERATIONS



IAN FARMER ASSOCIATES Geotechnical & Environmental Specialists	**PLOT OF SPT 'N' VALUE AND SHEAR STRENGTH WITH DEPTH**	Job no. 52562A
	2 Park Lane, Knebworth, Hertfordshire, SG3 6PJ	Fig No A5.1

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. 10.14, which was introduced by the Environment Act 1995, ref. 10.15;

'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. 10.28 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. 10.21 and SR3, ref. 10.16.

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. 10.32. 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. 10.33. 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. 10.34, 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 5930:1999, ref. 10.3, ISO 1997, ref. 10.4 and BS 10175:2001, 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. 10.19;

- 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 dig 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

A6.2.10 Soils will be compared to Suitable 4 Use Levels (S4ULs) published by LQM ref. 10.18 Assessment Criteria. However, no S4UL has been produced for lead and, therefore, the DEFRA C4SL has been adopted ref. 10.19. Where no S4UL or C4SL is available, the assessment criteria (AC) are generated using the Contaminated Land Exposure Assessment (CLEA) Software Version 1.06, ref. 10.18. Toxicological and physico-chemical/fate and transport data used to generate the AC has been 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.

A6.2.11 In the case of the majority of contaminants considered, the toxicological data has been drawn from the relevant CLR 9 TOX report, or updated toxicological data published by the Environment Agency (2009), ref. 10.17, where available. Where no TOX report is available reference has been made to the health criteria values, derived for use in Land Quality Press (2006), ref. 10.22, as this is considered to represent a peer reviewed data source. Similarly, fate and transport data has been derived in the first instance from Environment Agency (2003), ref. 10.35 and for contaminants not considered in this document the fate and transport data used in previous versions of the CLEA model has been used.

A6.2.12 Chemical laboratory test results are processed as follows. 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. 10.18. Individual concentrations are compared to the selected guideline values to identify concentrations of contaminants that are above the selected screening criteria.

A6.2.13 Where the risk estimation identifies significant concentrations of one or more contaminants, a further risk evaluation needs to be undertaken.

A6.2.14 The risk evaluation will address the potential pollutant linkages between an identified source of contamination and the likely receptors both on and off site.

A6.2.15 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

A6.2.16 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

A6.2.17 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 without Homegrown Produce

Residential without 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	3000	4700	6000	LQM/CIEH S4UL
	Acenaphthylene	2900	4600	6000	LQM/CIEH S4UL
	Anthracene	31000	35000	37000	LQM/CIEH S4UL
	Benzo(a)anthracene	11	14	15	LQM/CIEH S4UL
	Benzo(a)pyrene	3.2	3.2	3.2	LQM/CIEH S4UL
	Benzo(b)fluoranthene	3.9	4	4	LQM/CIEH S4UL
	Benzo(ghi)perylene	360	360	360	LQM/CIEH S4UL
	Benzo(k)fluoranthene	110	110	110	LQM/CIEH S4UL
	Chrysene	30	31	32	LQM/CIEH S4UL
	Dibenzo(ah)anthracene	0.31	0.32	0.32	LQM/CIEH S4UL
	Fluoranthene	1500	1600	1600	LQM/CIEH S4UL
	Fluorene	2800	3800	4500	LQM/CIEH S4UL
	Indeno(123-cd)pyrene	45	46	46	LQM/CIEH S4UL
	Naphthalene	2.3	5.6	13	LQM/CIEH S4UL
	Phenanthrene	1300	1500	1500	LQM/CIEH S4UL
	Pyrene	88	210	480	LQM/CIEH S4UL
Other Organics	Phenol	750	1300	2300	LQM/CIEH S4UL
Metals	Arsenic	40	40	40	LQM/CIEH S4UL
	Beryllium	1.7	1.7	1.7	LQM/CIEH S4UL
	Boron	11000	11000	11000	LQM/CIEH S4UL
	Cadmium	85	85	85	LQM/CIEH S4UL
	Chromium (III)	910	910	910	LQM/CIEH S4UL
	Chromium (VI)	21	21	21	LQM/CIEH S4UL
	Copper	7100	7100	7100	LQM/CIEH S4UL
	Lead	310	310	310	DEFRA C4SL
	Mercury	1.2	1.2	1.2	LQM/CIEH S4UL
	Nickel	180	180	180	LQM/CIEH S4UL
	Selenium	430	430	430	LQM/CIEH S4UL
	Vanadium	1200	1200	1200	LQM/CIEH S4UL
	Zinc	40000	40000	40000	LQM/CIEH S4UL

Residential without 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)	760 (283)	LQM/CIEH S4UL
EC >12-16	1100 (24)	2400 (59)	4300 (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)	370	690	1400	LQM/CIEH S4UL
EC >7-8 (toluene)	860	1800	3900	LQM/CIEH S4UL
EC >8-10	47	110	270	LQM/CIEH S4UL
EC >10-12	250	590	1200	LQM/CIEH S4UL
EC >12-16	1800	2300 (419)	2500	LQM/CIEH S4UL
EC >16-21	1900	1900	1900	LQM/CIEH S4UL
EC >21-35	1900	1900	1900	LQM/CIEH S4UL
EC >35-44	1900	1900	1900	LQM/CIEH S4UL
Aliphatic and Aromatic				
EC >44-70	1900	1900	1900	LQM/CIEH S4UL
BTEX				
Benzene	0.38	0.70	1.4	LQM/CIEH S4UL
Toluene	880	1900	3900	LQM/CIEH S4UL
Ethylbenzene	83	190	440	LQM/CIEH S4UL
m/p Xylenes	79	180	430	LQM/CIEH S4UL
o Xylene	88	210	480	LQM/CIEH S4UL

SOM = Soil Organic Matter
Values in brackets indicate the solubility or vapour saturation limit where this is exceeded by the GAC

Test Group	Testing Required?	PE Threshold	Metal Pipe/ Barrier Pipe	Limit of Detection	UKAS Accredited	Maximum concentration at proposed pipeline depth See Note [2]	Maximum site concentration See Note [3]	Locations and depths where concentrations exceed proposed pipeline threshold
Total VOCs	Where PRA has identified land potentially affected by contamination	0.5	Pass					
Total BTEX & MTBE		0.1	Pass	0.001	Y		<0.001	
Total SVOCs (excluding PAHs and those substance marked with an *)		2	Pass					
EC5-EC10 aliphatic & aromatic hydrocarbons		2	Pass	0.001	Y		<0.001	
EC10-EC16 aliphatic & aromatic hydrocarbons		10	Pass	1-2	Y		25	BH1 at 0.30m WS1 at 0.30m
EC16-EC40 aliphatic & aromatic hydrocarbons		500	Pass	8-10	Y		396	
Phenols (from SVOC analysis)		2	Pass					
Cresols & chlorinated phenols (from SVOC analysis)		2	Pass					
Ethers*	Only where identified	0.5	Pass					
Nitrobenzene*		0.5	Pass					
Ketones*		0.5	Pass					
Aldehydes*		0.5	Pass					
Amines*		Fail	Pass					
Corrosive		Pass	See Note[1]	-	Y		10.9	

All concentrations in mg/kg

Note [1] Threshold: For wrapped steel, corrosive if pH<7 and conductivity >400uS/cm. For wrapped ductile iron corrosive if pH<5, Eh not neutral and conductivity >400uS/cm. For copper, corrosive if pH<5 or >8 and Eh positive.

Note [2] Water pipes are normally laid at 0.75-1.35m below finished ground level.

Note [3] Also state if liquid free product is present in soil or groundwater.

APPENDIX 7

GAS GENERATION

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. 10.36, 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. 10.37. In 2015, British Standard, BS8485, ref. 10.38, 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. 10.14.

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. 10.39.

A7.1.4 The following is a summary of the key points from the guidance and should not be taken in isolation, thus a full understanding can only be made by reading the guidance documents in full.

A7.2 APPROACH

A7.2.1 A flow chart detailing the approach to assessing and characterising a site is given in BS8485, Figure 3. This may be summarised as follows.

- Undertake Preliminary Investigation (desk study and site reconnaissance);
- Develop Conceptual Site Model (CSM);
- Design and undertaken Ground Investigation;
- Refine CSM;
- Calculate hazardous gas flow rate for methane and carbon dioxide;
- Assess Gas Screening Value (GSV);
- Assign Characteristic Situation (CS);
- Design gas protective measures based on CS.

A7.3 POLLUTANT LINKAGE ASSESSMENT

A7.3.1 A pollutant linkage assessment is presented in Appendix 3 of the Preliminary Investigation 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. 10.41.

Table A7.1

		Generation potential of source				
Sensitivity of development		**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. 10.42 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. 10.43 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. 10.38, 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. 10.42 was originally developed in CIRIA Report 149, ref. 10.36.

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 (%))/100. 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.

A7.6.4 This method of site characterisation is also given in BS8485, ref. 10.38, and is summarised below.

Table A7.2

Characteristic Situation	Risk Classification	Gas screening value (CH_4 or CO_2(1/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

Notes

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 Appropriate gas protection measures should be selected based on the CS and building type, which are used to produce a minimum level of gas protection (score) in the range 0 to 7.5, as summarised in the following tables, ref. 10.38.

A7.7.2 Guidance on radon and VOCs is given in Annex G and Annex H of BS8485.

A7.7.3 When the minimum gas protection score has been determined for the building as a whole, or for each part of the building, then a combination of two or more of the following three types of protection measures should be used to achieve that score.

- The structural barrier of the floor slab, or of the basement slab and walls if a basement is present;
- Ventilation measures; and
- Gas resistant membrane.

Table A7.3

	Building Types			
	Type A	**Type B**	**Type C**	**Type D**
Ownership	Private	Private or commercial/ public, possible multiple	Commercial/public	Commercial/ industrial
Control (change of use, structural alterations, ventilation)	None	Some but not all	Full	Full
Room sizes	Small	Small/ medium	Small to large	Large industrial/ retail park style

Table A7.4

CS	**Minimum Gas Protection Score (Points)**			
	High Risk		**Medium Risk**	**Low Risk**
	Type A Building	**Type B Building**	**Type C Building**	**Type D Building**
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5[A]	5.5[A]	4.5	3.5
5	-[B]	6.5[A]	5.5	4.5
6	-[B]	-[B]	7.5	6.5

[A] Residential buildings should not be built on CS4 or higher sites 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.

[B] The gas hazard is too high for this empirical method to be used to define the gas protection measures.

A7.7.4 Having determined the minimum gas protection score for the building, or each different part of the building, the element or combination of elements to achieve that required score should be chosen from those listed in the guidance, ref. 10.38, Table 5, Table 6 and Table 7. No more than one element from each type/table should be combined to achieve the recommended gas protection score.

A7.7.5 Details of the acceptable measures and corresponding scores are given in BS8485, ref. 10.38, which should be referred to for completion of the assessment and design.

A7.7.6 The following stages are not included within the scope of services provided by Ian Farmer Associates, however, details of the design may be included in a Remediation Method Statement (RMS) for a site.

- Detailed design;
- Implementation;
- Validation.

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. 10.37.

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 A7.5

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				
	5	**0.63**	10	**1.56**
Amber 2				
	20	**1.56**	30	**3.13**
Red				

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 A7.6

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.
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 determined 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 A7.7** below. Then, a combination of ventilation and/or barrier system should be chosen from **Table A7.8** to meet that requirement.

Table A7.7

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 A7.7**, an element or combination of elements from a), b), c) or d) in **Table A7.8**, should be chosen to achieve the required level of protection.

Table A7.8

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. 10.38*
	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.*
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	

PROTECTION ELEMENT/SYSTEM		SCORE	COMMENTS
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	
Permanent monitoring and alarm system[A)]	Installed in the underfloor venting/ dilution system	2	*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.*
	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. 10.38)*
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. 10.40 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.

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