APPENDIX 3

Ground Investigation Report

GROUND INVESTIGATION REPORT

for the site at

5 HERMIT PLACE, KILBURN, LONDON NW6 4BZ

on behalf of

CASTLE TRADING LIMITED C/O MICHAEL BLACKER PARTNERSHIP

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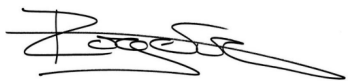
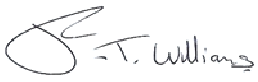
V1.01 Dec 2014		
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1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Castle Trading Limited, c/o Michael Blacker Partnership, on the 21st November 2014 to undertake a Ground Investigation on a site at 5 Hermit Place, Kilburn, London NW6 4BZ. The scope of the investigation was detailed within the Ground and Water Limited email fee proposal dated 21st November 2014.

1.2 Aims of the Investigation

The aim of the investigation was understood to be to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

The investigation was to be undertaken to provide parameters for the design of foundations by means of in-situ and laboratory geotechnical testing undertaken on soil samples recovered from trial holes.

The requirements of the London Borough of Camden, Camden Geological, Hydrogeological and Hydrological Study, Guidance for Subterranean Development (November 2010) was reviewed with respect to this report.

A Desk Study and full scale contamination assessment were not part of the remit of this report.

The techniques adopted for the investigation were chosen considering the anticipated ground conditions and development proposals on-site, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3 Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

2.0 SITE SETTING

2.1 Site Location

The site comprised an approximately rectangular shaped plot of land, totalling ~50m^2 in area and orientated in a north-west to south-east direction. The site was located ~50m north-east of Hermit Place's junction with Kilburn Vale in the Kilburn area of Hampstead. The site was located in the London Borough of Camden. Kilburn Vale, located ~50m south-west of the site, was noted to be situated at 32.1m AOD.

The national grid reference for the centre of the site was approximately TQ 25553 83752. A site location plan is given within Figure 1. A plan showing the site area is given within Figure 2.

2.2 Site Description

The site was occupied by a single storey brick built garage structure with metal roller shutter doors. A ~1.0m wide concrete ramp was noted between Hermit Place and the garage. The garage was noted to have a concrete floor in good condition. An aerial view of the site is provided within Figure 3.

2.3 Proposed Development

At the time of reporting, December 2014, details of the proposed development were not known to Ground and Water Limited but for the purposes of this report a residential development has been assumed. An assumed basement is anticipated to be founded at ~3.0 – 3.5m below existing ground level (bgl).

The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7. The proposed foundation loads were not known to Ground and Water Limited at the time of reporting but are likely to range from 75 – 150kN/m^2.

The proposed development will not involve any re-profiling of the site and its immediate environs. It is understood that no trees will be removed to facilitate the construction of the basement.

The proposed development was understood not to involve any re-profiling of the site and its immediate environs. It is understood that no trees will be removed to facilitate the construction of the basement.

2.4 Geology

The geology maps of the British Geological Survey of Great Britain of the Kilburn area (Sheet No. 256, North London) revealed the site to be situated on the London Clay Formation.

Figure 3 of the Camden Geological, Hydrogeological and Hydrological Study indicated that no Made Ground or Worked Ground was noted within a close proximity of the site.

London Clay Formation

The London Clay Formation comprises stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of gypsum (Selenite) are often found within the weathered part of the London Clay Formation, and precautions against sulphate attack to concrete are sometimes required.

The lowest part of the formation is a sandy bed with black rounded gravel and occasional layers of

sandstone and is known as the Basement Bed.

A BGS boreholes record ~120m north of the site revealed 0.45m of Made Ground over a firm, becoming stiff brown, fissured silty clay with selenite crystals and silt pockets.

2.5 Slope Stability and Subterranean Developments

The site was not situated within an area where a natural or man-made slope of greater than 7^{o} was present (Figure 16 Camden Geological, Hydrogeological and Hydrological Study).

Figure 17 of the Camden Geological, Hydrogeological and Hydrological Study indicated the site was not situated within an area prone to landslides.

Figure 18 of the Camden Geological, Hydrogeological and Hydrological Study indicated that no major subterranean infrastructure (including existing and proposed tunnels) was noted within close proximity to the site. The map showed that an over ground train line was present ~100m south of the site.

2.6 Hydrogeology and Hydrology

A study of the aquifer maps on the Environment Agency website, and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study, revealed the site to be located on **Unproductive Strata** comprising the bedrock of the London Clay Formation. No designation was given for any superficial deposits due to their likely absence.

Unproductive strata are rock layers with low permeability that have negligible significance for water supply or river base flow. These were formerly classified as non-aquifers.

Superficial (Drift) deposits are permeable unconsolidated (loose) deposits, for example, sands and gravels. The bedrock is described as solid permeable formations e.g. sandstone, chalk and limestone.

Examination of the Environment Agency records showed that the site did not fall within a Groundwater Source Protection Zone as classified in the Policy and Practice for the Protection of Groundwater.

There were no surface water features within a close proximity of the site in accordance with Figure 12 of the Camden Geological, Hydrogeological and Hydrological Study. Figure 11 revealed the site was located close to where a westerly flowing tributary of the “Lost” Westbourne River was present.

Figure 14 of the Camden Geological, Hydrogeological and Hydrological Study revealed the site was not located within the catchment of Hampstead Ponds.

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at moderate to deep depth (4-6m below existing ground level (bgl)) and it was considered that the groundwater was flowing in a south-easterly direction in accordance with the local topography and towards a groundwater source protection borehole ~1.7km south-east of the site.

Examination of the Environment Agency records showed that the site was not situated within a floodplain or flood warning area. Figure 15 the Camden Geological, Hydrogeological and Hydrological Study revealed that Priory Road ~75m east of the site suffered surface water flooding in

2002.

2.7 Radon

BRE 211 (2007) Map 5 of London, Sussex and West Kent revealed the site **was not** located within an area where mandatory protection measures against the ingress of Radon were required. The site **was not** located within an area where a risk assessment was required.

3.0 FIELDWORK

3.1 Scope of Works

Fieldwork was undertaken on the 24th November 2014 and comprised the drilling of one Premier Windowless Sampler Boreholes (BH1) to a depth of 15.45m bgl. Standard Penetration Testing (SPT's) was undertaken at 1.00m intervals during construction of the borehole.

A groundwater monitoring standpipe was installed in BH1 to a depth of 5.00m bgl to enable the measurement of standing groundwater levels.

The construction of the well installed can be seen tabulated below.

Combined Bio-gas and Groundwater Monitoring Well Construction				
Trial Hole	**Depth of Installation (m bgl)**	**Thickness of slotted piping with gravel filter pack (m)**	**Depth of plain piping with bentonite seal (m bgl)**	**Piping external diameter (mm)**
BH1	5.00	4.00	1.00	63

The approximate locations of the trial holes can be seen within Figure 4.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, exploratory positions were relocated away from these areas.

Upon completion of the site works, the trial holes were backfilled and made good/reinstated in relation to the surrounding area.

3.2 Sampling Procedures

Small disturbed samples were recovered from the trial holes at the depths shown on the trial hole records. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons.

A selection of samples were despatched for geotechnical testing purposes.

4.0 ENCOUNTERED GROUND CONDITIONS

4.1 Soil Conditions

All exploratory holes were logged by David McMillan of Ground and Water Limited generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial holes constructed on the site generally conformed to that anticipated from examination of the geology map. A capping of Made Ground was noted to overlie the London Clay Formation.

The ground conditions encountered during the investigation are described in this section. For more complete information about the Made Ground and the London Clay Formation at particular points, reference must be made to the individual trial hole logs within Appendix B.

The trial hole location plan can be viewed in Figure 4.

For the purposes of discussion the succession of conditions encountered in the trial holes in descending order can be summarised as follows:

Made Ground
London Clay Formation

Made Ground

Made Ground was encountered underlying a 0.25m thickness of concrete hardstanding to a depth of 0.40m bgl. The Made Ground comprised a dark brown slightly clayey gravelly sand to sandy gravel. The sand was fine to coarse grained and the gravel was fine to coarse, sub-angular to sub-rounded, occasional to abundant flint, brick and concrete.

London Clay Formation

The soils of the London Clay Formation were encountered underlying the Made Ground for the remaining depth of BH1, a depth of 15.45m bgl. The deposits generally comprised an orange brown to mid brown, becoming dark brown and then dark grey with depth, silty clay. Orange silt or fine sand lenses and selenite crystals were noted from 3.00m bgl and shell fragments were noted from 10.90m bgl

4.2 Roots Encountered

Fine roots were noted to a depth 1.50m bgl in BH1 during the intrusive investigation and traces of decayed rootlets were also noted at 1.50m bgl during the geotechnical laboratory testing.

It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

4.3 Groundwater Conditions

Groundwater was not encountered in the BH1 during the intrusive investigation. The standpipe installed in BH1 was noted to be dry on the 15th December 2014. The result of a second return visit to monitor the water level within the well installed was not available at the time of reporting and

will be issued as an addendum to this report.

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site. The investigation was undertaken in November and December 2014, when groundwater levels are rising to their annual maximum (highest elevation).

Isolated pockets of groundwater may be perched within any Made Ground found at other locations around the site.

4.4 Obstructions

No artificial or natural sub-surface obstructions were noted during construction of the trial holes.

5.0 INSITU AND LABORATORY GEOTECHNICAL TESTING

5.1 In-Situ Geotechnical Testing

Standard Penetration Tests (SPT's) were undertaken at 1.0m intervals in BH1. The test results are presented on the borehole logs within Appendix B.

Windowless Sampler Boreholes provide samples of the ground for assessment but they do not give any engineering data. The standard penetration test (SPT) is an in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil. The test uses a thick-walled sample tube, with an outside diameter of 50 mm and an inside diameter of 35 mm, and a length of around 650mm. This is driven into the ground at the bottom of a borehole by blows from a slide hammer with a weight of 63.5 kg falling through a distance of 760 mm. The sample tube is driven 150 mm into the ground and then the number of blows needed for the tube to penetrate each 150 mm up to a depth of 450 mm is recorded. The sum of the number of blows is termed the "standard penetration resistance" or the "N-value".

The cohesive soils of the London Clay Formation were classified based on the table below.

Undrained Shear Strength from Field Inspection/SPT results Cohesive Soils (EN ISO 14688-2:2004 & Stroud (1974))		
Classification	**Undrained Shear Strength (kPa)**	**Field Indications**
Extremely High	>300	-
Very High	150 – 300	Brittle or very tough
High	75 – 150	Cannot be moulded in the fingers
Medium	40 – 75	Can be moulded in the fingers by strong pressure
Low	20 – 40	Easily moulded in the fingers
Very Low	10 – 20	Exudes between fingers when squeezed in the fist
Extremely Low	<10	-

An interpretation of the in-situ geotechnical testing results is given in the table below.

In-Situ Geotechnical Testing Results Summary					
Strata	**SPT "N" Blow Counts**	**Undrained Shear Strength kPa (based on Stroud, 1974)**	**Soil Type**		**Trial Hole**
			Cohesive	**Granular**	
London Clay Formation	4 – 15 16 – 35	20 – 75 80 – 165	V Low/Low – Medium/High High – V High	-	BH1 (0.40 – 4.30m bgl) BH1 (4.30 – 15.45m bgl)

It must be noted that field measurements of undrained shear strength are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone etc.

The test results are presented on the trial hole logs within Appendix B.

5.2 Laboratory Geotechnical Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by K4 Soils Laboratory and QTS Environmental Limited, was undertaken on samples recovered from the London Clay Formation. The results of the tests are presented in Appendix C.

The test procedures used were generally in accordance with the methods described in BS1377:1990.

Details of the specific tests used in each case are given below:

Standard Methodology for Laboratory Geotechnical Testing		
Test	**Standard**	**Number of Tests**
Atterberg Limit Tests	BS1377:1990:Part 2:Clauses 3.2, 4.3 & 5	5
Moisture Content	BS1377:1990:Part 2:Clause 3.2	4
One Dimensional Consolidation Test	BS1377:1990:Part 5:Clause 3 and 4	1
Water Soluble Sulphate & pH	BS1377:1990:Part 3:Clause 5	2
BRE Special Digest 1 (incl. Ph, Electrical Conductivity, Total Sulphate, W/S Sulphate, Total Chlorine, W/S Chlorine, Total Sulphur, Ammonium as NH4, W/S Nitrate, W/S Magnesium)	BRE Special Digest 1 "Concrete in Aggressive Ground (BRE, 2005).	1

5.2.1 Atterberg Limit Tests

A précis of Atterberg Limit Tests undertaken on five samples of the London Clay Formation can be seen tabulated below.

Atterberg Limit Tests Results Summary							
Stratum/Depth	**Moisture Content (%)**	**Passing 425 µm sieve (%)**	**Modified PI (%)**	**Soil Class**	**Consistency Index (Ic)**	**Volume Change Potential**	
						NHBC	**BRE**
London Clay Formation	25 - 34	100	51 – 58	CH	Stiff – V Stiff	High	High

NB: NP – Non-plastic
BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)
Soil Classification based on British Soil Classification System.
Consistency Index (Ic) based on BS EN IS0 14688-2:2004.

5.2.2 Comparison of Soil's Moisture Content with Index Properties

5.2.2.1 Liquidity Index Analyses

The results of the Atterberg Limit tests undertaken on five samples of the London Clay Formation were analysed to determine the Liquidity Index of the samples. This gives an indication as to whether the samples recovered showed a moisture deficit and their degree of consolidation. The results are tabulated overpage.

The test results are presented within Appendix C.

Liquidity Index Calculations Summary					
Stratum/Trial Hole/Depth	**Moisture Content (%)**	**Plastic Limit (%)**	**Modified Plasticity Index (%)**	**Liquidity Index**	**Result**
London Clay Formation BH1/1.00m bgl (Orange brown slightly mottled grey silty CLAY)	34	30	55	0.073	Heavily Overconsolidated.
London Clay Formation BH1/2.50m bgl (Orange brown slightly mottled blue grey silty CLAY)	33	29	55	0.073	Heavily Overconsolidated
London Clay Formation BH1/5.00m bgl (Orange brown silty CLAY).	33	28	51	0.059	Heavily Overconsolidated.
London Clay Formation BH1/10.00m bgl (Brown silty CLAY with traces of selenite crystals)	29	28	55	0.018	Heavily Overconsolidated.
London Clay Formation BH1/15.00m bgl (Dark grey silty CLAY).	25	27	58	-0.034	**Potential Moisture Deficit**

The results in the table above indicate that a potential moisture deficit is present within one sample of the London Clay Formation tested (BH1/15.00m). The sample was described as dark grey silty clay. Roots were noted to a depth of 1.50m bgl. Consequently, the apparent moisture deficit is likely to be related to the lithology of the soil (heavily overconsolidated soils) rather than the water demand from the roots.

Liquidity Index testing revealed no evidence for moisture deficit within the remaining heavily overconsolidated samples of the London Clay Formation tested.

5.2.2.2 Liquid Limit

A comparison of the soil moisture content and the liquid limit can be seen tabulated overpage.

Moisture Content vs. Liquid Limit				
Strata/Trial Hole/Depth/Soil Description	**Moisture Content (MC) (%)**	**Liquid Limit (LL) (%)**	**40% Liquid Limit (LL)**	**Result**
London Clay Formation **BH1/1.00m bgl** (Orange brown slightly mottled grey silty CLAY)	34	85	34.0	MC = 0.4 x LL (No significant moisture deficit)
London Clay Formation **BH1/2.50m bgl** (Orange brown slightly mottled blue grey silty CLAY)	33	84	33.6	**MC < 0.4 x LL** **(Potentially significant moisture deficit)**
London Clay Formation **BH1/5.00m bgl** (Orange brown silty CLAY).	33	79	31.6	MC > 0.4 x LL (No significant moisture deficit)
London Clay Formation **BH1/10.00m bgl** (Brown silty CLAY with traces of selenite crystals)	29	83	33.2	**MC < 0.4 x LL** **(Potentially significant moisture deficit)**
London Clay Formation **BH1/15.00m bgl** (Dark grey silty CLAY).	25	85	34.0	**MC < 0.4 x LL** **(Potentially significant moisture deficit)**

The results in the table above indicate that a potential significant moisture deficit was present within three samples of the London Clay Formation tested (BH1/2.50m, BH1/10.00m and BH1/15.00m bgl). The moisture content values were below 40% of the liquid limit. .

The samples were described as silty clays. Traces of selenite crystals were also noted at 10.00m bgl. Roots were noted to a depth of 1.50m bgl in BH1 by the supervising engineer and during geotechnical laboratory testing. Geotechnical testing on a shallower sample (BH1/1.00m bgl) showed no potential moisture deficit. The apparent moisture deficit is therefore likely to be related to the lithology of the soil (heavily overconsolidated soils with traces of selenite crystals) rather than the water demand from the roots.

The results in the table above indicate that the remaining samples of the London Clay Formation tested showed no evidence of a significant moisture deficit.

5.2.3 Moisture Content Profiling

Moisture content versus depth plot for BH1 can be seen within Figure 5.

Whilst Figure 5 shows a possible moisture deficit in BH1 at 1.50m and 3.00m bgl due to a lowering of the moisture content of the respective samples of the London Clay Formation from those depths. Roots were noted to a depth of 1.50m bgl by the supervising engineer and therefore the lower moisture content at 1.50m was likely due a combination of both the lithology of the soils (Heavily overconsolidated soils) and the moisture demand from nearby trees. The deeper lower moisture content at 3.00m bgl was likely a result of the lithology alone (heavily overconsolidated soils and traces of selenite crystals). No other significant areas of very low moisture content were noted, with the profile showing variations in moisture content that would be as expected based on variations in lithology, rather than the moisture demand from nearby trees.

5.2.4 Swelling Test

A one dimensional Swelling Test was undertaken on a disturbed sample obtained from BH1 at a depth of 3.50m bgl. The results of the test are tabulated below.

One Dimensional Consolidation Test - Swelling									
Stratum/Depth		Height (mm)	Moisture Content (%)	Bulk Density (Mg/m^3)	Dry Density (Mg/m^3)	Void Ratio	Degree of Saturation (%)	Particle Density (Mg/m^3)	Swelling Pressure (kpa)
London Clay Formation/ BH1/3.50m bgl	Initial	15.81	33	1.95	1.48	0.85	101.2	2.74	75
	Final	16.78	37	1.91	1.39	0.97	-	-	-

It must be noted that the sample was remoulded and this must be taken into account in final design.

5.2.5 Sulphate and pH Tests

Sulphate and pH tests were undertaken on two samples from the London Clay Formation (BH1/1.50m and BH1/3.00m bgl). A sulphate concentration of 520-2740mg/l with a pH of 7.7-7.9 was determined.

5.2.6 BRE Special Digest 1

In accordance with BRE Special Digest 1 'Concrete in Aggressive Ground' (BRE, 2005) one sample of the London Clay Formation (BH1/7.00m) were scheduled for laboratory analysis to determine parameters for concrete specification.

The results are given within Appendix D and a summary is tabulated below.

Summary of Results of BRE Special Digest Testing			
Determinand	Unit	Minimum	Maximum
pH	-	8.4	-
Ammonium as NH_4	mg/kg	8.4	-
Sulphur	mg/kg	679	-
Chloride (water soluble)	mg/kg	218	-
Magnesium (water soluble)	g/l	0.0159	-
Nitrate (water soluble)	mg/kg	63	-
Sulphate (water soluble)	g/l	0.71	-
Sulphate (total)	mg/kg	2733	-

5.3 Chemical Laboratory Testing – Human Health Risk Assessment

A programme of chemical laboratory testing, scheduled by Ground and Water Limited and carried out by QTS Environmental Limited, was undertaken on one sample of Made Ground (BH1/0.30m).

A Desk Study and full scale contamination assessment were not part of the remit of this report. However, one soil sample was sent off for analysis for a broad range of contaminants in accordance

with DEFRA/CLEA methodologies. The sample tested and the reasons for testing can be seen tabulated below.

Methodology for Sampling Locations and Chemical Laboratory Testing		
Trial Hole	**Depth (m bgl)**	**Sampling Strategy**
BH1	0.30m	Representative sample of Made Ground from BH1

Soil sampling depths were chosen to reflect the receptors of concern, human health, and typically comprised a surface or near surface sample and then at approximately 0.50m depth increments thereafter, extending into the underlying natural soils. The receptors relevant to the sampling depths can be seen below:

Near surface samples	Direct ingestion, dermal contact and dust inhalation. Protection of end-users and maintenance workers e.g. Landscape Gardeners. Protection of shallow rooted plants.
>0.5m below ground level	Protection of deep rooted plants.

The depth of soil sampling can be seen within the trial hole logs presented in Appendix B.

The analysis suite is presented below and comprised:

- Semi Metals and Heavy Metals incl. Arsenic, Cadmium, Chromium (incl. Hexavalent Chromium), Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc (BH1/0.30m);
- Asbestos Screen (BH1/0.30m);
- Polycyclic Aromatic Hydrocarbons (PAHs) incl. Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(ghi)perylene (BH1/0.30m);

The chemical laboratory results are presented in Appendix D.

5.3.1 Soil Assessment Criteria

The derivation of Soil Assessment Criteria used within this report can be seen within Appendix E.

5.3.2 Determination of Representative Contamination Concentration

At the time of reporting, December 2014, details of the proposed development were not known to Ground and Water Limited but for the purposes of this report a residential development has been assumed. An assumed basement is anticipated to be founded at ~3.0 – 3.5m below existing ground level (bgl).

Therefore, the results of the chemical laboratory testing were compared to the Soil Guideline Values (SGVs) and General Assessment Criteria (GAC) for a ***'Residential'*** land-use scenario, as this was considered the most appropriate land-use scenario. The C4SL LLTC for

Lead was compared to a **'Residential with plant uptake'** land-use scenario.

Where a contaminant of concern's SGV/GAC varies according to the soil's Soil Organic Matter (SOM), the SOM recorded for the sample was used to derive the appropriate SGV/GAC. The sample of Made Ground analysed had a SOM of 0.2%.

The results of the comparison of the representative contaminants concentrations are presented in the table overpage.

Soil Guideline Values and General Acceptance Criteria Results	
Substance	**Sample location where available SGV, GAC or C4SL LLTC were exceeded for relevant land-use scenario**
	"Residential" Land-Use Scenario
Arsenic	None
Boron	None
Cadmium	None
Chromium (III)	None
Hexavalent Chromium (VI)	None
Lead	**BH1/0.30m**
Mercury (Elemental)	None
Nickel	None
Selenium	None
Vanadium	None
Copper	None
Zinc	None
Boron	None
Cyanide (Total)	None
Phenol	None
Naphthalene	None
Acenapthylene	None
Acenapthene	None
Fluorene	None
Phenanthrene	None
Anthracene	None
Fluoranthene	None
Pyrene	None
Pyrene	None
Benzo (a)anthracene	None
Benzo(b)fluoranthene	None
Benzo(k)fluoranthene	None
Indeno(1,2,3-cd)pyrene	None
Benzo(ghi)perylene	None
Benzo(a)pyrene	None
Dibenz(a,h)anthracene	None
Asbestos Screen	None

Chemical laboratory testing revealed an elevated levels of lead within the one sample of the Made Ground above the guideline level of 450mg/kg for a "Residential with plant uptake" land-use scenario with a concentration of 669mg/kg in the sample BH1/0.30mbgl.

Chemical laboratory testing revealed no other elevated levels of determinants were noted above the guideline levels for a ***'Residential'*** land-use scenario in the sample of Made Ground tested (BH1/0.30m bgl).

In addition, the intrusive investigation did not reveal any visual or olfactory evidence to suggest any hydrocarbon-type contamination in the trial holes excavated on the site.

Given the small size of the site and the limited number of Made Ground samples tested, the use of CLAIRE Statistical Analysis on the results of chemical laboratory testing was considered inappropriate.

Given the likely low mobility of lead qualitative risk assessment has indicated that the determinants noted pose no unacceptable risk to groundwater and therefore the Made Ground can remain under areas of permanent hardstanding.

Given the proposed development is likely to comprise a mews type property with 100% hardstanding and a basement beneath the entire footprint of the structure then no remediation is considered necessary. Should soft landscaped areas be considered then remediation is likely to be required.

6.0 ENGINEERING CONSIDERATIONS

6.1 Soil Characteristics and Geotechnical Parameters

Based on the results of the intrusive investigation and geotechnical laboratory testing the following interpretations have been made with respect to engineering considerations.

- Made Ground was encountered underlying a 0.25m thickness of concrete hardstanding in BH1 to a depth of 0.40m bgl.

  As a result of the inherent variability of Made Ground, it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

- The soils of the London Clay Formation were encountered underlying the Made Ground for the remaining depth of BH1, a depth of 15.45m bgl. The deposits generally comprised an orange brown to mid brown, becoming dark brown and then dark grey with depth, silty clay. Orange silt or fine sand lenses and selenite crystals were noted from 3.00m bgl and shell fragments were noted from 10.90m bgl

  The cohesive soils of the London Clay Formation comprised very low/low to medium/high undrained shear strength (20-75kPa) soils from 0.40-4.30m bgl and with a high to very high undrained shear strength (80-165kPa) between 4.30-15.45m bgl.

  The soils of the London Clay Formation were shown to have a **high** potential for volume change in accordance both BRE240 and NHBC Standards Chapter 4.2.

  Consistency Index calculations indicated the cohesive London Clay Formation to be stiff to very stiff. Liquidity Index testing revealed the soils to be heavily overconsolidated.

  Geotechnical analysis revealed a potential significant moisture deficit was present within three samples of the London Clay Formation tested (BH1/2.50m, BH1/10.00m and BH1/15.00m bgl). The moisture content values were below 40% of the liquid limit. The apparent moisture deficit was attributed to the lithology of the soil (heavily overconsolidated soils with traces of selenite crystals) rather than the water demand from the roots.

  Moisture content profiling revealed a slight moisture deficit within the soils of the London Clay Formation at 1.50m bgl.

  The soils of the London Clay Formation are heavily overconsolidated cohesive soils and are therefore likely to be a suitable stratum for traditional strip, mat or piled foundations for the basement or foundations structurally unattached to the basement. The settlements induced on loading are likely to be low to moderate.

  The final design of foundations will need to take into account the volume change potential of the soil, the depth of root penetration and/or moisture deficit and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are discussed in the next section of this report.

- Fine roots were noted to a depth 1.50m bgl in BH1 during the intrusive investigation and traces of decayed rootlets were also noted at 1.50m bgl during the geotechnical laboratory testing.

- Groundwater was not encountered in the BH1 during the intrusive investigation. The standpipe installed in BH1 was noted to be dry on the 15th December 2014. The result of a second return visit to monitor the water level within the well installed was not available at the time of reporting and will be issued as an addendum to this report.

6.2 Basement Foundations

At the time of reporting, December 2014, details of the proposed development were not known to Ground and Water Limited but for the purposes of this report a residential development has been assumed. An assumed basement is anticipated to be founded at ~3.0 – 3.5m below existing ground level (bgl).

The proposed development fell within Geotechnical Design Category 2 in accordance with Eurocode 7. The proposed foundation loads were not known to Ground and Water Limited at the time of reporting but are likely to range from 75 – 150kN/m^2.

Foundations should be designed in accordance with soils of **high volume change potential** in accordance with BRE Digest 240 and NHBC Chapter 4.2.

Given the cohesive nature of the shallow deposits foundations must therefore **not** be placed within cohesive root penetrated and/or desiccated soils and the influence of the trees surrounding the site must be taken into account (NHBC Standards Chapter 4.2). It is recommended that foundations are taken at least 300mm into non-root penetrated strata or granular soils of no volume change potential.

Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping. Should trees be removed from the footprint of the proposed building then an alternative foundation system, such as piles or isolated pads should be considered.

Fine roots were noted to a depth 1.50m bgl in BH1 during the intrusive investigation and traces of decayed rootlets were also noted to 1.50m bgl during the geotechnical laboratory testing therefore a minimum foundation depth of ~1.80m bgl is required.

It is considered likely the proposed basement will be constructed with load bearing concrete retaining walls with semi-ground bearing concrete floors. The following bearing capacities could be adopted for 5.0m long by 0.75m and 1.00m wide footings or a 1.50m by 1.50m pad at a depth of 3.00m and 3.50m bgl for any basement constructed. The bearing capacities and settlements were determined based on BH1.

Limit State: Bearing Capacities Calculated		
Depth (m BGL)	**Foundation System**	**Limit Bearing Capacity (kN/m^2)**
3.00m	5.00m by 0.75m Strip	261.35
	5.00m by 1.00m Strip	261.35

Serviceability State: Settlement Parameters Calculated			
Depth (m BGL)	**Foundation System**	**Limit Bearing Capacity (kN/m^2)**	**Settlement (mm)**
3.00m	5.00m by 0.75m Strip	150	<17
	5.00m by 1.00m Strip	150	<21

Limit State: Bearing Capacities Calculated		
Depth (m BGL)	**Foundation System**	**Limit Bearing Capacity (kN/m^2)**
3.50m	5.00m by 0.75m Strip	265.01
	5.00m by 1.00m Strip	265.01
Serviceability State: Settlement Parameters Calculated		
Depth (m BGL)	**Foundation System**	**Limit Bearing Capacity (kN/m^2)**	**Settlement (mm)**
3.50m	5.00m by 0.75m Strip	150	<15
	5.00m by 1.00m Strip	150	<18

It must be noted that a bearing capacity of less than 50kN/m^2 at 3.00m bgl and 55kN/m^2 at 3.50m bgl may results in heave of the underlying soils. A swelling pressure of 75kpa was determined at 3.50m bgl based on the result of a remoulded sample.

Groundwater was not encountered in the BH1 during the intrusive investigation. The standpipe installed in BH1 was noted to be dry on the 15th December 2014. The result of a second return visit to monitor the water level within the well installed was not available at the time of reporting and will be issued as an addendum to this report.

Based on the groundwater readings taken during this investigation to-date, it was considered unlikely that groundwater would be encountered during basement construction.

Perched groundwater may be encountered within the Made Ground. The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

It must be mentioned that it was assumed that excavations will be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation for even a short time not only would an increase in heave occur resulting from the soil increasing in volume by taking up water, but also the shear strength and hence the bearing capacity would also be reduced.

The basement must be suitably tanked to prevent ingress of any groundwater, if applicable, and also surface water run-off. The basement must also be designed to take into account pressure exerted by the presence of groundwater in and around the basement, if applicable.

6.3 Piled Foundations

Based on the results of the intrusive investigation piled foundations are unlikely to be required at the site.

6.4 Basement Excavations & Stability

Shallow excavations in the Made Ground and London Clay Formation are likely to be marginally

stable at best. Long, deep excavations, through both of these strata are likely to become unstable.

The excavation of the basement must not affect the integrity of the adjacent structures beyond the boundaries. The excavation must be supported by suitably designed retaining walls. It is considered unlikely that battering the sides of the excavation, casting the retaining walls and then backfilling to the rear of the walls would be suitable given the close proximity of the party walls.

The retaining walls for the basement will need to be constructed based on cohesive soils with an appropriate angle of shear resistance (*Φ*') for the ground conditions encountered.

Based on the ground conditions encountered within the boreholes the following parameters could be used in the design of retaining walls. These have been designed based on the SPT profile recorded, results of geotechnical classification tests and reference to literature.

Retaining Wall/Basement Design Parameters					
Strata	**Unit Volume Weight (kN/m^3)**	**Cohesion Intercept (c') (kPa)**	**Angle of Shearing Resistance (Ø)**	**Ka**	**Kp**
Made Ground	~15	0	12	0.66	1.52
London Clay Formation	~20-22	0	24	0.42	2.37

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

Based on the groundwater readings taken during this investigation to date, it was considered likely that perched groundwater would be encountered during basement construction. Dewatering from sumps introduced into the floor of the excavation is likely to be required. Consideration should be given to creating a coffer dam using contiguous piled or sheet piled walls to aid basement construction below the perched water table.

6.5 Hydrogeological Effects

The proposed development is located on **Unproductive Strata** relating to the London Clay Formation.

The ground conditions encountered generally comprised a capping of Made Ground over the cohesive London Clay Formation. Based on a visual appraisal of the soils encountered the permeability of the London Clay Formation was likely to be very low to negligible permeability.

Groundwater was not encountered in the BH1 during the intrusive investigation. The standpipe installed in BH1 was noted to be dry on the 15th December 2014. The result of a second return visit to monitor the water level within the well installed was not available at the time of reporting and will be issued as an addendum to this report.

The Environment Agency records show that the highest recorded tide for the nearest river station on the River Thames at Westminster is 4.50m AOD with high tides generally at ~3.00m AOD. The

elevation of the site is ~32.1.0m AOD. Based on a 3.00 - 3.50m bgl deep basement slab a formation level of 39.1-38.60m AOD is assumed. This means that the basement will be constructed above general high tide levels of the River Thames.

Based on the above it is considered likely that perched water will be encountered during basement construction, but the basement will not be constructed below the groundwater table. In relation to the basement, once constructed, the Made Ground will act as a slightly porous medium for water to migrate however additional drainage should be considered as the London Clay Formation will act as a barrier for groundwater migration.

6.6 Sub-Surface Concrete

Sulphate concentrations measured in 2:1 water/soil extracts taken from the Made Ground and London Clay Formation, from both the geotechnical and chemical laboratory testing, fell into Class DS-1, DS-2 and DS-3 of the BRE Special Digest 1, 2005, *'Concrete in Aggressive Ground'.*

Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-2s. For the classification given, the "static" and "natural" case was adopted given the presence of the limited thickness of Made Ground and use of the site. The sulphate concentration in the samples ranged from 120-2740mg/l with a pH range of 7.7-9.2. The total sulphate concentration was 0.27%.

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1, 2005, *'Concrete in Aggressive Ground'* taking into account the pH of the soils.

It is prudent to note that pyrite nodules may be present within the London Clay Formation. Pyrite can oxidise to gypsum and this normally only occurs in the upper weathered layer, but excavation allows faster oxidation and water soluble sulphate values can rapidly increase during construction. Therefore rising sulphate values should be taken into account should ferruginous staining/pyrite nodules be encountered within the London Clay Formation.

6.7 Surface Water Disposal

Infiltration tests were beyond the scope of the investigation.

Soakaway construction within the cohesive soils of the London Clay Formation is unlikely to prove satisfactory due to negligible to low anticipated infiltration rates. Therefore an alternative method of surface water disposal is required.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources.

The principles of sustainable urban drainage system (SUDS) should be applied to reduce the risk of flooding from surface water ponding and collection associated with the construction of the basement.

6.8 Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation. For example, there may have been underground storage tanks (UST's) not identified during the Ground Investigation for which there is no historical or contemporary evidence.

Such occurrences may be discovered during the demolition and construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Local Authority will need to be informed.

6.9 Waste Disposal

The excavation of foundations is likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal all waste must be classified as;

- Inert;
- Non-hazardous, or;
- Hazardous.

The Environment Agency's Hazardous Waste Technical Guidance (WM2) document outlines the methodology for classifying wastes.

Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

Based on a risk phrase analysis of the chemical laboratory test results, in accordance with EC Hazardous Waste Directive and undertaken by Ground and Water Limited, the Made Ground encountered on-site was **NON-HAZARDOUS.** The results of the assessment are given within Appendix F.

INERT waste classification should be undertaken to determine if the proposed waste confirms to INERT or NON-HAZARDOUS Waste Acceptable Criteria (WAC).

It is important to note that whilst we consider our in-house assessment tool to be an accurate interpretation of the requirements of WM2, therefore producing an initial classification in accordance with the guidance, landfill operators have their own assessment tools and can often come to different conclusions. As a result, some landfill operators could refuse to take apparently suitable waste. It is recommended that the receiving landfill views the results of this assessment and the chemical laboratory results to determine their own classification.

6.10 Imported Material

Any soil which is to be imported onto the site must undergo chemical analysis to prove that it is suitable for the purpose for which it is intended.

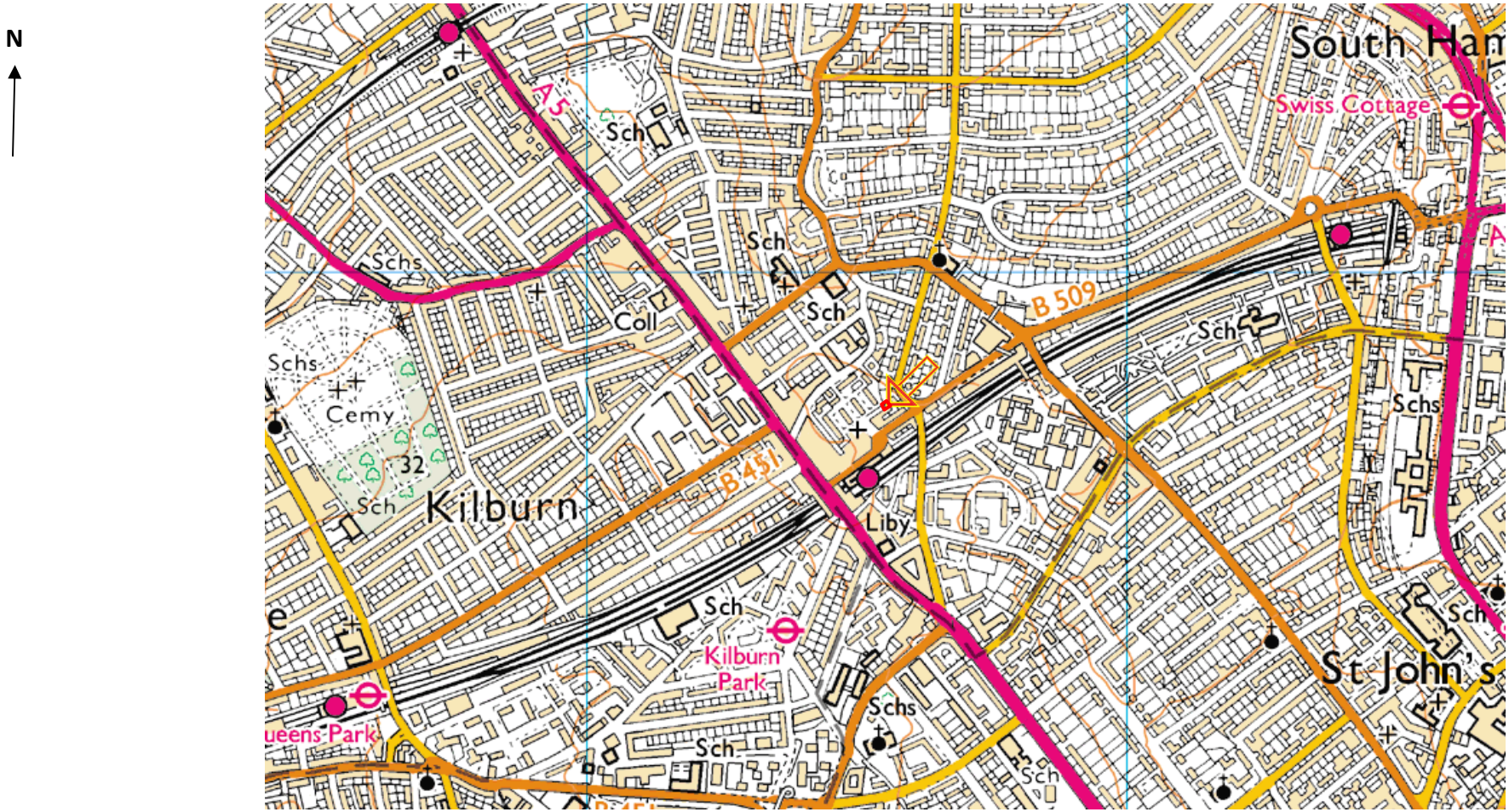
The Topsoil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, either prior to placing (ideally) or after placing, to ensure that the human receptor cannot come into contact with compounds that could be detrimental to human health.

6.11 Duty of Care

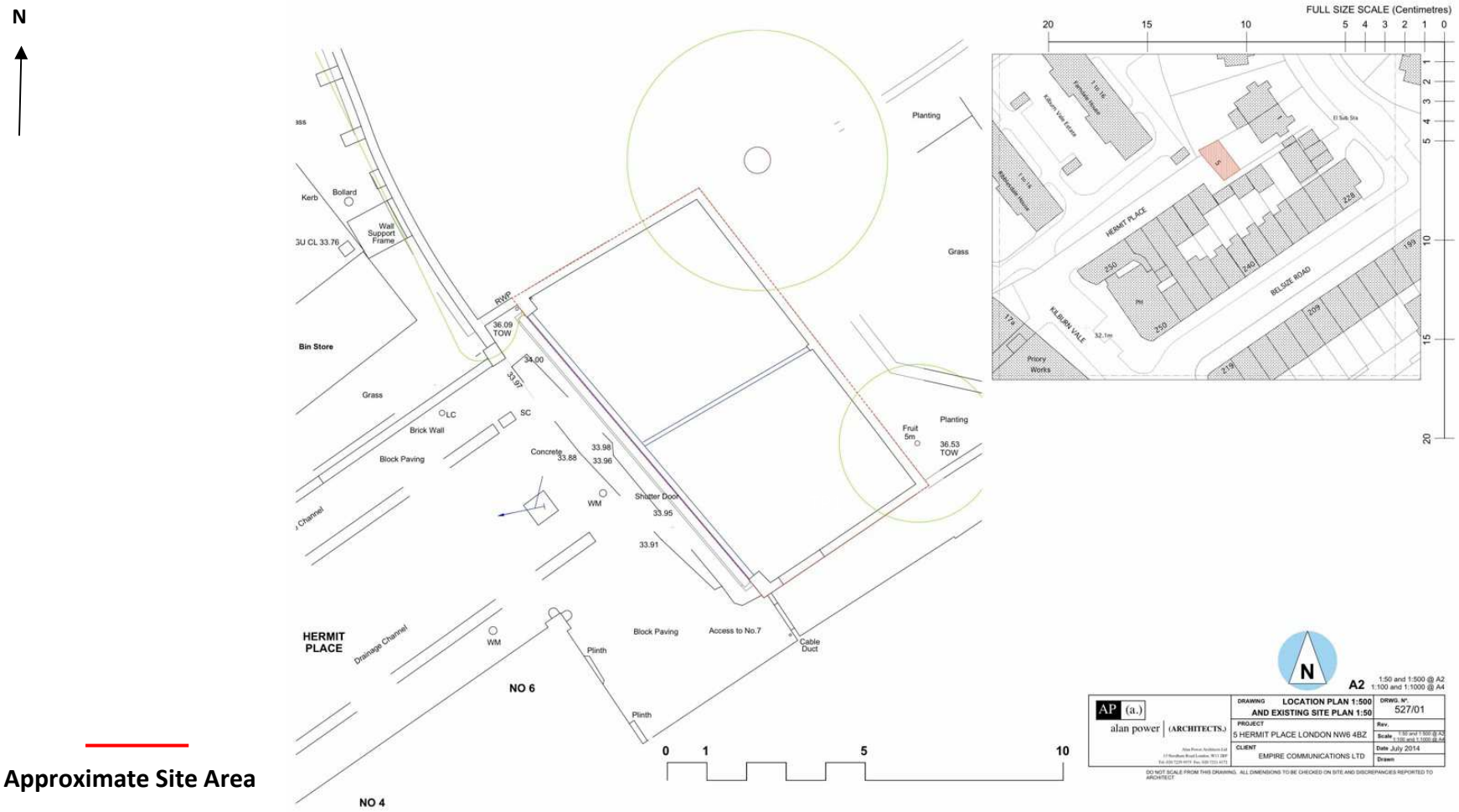
Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust were generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.



Project: 5 Hermit Place, Kilburn, London NW6 4BZ		**Figure 1**
Client: Castle Trading Ltd c/o Michael Blacker Partnership	**Date:** December 2014	ground&water
Site Location Plan	**Ref:** GWPR1098	



Approximate Site Area

NOT TO SCALE

Project: 5 Hermit Place, Kilburn, London NW6 4BZ	**Figure 2**
Client: Castle Trading Ltd c/o Michael Blacker Partnership	**Date:** December 2014
Site Development Area	**Ref:** GWPR1098

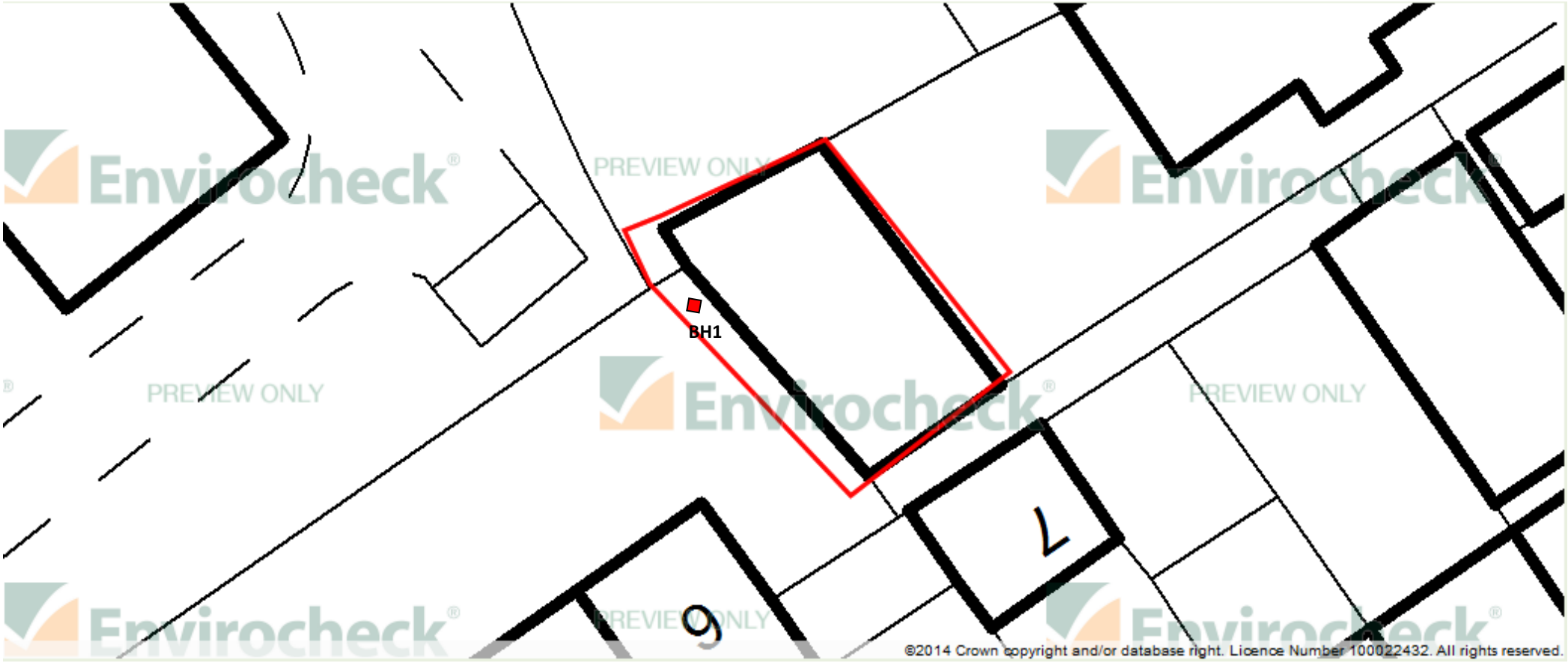
ground&water

N

Approximate Site Area

NOT TO SCALE

Project: 5 Hermit Place, Kilburn, London NW6 4BZ		**Figure 3**
Client: Castle Trading Ltd c/o Michael Blacker Partnership	**Date:** December 2014	ground&water
Aerial View of the Site	**Ref:** GWPR1098	



Key:

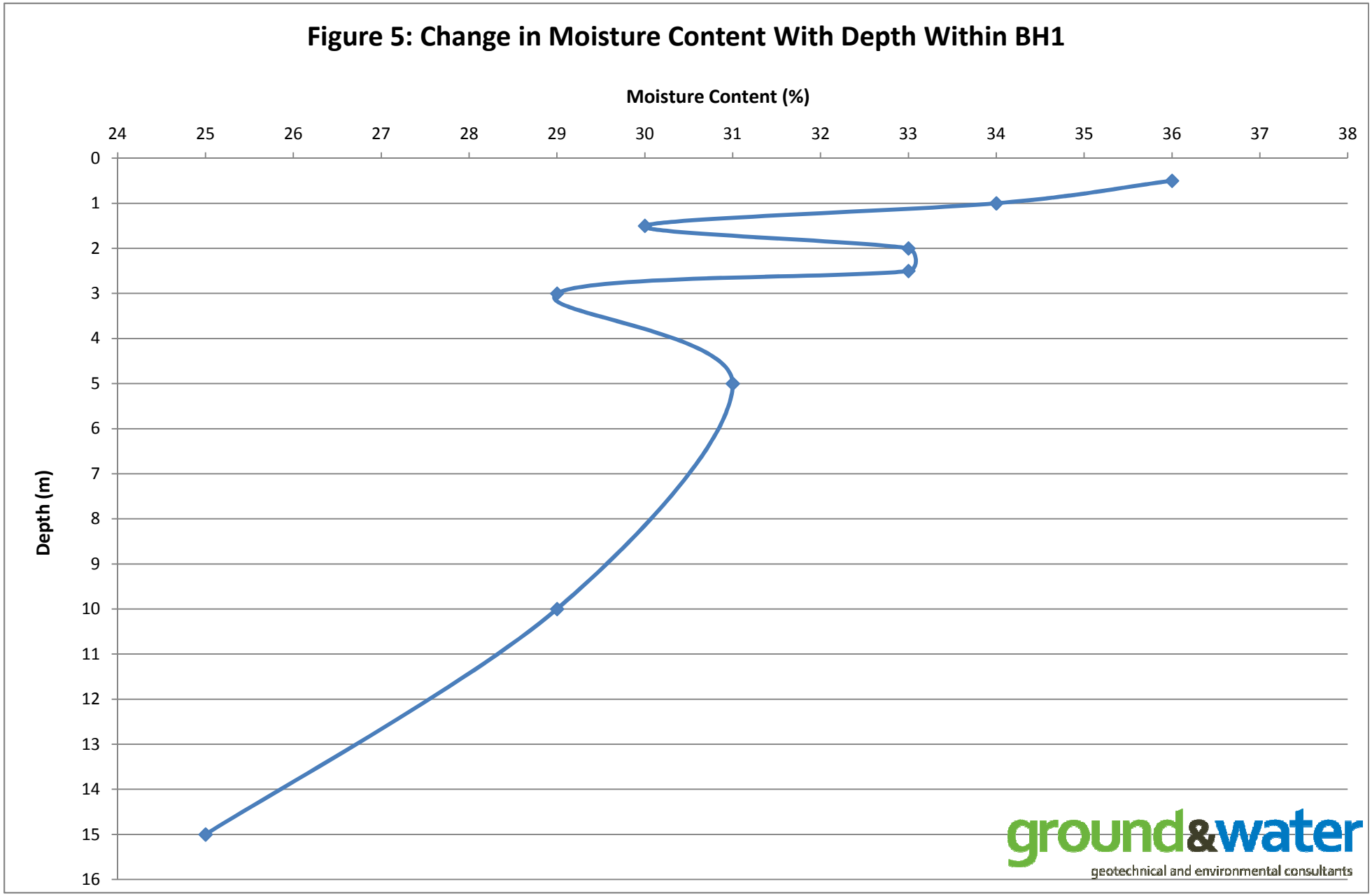
BH1 Windowless Sampler Borehole

Approximate Site Area

NOT TO SCALE

Project: 5 Hermit Place, Kilburn, London NW6 4BZ		Figure 4
Client: Castle Trading Ltd c/o Michael Blacker Partnership	Date: December 2014	ground&water
Trial Hole Location Plan	Ref: GWPR1098	

Figure 5: Change in Moisture Content With Depth Within BH1



APPENDIX A
Conditions and Limitations

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief; as such these do not necessarily address all aspects of ground behaviour at the site. No liability is accepted for any reliance placed on it by others unless specifically agreed in writing.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

This report is based on readily available geological records, the recorded physical investigation, the strata observed in the works, together with the results of completed site and laboratory tests. Whilst skill and care has been taken to interpret these conditions likely between or below investigation points, the possibility of other characteristics not revealed cannot be discounted, for which no liability can be accepted. The impact of our assessment on other aspects of the development required evaluation by other involved parties.

The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous in ground activities. The ground conditions have been samples or monitored in recorded locations and tests for some of the more common chemicals generally expected. Other concentrations of types of chemicals may exist. It was not part of the scope of this report to comment on environment/contaminated land considerations.

The conclusions and recommendations relate to 5 Hermit Place, Kilburn, London NW6 4BZ.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sampler borehole implies the specific technique used to produce a trial hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

APPENDIX B
Fieldwork Logs

ground &water
geotechnical and environmental consultants

Ground and Water Ltd
Tel: 0333 600 1221
email: enquiries@groundandwater.co.uk
www.groundandwater.co.uk

Borehole No
BH1
Sheet 1 of 2

Project Name	Project No.	Co-ords: -	Hole Type
5 Hermit Place	GWPR1098		WS
Location: London NW6 4BZ		Level: -	Scale 1:50
Client: Castle Trading Ltd		Dates: 24/11/2014	Logged By FW

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
					0.25			CONCRETE
		0.30	D		0.40			MADE GROUND: Dark brown slightly clayey gravelly sand to sandy gravel. Sand is fine to coarse grained. Gravel is fine to coarse, sub-angular to sub-rounded, occasional to abundant flint, brick and concrete.
		0.50	D					
		0.80	D					
		1.00	SPT	N=4 (1,1/ 1,1,1,1)				LONDON CLAY FORMATION: Orange brown to mid brown silty CLAY with rare grey to blue grey mottling. Rare silt and fine sand lenses and selenite crystals noted from ~3.00m bgl.
		1.00	D					
		1.50	D					
		2.00	SPT	N=6 (1,1/ 1,1,2,2)				
		2.00	D					
		2.50	D					
		3.00	SPT	N=11 (2,2/ 2,3,3,3)				
		3.00	D					
		3.50	D					
		4.00	SPT	N=15 (2,2/ 3,3,4,5)				
		4.00	D					
		4.50	D					
		5.00	SPT	N=16 (3,3/ 4,4,4,4)				
		5.00	D					
		5.50	D					
					5.80			LONDON CLAY FORMATION: Mid brown silty CLAY becoming dark brown with depth. Rare orange silt and fine sand lenses noted.
		6.00	SPT	N=17 (4,3/ 4,4,4,5)				
		6.00	D					
		6.50	D					
		7.00	SPT	N=18 (4,4/ 4,4,5,5)				
		7.00	D					
		7.50	D					
		8.00	SPT	N=19 (4,4/ 5,5,4,5)				
		8.00	D					
		8.50	D					
		9.00	SPT	N=22 (4,5/ 5,5,6,6)				
		9.00	D					
		9.50	D					
		Type		Results				

Continued next sheet

Remarks: No groundwater encountered.
50mm combined bio-gas and groundwater installation to 5.0m bgl.
Roots noted to ~1.50m bgl.

AGS

ground &water
geotechnical and environmental consultants

Ground and Water Ltd
Tel: 0333 600 1221
email: enquiries@groundandwater.co.uk
www.groundandwater.co.uk

Borehole No
BH1
Sheet 2 of 2

Project Name	Project No.	Co-ords: -	Hole Type
5 Hermit Place	GWPR1098		WS
Location: London NW6 4BZ		Level: -	Scale 1:50
Client: Castle Trading Ltd		Dates: 24/11/2014	Logged By FW

Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		10.00	SPT	N=25				LONDON CLAY FORMATION: Mid brown silty CLAY becoming dark brown with depth. Rare orange silt and fine sand lenses noted.
		10.00	D	(5,5/ 6,6,6,7)				
		10.50	D					
					10.90			
		11.00	SPT	N=27				LONDON CLAY FORMATION: Dark grey silty CLAY with shell fragments and selenite crystals.
		11.00	D	(5,6/ 6,7,7,7)				
		11.50	D					
		12.00	SPT	N=28				
		12.00	D	(6,5/ 7,7,7,7)				
		12.50	D					
		13.00	SPT	N=34				
		13.00	D	(6,7/ 9,9,8,8)				
		13.50	D					
		14.00	SPT	N=35				
		14.00	D	(7,8/ 8,9,9,9)				
		14.50	D					
		15.00	SPT	N=35				
		15.00	D	(7,9/ 8,9,9,9)				
					15.45			End of Borehole at 15.45 m
			Type	Results				

Remarks: No groundwater encountered.
50mm combined bio-gas and groundwater installation to 5.0m bgl.
Roots noted to ~1.50m bgl.

AGS

APPENDIX C
Geotechnical Laboratory Test Results

Project Name:	5 Hermit Place, London			**Samples Received:**	03/12/2014
				Project Started:	04/12/2014
Client:	Ground and Water Ltd			**Testing Started:**	10/12/2014
Project No:	GWPR1098	**Our job/report no:**	17954	**Date Reported:**	11/12/2014

K4 SOILS

Borehole No:	Sample No:	Depth (m)	Description	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Passing 0.425 mm (%)	Remarks
BH1	-	0.50	Brown silty CLAY with rare fm sub-angular gravel	36					
BH1	-	1.00	Orange brown slightly mottled grey silty CLAY	34	85	30	55	100	
BH1	-	1.50	Brown and occasional grey silty CLAY with traces of decayed rootlets	30					
BH1	-	2.00	Brown and occasional grey silty CLAY	33					
BH1	-	2.50	Orange brown slightly mottled blue grey silty CLAY	33	84	29	55	100	
BH1	-	3.00	Brown and occasional grey silty CLAY with traces of selenite crystals	29					
BH1	-	5.00	Orange brown silty CLAY	31	79	28	51	100	
BH1	-	10.00	Brown silty CLAY with traces of selenite crystals	29	83	28	55	100	
BH1	-	15.00	Dark grey silty CLAY	25	85	27	58	100	

UKAS TESTING 2519

Summary of Test Results

BS 1377 : Part 2 : Clause 4.4 : 1990 Determination of the liquid limit by the cone penetrometer method.

BS 1377 : Part 2 : Clause 5 : 1990 Determination of the plastic limit and plasticity index.

BS 1377 : Part 2 : Clause 3.2 : 1990 Determination of the moisture content by the oven-drying method.

Checked and Approved

Initials: K.P

Date: 11/12/2014

Client name & address:			**Samples Received**	03/12/2014	**K4 SOILS**
Ground and Water Ltd			**Project Started**	04/12/2014	
Project Name:	5 Hermit Place, London		**Testing Started**	10/12/2014	
Project No:	GWPR109	**Our Job / report no:** 17954	**Date Reported:**	19/12/2014	
Sample description:			**Sample no/ type:**	U	**BH no:** BH1
Brown slightly mottled blue grey CLAY with occasional yellow silt pockets and rootlets					**Depth (m):** 3.50

Test details

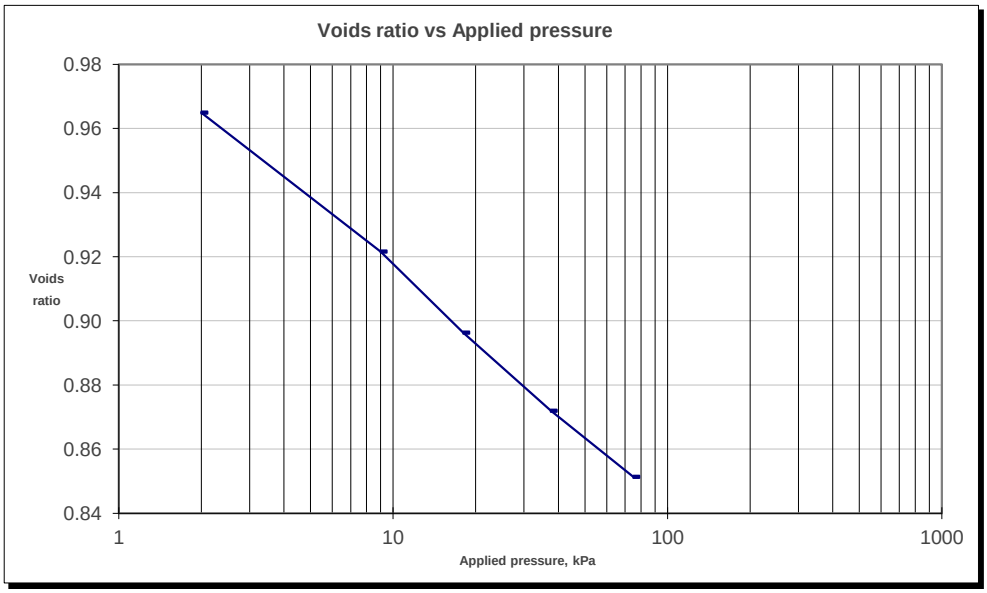
Depth within original sample m : 3.60 Orientation within original sample : Vertical

Specimen details

		Initial	Final
Height	mm :	15.81	16.78
Diameter	mm :	75	-
Bulk density	Mg/m3 :	1.95	1.91
Moisture content	% :	31	37
Dry density	Mg/m3 :	1.48	1.39
Voids Ratio	:	0.85	0.97
Degree of saturation	% :	101.2	-
Particle density	Mg/m3 :	2.74	-
Swelling pressure	kPa :	75	-

Consolidation Stage

Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN	Stage number	Applied Pressure kPa	Voids Ratio	Coefficient of Consolidation m2/year	Coefficient of Compressibility m2/MN
1	75	0.8514	-	-	11				
2	38	0.8720	0.12	0.297	12				
3	18	0.8963	0.16	0.667	13				
4	9	0.9216	0.17	1.482	14				
5	2	0.9650	0.11	3.221	15				
6					16				
7					17				
8					18				
9					19				
10					20				



UKAS TESTING 2519

One-Dimensional Consolidation Test

BS 1377 : Part 5 : Clause 3 & 4 : 1990

Determination of the one-dimensional consolidation properties

Approved by

Initials : kp

Date : 19/12/2014

Project Name:	5 Hermit Place, London		
Client:	Ground and Water Ltd	Project no:	GWPR1098
		Our job no:	17954

K4 SOILS

Borehole No:	Sample No:	Depth m	Description	pH	Sulphate content (g/l)
BH1	-	1.50	Brown and occasional grey silty CLAY with traces of decayed rootlets	7.9	0.52
BH1	-	3.00	Brown and occasional grey silty CLAY with traces of selenite crystals	7.7	2.74

Date 11/12/2014

Summary of Test Results

BS 1377 : Part 3 :Clause 5 : 1990

Determination of sulphate content of soil and ground water : gravimetric method

Checked and Approved

Initials : kp

Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU

APPENDIX D
Chemical Laboratory Test Results

Francis Williams
Ground & Water Ltd
2 The Long Barn
Norton Farm
Selborne Road
Alton
Hampshire
GU34 3NB

QTS Environmental Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 14-27022

Site Reference:	5 Hermit Place, London NW6
Project / Job Ref:	GWPR1098
Order No:	None Supplied
Sample Receipt Date:	03/12/2014
Sample Scheduled Date:	03/12/2014
Report Issue Number:	1
Reporting Date:	09/12/2014

Authorised by:

Russell Jarvis
Director
On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Director
On behalf of QTS Environmental Ltd

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Kent ME17 2JN
Tel : 01622 850410

mCERTS THE ENVIRONMENT AGENCY'S MONITORING CERTIFICATION SCHEME

UKAS TESTING 4480

Soil Analysis Certificate							
QTS Environmental Report No: 14-27022	**Date Sampled**	02/12/14	02/12/14			
Ground & Water Ltd	**Time Sampled**	None Supplied	None Supplied			
Site Reference: 5 Hermit Place, London NW6	**TP / BH No**	BH1	BH1			
Project / Job Ref: GWPR1098	**Additional Refs**	None Supplied	None Supplied			
Order No: None Supplied	**Depth (m)**	0.30	7.00			
Reporting Date: 09/12/2014	**QTSE Sample No**	127905	127906			

Determinand	Unit	RL	Accreditation					
Asbestos Screen	N/a	N/a	ISO17025	Not Detected				
pH	pH Units	N/a	MCERTS	9.2	8.4			
Total Cyanide	mg/kg	< 2	NONE	< 2				
Total Sulphate as SO_4	mg/kg	< 200	NONE		2733			
W/S Sulphate as SO4 (2:1)	g/l	< 0.01	MCERTS	0.12	0.71			
Total Sulphur	mg/kg	< 200	NONE		679			
Organic Matter	%	< 0.1	NONE	0.2				
Total Organic Carbon (TOC)	%	< 0.1	NONE	0.1				
Ammonium as NH_4	mg/kg	< 0.5	NONE		8.4			
W/S Chloride (2:1)	mg/kg	< 1	MCERTS		218			
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	MCERTS		63			
Arsenic (As)	mg/kg	< 2	MCERTS	9				
W/S Boron	mg/kg	< 1	NONE	< 1				
Cadmium (Cd)	mg/kg	< 0.5	MCERTS	2				
Chromium (Cr)	mg/kg	< 2	MCERTS	43				
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2				
Copper (Cu)	mg/kg	< 4	MCERTS	103				
Lead (Pb)	mg/kg	< 3	MCERTS	669				
W/S Magnesium	g/l	< 0.0001	NONE		0.0159			
Mercury (Hg)	mg/kg	< 1	NONE	< 1				
Nickel (Ni)	mg/kg	< 3	MCERTS	38				
Selenium (Se)	mg/kg	< 3	NONE	< 3				
Vanadium (V)	mg/kg	< 2	NONE	61				
Zinc (Zn)	mg/kg	< 3	MCERTS	397				
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2				

Analytical results are expressed on a dry weight basis where samples are dried at less than $30^{O}C$

Analysis carried out on the dried sample is corrected for the stone content

The samples have been examined to identify the presence of asbestiform minerals by polarising light microscopy and dispersion staining technique to In-House Procedures QTSE600 Determination of Asbestos in Bulk Materials; Asbestos in Soils/Sediments (fibre screening and identification)

This report refers to samples as received, and QTS Environmental Ltd, takes no responsibility for the accuracy or competence of sampling by others.

The material description shall be regarded as tentative and is not included in our scope of UKAS Accreditation.

Opinions and interpretations expressed herein are outside the scope of UKAS Accreditation.

Asbestos Analyst: Graham Revell

RL: Reporting Limit

Pinch Test: Where pinch test is positive it is reported "Loose Fibres - PT" with type(s).

Subcontracted analysis $^{(S)}$

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Soil Analysis Certificate - Speciated PAHs							
QTS Environmental Report No: 14-27022	**Date Sampled**	02/12/14					
Ground & Water Ltd	**Time Sampled**	None Supplied					
Site Reference: 5 Hermit Place, London NW6	**TP / BH No**	BH1					
Project / Job Ref: GWPR1098	**Additional Refs**	None Supplied					
Order No: None Supplied	**Depth (m)**	0.30					
Reporting Date: 09/12/2014	**QTSE Sample No**	127905					

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1				
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1				
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1				
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1				
Phenanthrene	mg/kg	< 0.1	MCERTS	0.31				
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1				
Fluoranthene	mg/kg	< 0.1	MCERTS	0.71				
Pyrene	mg/kg	< 0.1	MCERTS	0.61				
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	0.36				
Chrysene	mg/kg	< 0.1	MCERTS	0.38				
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	0.47				
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	0.16				
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	0.36				
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	0.29				
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1				
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	0.36				
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	4				

Analytical results are expressed on a dry weight basis where samples are dried at less than 30^{O}C

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Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 14-27022	
Ground & Water Ltd	
Site Reference: 5 Hermit Place, London NW6	
Project / Job Ref: GWPR1098	
Order No: None Supplied	
Reporting Date: 09/12/2014	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
127905	BH1	None Supplied	0.30	14.5	Brown loamy gravel with rubble
127906	BH1	None Supplied	7.00	19.4	Brown clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

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Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 14-27022
Ground & Water Ltd
Site Reference: 5 Hermit Place, London NW6
Project / Job Ref: GWPR1098
Order No: None Supplied
Reporting Date: 09/12/2014

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	TPH LQM	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6 - C10)	Determination of hydrocarbons C6-C10 by headspace GC-MS	E001

D Dried
AR As Received

Appendix E
Soil Assessment Criteria

Appendix E
Soil Guideline Values and Genera Assessment Criteria

E1 Assessment Criteria

The Contaminated Land Regime reflects the UK Government's stated objectives of achieving sustainable development through the 'suitable for use approach'.

E1.1 Contaminated Land Exposure Assessment Model (CLEA)

Current United Kingdom risk assessment practice is based on the Contaminated Land Exposure Assessment Model (CLEA).

The CLEA Guidance comprises the following documents:

1) EA Science Report SC050021/SR2: *Human health toxicological assessment of contaminants in soil.*
2) EA Science Report SC050021/SR3: *Updated technical background to the CLEA model.*
3) EA CLEA Bulletin (2009).
4) CLEA software version 1.06 (2009)
5) Toxicological reports and SGV technical notes.

The CLEA guidance and tools:

- *do not cover other types of risk to humans, such as fire, suffocation or explosion, or short-term and acute exposures.*
- *do not cover risks to the environment, such as groundwater, ecosystems or buildings.*
- *do not provide a definitive test for telling when human health risks are significant.*
- *are not a legal requirement in assessing land contamination risks. They are not part of the legal regime for Part 2A of the Environmental Protection Act 1990.*

The CLEA guidance derives soil concentrations of contaminants above which (in the opinion of the EA) there may be a concern that warrants further investigation. It does not provide a definitive test for establishing that the risk is significant.

E1.2 Land-use Scenarios

The CLEA model uses a range of standard land-use scenarios to develop conceptual exposure models as follows:

1 Residential

Generic scenario assumes a typical two-storey house built on a ground bearing slab with a private garden having a lawn, flowerbeds and a small fruit and vegetable patch.

- Critical receptor is a young female child (zero to six years old)
- Exposure duration is six years.
- Exposure pathways include direct soil and indoor dust ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and indoor dust and inhalation of indoor and outdoor dust and vapours.
- Building type is a two-storey small terraced house.

A sub-set of this land-use is residential apartments with communal landscaped gardens where the consumption of home grown vegetables will not occur.

2) Allotments

Provision of open space (about 250sq.m) commonly made available to tenants by the local authority to grow fruit and vegetable for their own consumption. Typically, there are a number of plots to a site which may have a total area of up to 1 hectare. The tenants are assumed to be adults and that young children make occasional accompanied visits.

Although some allotment holders may choose to keep animals including rabbits, hens, and ducks, potential exposure to contaminated meat and eggs is not considered.

- Critical receptor is a young female child (zero to six years old)
- Exposure duration is six years.
- Exposure pathways include direct soil ingestion, consumption of homegrown produce and any adhering soil, skin contact with soils and inhalation of outdoor dust and vapours.
- There is no building.

3) Commercial/Industrial

The generic scenario assumes a typical commercial or light industrial property comprising a three-storey building at which employees spend most time indoors and are involved in office-based or relatively light physical work.

- Critical receptor is a working female adult (aged 16 to 65 years old).
- Exposure duration is a working lifetime of 49 years.
- Exposure pathways include direct soil and indoor dust ingestion, skin contact with soils and dusts and inhalation of dust and vapours.
- Building type is a three-storey office (pre 1970).

E1.3 Soil Guideline Values

The EA are publishing a series of SGV reports for a selection of common contaminants relevant to the assessment of land contamination.

SGV's are generic assessment criteria based on CLEA standard land-uses and can be used to simplify the assessment of human health risks from long-term exposure to chemical contamination in soil. They do not cover short-term exposure (i.e. construction and maintenance workers), acute exposure or other

risks such as fire, suffocation or explosion, as might arise from an accumulation of gases such as methane and carbon dioxide, or either odour or aesthetic issues.

SGV's represent 'trigger values', indicators that soil concentrations above the SGV level may pose a possibility of *significant harm* to human health. The converse, where soil concentrations are less that the SGV, is that the long-term human health risks are considered to be tolerable or minimal.

E1.4 Generic Assessment Criteria

If an SGV is not available for a substance identified in the soil then the range of Generic Assessment Criteria published from a collaborative research by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health or CL:AIRE, the Environment Industries Commission (EIC) and The Association of Geotechnical and Geo-environmental Specialists (AGS) will be used:

For derivation of these Generic Assessment Criteria reference must be made to:

Nathanial, P., McCaffrey, C., Ashmore, M., Cheng, Y., Gillet, A., Ogden, R., Scott, D. *The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment (2nd edition)*. **Land Quality Press**. 2009.

CL:AIRE, *The Soil Generic Assessment Criteria for Human Health Risk Assessment.* **Contaminated Land: Applications in the Real Environment**. 2009.

In the case of Lead, no SGV or GAC has been published to date. This is likely to be due to the toxicity review that is currently being undertaken by the Environment Agency. In the absence of updated toxicity information the SGV derived using CLEA 1.01 methodology and related toxicity will be used.

E1.5 Detailed Quantitative Risk Assessments (DQRA)

Where the adoption of an SGV/GAC is not appropriate, for instance when the intended land-use is at variance the CLEA standard land-uses then a DQRA may be undertaking to develop site specific values for relevant soil contaminants.

⇒ Establishing the plausibility that generic exposure pathways exist in practice by measurement and observation.

⇒ Developing more accurate parameters using site data.

E1.6 Ongoing development of CLEA based guidance

The EA is involved in a programme of publishing SGV's and related toxicity data (the TOX reports). As at July 2009 ten SGV's and matching TOX reports had been published.

Soil Assessment Criteria (SAC's) may be derived using toxicity data from the updated TOX reports, where these are published, or from the original TOX reports. SGV reports also take account of recent updates for plant uptake and other factors.

⇒ GAC's developed by CLEA guidance and given in this report will need to be assessed against updated TOX reports and SGV's when these are published.

⇒ SGV reports may give values that differ from the GAC's used in this report.

⇒ These variations may materially alter the remediation requirement for the site, requiring either an increase or decrease in the extent, type and cost of remediation.

E1.7 Phytotoxicity

CLEA guidance only addresses human health toxicity; assessment of plant toxicity (phytotoxicity) is based on threshold trigger values obtained from the following source:

- ICRCL 70/90: *Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing*.

E1.8 Statistical Tests

DEFRA R&D Publication CLR 7 (DOE 1994) addressed the statistical treatment of test results and their comparison to Soil Guideline Values.

Consideration must be given to the appropriate area of land to be considered termed the critical averaging area.

For a communal open space or commercial land-use, the critical averaging area will depend on the proposed layout. For a residential use with private gardens the averaging area is the individual plot.

It may be appropriate to compare the upper 95th percentile concentration with the Soil Guideline Value, subject to applying a statistical test to establish that the range of concentrations are reasonably consistent and belonging to the same underlying distribution of data.

The DEFRA discussion paper Assessing risks from land contamination – a proportionate approach ('the way forward') (CLAN06/2006) aimed to increase understanding of the role that statistics can play in quantifying the uncertainty attached to the estimates of the mean concentration of contaminants in soil. In direct response CLAIRE/CIEH published a joint report, *Guidance in comparing soil contamination data with a critical concentration* (CLAIRE/CIEH 2008). A software implementation of the statistical techniques given in the report was published by ESI International (2008).

Treatment of Hot-Spots

⇒ A statistical test is applied to establish whether the data is a part of a single set, or whether data outliers are present.

⇒ Provided that the data is based on random sampling and no distinct contamination source was present at the sampling location, the hot-spot(s) may be excluded and the mean of the remaining data assessed.

E2.1 Category 4 **Screening Levels (C4SLs)**

The overall objective of the C4SLs research project has been to assist the provision of technical guidance in support of Defra's revised Statutory Guidance (SG) for

Part 2A of the Environmental Protection Act 1990 (Part 2A) (Defra, 2012a). Specifically, the project aimed to deliver:

• A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and

• A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

To help achieve a more targeted approach to identifying and managing contaminated land in relation to the risk (or possibility) of harm to human health, the revised SG presented a new four category system for considering land under Part 2A, ranging from Category 4, where there is no risk that land poses a significant possibility of significant harm (SPOSH), or the level of risk is low, to Category 1, where the risk that land poses a significant possibility of significant harm (SPOSH) is unacceptably high. More specific guidance on what type of land should be considered as Category 4 (Human Health) is provided in Paragraphs 4.21 and 4.22 of the revised SG, as follows:

"4.21 The local authority should consider that the following types of land should be placed into Category 4: Human Health:

(a) Land where no relevant contaminant linkage has been established.

(b) Land where there are only normal levels of contaminants in soil, as explained in Section 3 of this Guidance.

(c) Land that has been excluded from the need for further inspection and assessment because contaminant levels do not exceed relevant generic assessment criteria in accordance with Section 3 of this Guidance, or relevant technical tools or advice that may be developed in accordance with paragraph 3.30 of this Guidance.

(d) Land where estimated levels of exposure to contaminants in soil are likely to form only a small proportion of what a receptor might be exposed to anyway through other sources of environmental exposure (e.g. in relation to average estimated national levels of exposure to substances commonly found in the environment, to which receptors are likely to be exposed in the normal course of their lives).

4.22 The local authority may consider that land other than the types described in paragraph 4.21 should be placed into Category 4: Human Health if following a detailed quantitative risk assessment it is satisfied that the level of risk posed is sufficiently low."

The C4SLs are intended as "relevant technical tools" (in relation to Paragraph 4.21(c)) to help local authorities and others when deciding to stop further assessment of a site, on the grounds that it falls within Category 4 (Human Health).

The Impact Assessment (IA), which accompanied the revised SG (Defra, 2012b) provides further information on the nature and potential role of the C4SLs. Paragraph 47(h) of the IA states that:

"The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary)

Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land."

A key distinction between the Soil Guideline Values (SGVs) and the C4SLs is the level of risk that they describe. As described by the Environment Agency (2009a):
"SGVs are guidelines on the level of long-term human exposure to individual chemicals in soil that, unless stated otherwise, are tolerable or pose a minimal risk to human health."

The implication of Paragraph 47(h) of the IA (see above) is that minimal risk is well within Category 4 and that the C4SLs should describe a higher level of risk which, whilst not minimal, can still be considered low enough to allow a judgement to be made that land containing substances at, or below, the C4SLs would typically fall within Category 4. This reflects Paragraph 4.20 of the revised SG, which states:

"4.20 The local authority should not assume that land poses a significant possibility of significant harm if it considers that there is no risk or that the level of risk posed is low. For the purposes of this Guidance, such land is referred to as a "Category 4: Human Health" case. The authority may decide that the land is a Category 4: Human Health case as soon as it considers it has evidence to this effect, and this may happen at any stage during risk assessment including the early stages."

C4SLs, therefore, should not be viewed as "SPOSH levels" and they should not be used as a legal trigger for the determination of land under Part 2A.

The generic screening values referred to before usually take the form of risk-based Soil Guideline Values (SGVs) or other Generic Assessment Criteria (GACs) that are most typically derived using the Environment Agency's Contaminated Land Exposure Assessment (CLEA) model, as described in the Environment Agency's SR2, SR3 and SR7 reports (EA, 2009b & c; EA, 2008). It is anticipated that C4SLs will be used in a similar manner; as generic screening criteria that can be used within a GQRA, albeit describing a higher level of risk than the SGVs.

The suggested approach to the development of C4SLs consists of the retention and use of the CLEA framework, modified according to considerations of the underlying science within the context of Defra's policy objectives relating to the revised SG. Within this context, it is suggested that the development of C4SLs may be achieved in one of three ways, namely:
• By modifying the toxicological parameters used within CLEA (while maintaining current exposure parameters);
• By modifying the exposure parameters embedded within CLEA (while maintaining current toxicological "minimal risk" interpretations); and
• By modifying both toxicological and exposure parameters.

There is also a suggested check on "other considerations" (e.g., background levels, epidemiological data, sources of uncertainty) within the approach, applicable to all three options.

It is suggested that a new term is defined for the toxicological guidance values associated with the derivation of C4SLs – a Low Level of Toxicological Concern (LLTC). A LLTC should represent an intake of low concern that remains suitably

protective of health, and definitely does not approach an intake level that could be defined as SPOSH.

E2 Soil Guideline Values, General Acceptance Criteria and C4SL LLTC's

Soil Guideline Values, General Acceptance Criteria and C4SL LLTC's used in the preparation of this report is tabulated in the following pages:

DEFRA CLEA 1.04 Soil Guideline Values (as at January 2011)

Soil Guideline Values CLEA 1.06 (Sandy Loam, pH 7, SOM 6%)			
Contaminant	**Residential (mg/kg DW)**	**Allotments (mg/kg DW)**	**Commercial (mg/kg DW)**
Inorganic			
Arsenic	32	43	640
Cadmium	10	1.8	230
Mercury			
- Elemental	1.0	26	26
- Inorganic	170	80	3600
- Methyl	11	8	410
Nickel	130	230	1800
Selenium	350	120	13000
Organic May not be protective if SOM <6%			
Phenol	420	280	3200 (38,000*)
Benzene	0.33	0.07	95
Toluene	610	120	4400
Ethylbenzene	350	90	2800
Xylenes			
- o-xylene	250	160	2600
-m-xylene	240	180	3500
-p-xylene	230	160	3200
Dioxins, Furans and Diozin-like PCB's**	0.008	0.008	0.24

* Based on a threshold protective of direct skin contact with phenol (guideline in brackets based on health affects following long term exposure provided for illustration only)

**SGV should be compared with the sum of the soil concentration of all congeners – Table 2 Science Report SC050021/Dioxins SGV.

Cont'd Overleaf:

C4SL Low Level of Toxicological Concern

C4SL Low Level of Toxicological Concern						
Contaminant	**Residential With Plant Uptake (mg/kg)**	**Residential Without Plant Uptake (mg/kg)**	**Commercial & Industrial (mg/kg)**	**Allotments (mg/kg)**	**Public Open Space (Residential)**	**Public Open Space (Park)**
Lead	<210	<330	<6000	<84	<760	<1400
Benzo(a)pyrene (HCV with suggested changes to exposure parameters)	2.4	2.5	36	2.7	4.9	10
Benzo(a)pyrene (LLTCs with no changes to exposure parameters)	3.2	3.4	76	5.1	N/A	N/A
Benzo(a)pyrene (LLTCs with suggested changes to exposure parameters)	5.0	5.3	76	5.7	10	21

LQM CIEH General Assessment Criteria (2nd edition)

LQM CIEH General Assessment Criteria			
Contaminant	**Residential (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Metals:			
Beryllium	51	55	420
Boron	291	45	192000
Chromium (III)	3000	34600	30400
Chromium (VI)	4.3	2.1	35
Copper	2330	524	71700
Vanadium	75	18	3160
Zinc	3750	618	665000

CL:AIRE Soil Generic Assessment Criteria				
Contaminant	**Residential (mg/kg)**	**Residential without plant uptake (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Metals:				
Antimony	ND	550	ND	7500
Barium	ND	1300	ND	22000
Molybdenum	ND	670	ND	17000

Cont'd Overleaf:

Phytotoxicity Recommendations

ICRCL 70/90 ***Restoration of metalliferous mining areas***

Phytotoxicity (Harmful to Plants) Threshold Trigger Values	
Copper	250mg/kg
Zinc	1000mg/kg
Notes: Many cultivars and specifically grasses have a high tolerance and there will be no ill-effect at the threshold trigger values given for neutral or near neutral pH. Site observation of plant vitality may give additional guidance.	

General Assessment Criteria For Polycyclic Aromatic Hydrocarbons (PAH's)

Determinants		Residential (mg/kg)	Allotments (mg/kg)	Commercial (mg/kg)
Acenapthene	1.0% SOM	210	34	85,000 (57) [sol]
	2.5% SOM	480	85	98,000 (141) [sol]
	6.0% SOM	100	200	100,000
Acenapthylene	1.0% SOM	170	28	84,000 (86) [sol]
	2.5% SOM	400	69	97,000 (212) [sol]
	6.0% SOM	850	160	100,000
Anthracene	1.0% SOM	2,300	380	530,000
	2.5% SOM	4,900	950	540,000
	6.0% SOM	9,200	2200	540,000
Benzo(a)anthracene	1.0% SOM	3.1	2.5	90
	2.5% SOM	4.7	5.5	95
	6.0% SOM	5.9	10	97
Benzo(a)pyrene	1.0% SOM	0.83	0.6	14
	2.5% SOM	0.94	1.2	14
	6.0% SOM	1.0	2.1	14
Benzo(b)flouranthene	1.0% SOM	5.6	3.5	100
	2.5% SOM	6.5	7.4	100
	6.0% SOM	7.0	13	100
Benzo(ghi)perylene	1.0% SOM	44	70	650
	2.5% SOM	46	120	660
	6.0% SOM	47	160	660
Benzo(k)flouranthene	1.0% SOM	8.5	6.8	140
	2.5% SOM	9.6	14	140
	6.0% SOM	10	23	140
Chrysene	1.0% SOM	6.0	2.6	140
	2.5% SOM	8.0	5.8	140
	6.0% SOM	9.3	12	140
Dibenzo(ah)anthracene	1.0% SOM	0.76	0.76	13
	2.5% SOM	0.86	1.5	13
	6.0% SOM	0.90	2.3	13

Cont'd Overleaf:

General Assessment Criteria For Polycyclic Aromatic Hydrocarbons (PAH's) Cont'd

Determinants		Residential (mg/kg)	Allotments (mg/kg)	Commercial (mg/kg)
Flouranthene	1.0% SOM	260	52	23,000
	2.5% SOM	460	130	23,000
	6.0% SOM	670	290	23,000
Flourene	1.0% SOM	160	27	64,000 (31) [sol]
	2.5% SOM	380	67	69,000
	6.0% SOM	780	160	71,000
Indeno(123-cd)pyrene	1.0% SOM	3.2	1.8	60
	2.5% SOM	3.9	3.8	61
	6.0% SOM	4.2	7.1	62
Napthalene	1.0% SOM	1.5	4.1	200 (76) [sol]
	2.5% SOM	3.7	9.9	480 (183) [sol]
	6.0% SOM	8.7	23	1100 (432) [sol]
Phenanthrene	1.0% SOM	92	16	22,000
	2.5% SOM	200	38	22,000
	6.0% SOM	380	90	23,000
Pyrene	1.0% SOM	560	110	54,000
	2.5% SOM	1,000	270	54,000
	6.0% SOM	1,600	620	54,000

[vap] – GAC presented exceeds the vapour saturation limit, which is presented in brackets.
[sol] – GAC presented exceeds the soil saturation limit, which is presented in brackets.

LQM CIEH General Assessment Criteria (cont.)

General Assessment Criteria For TPH

Aliphatic		Residential (mg/kg)	Allotments (mg/kg)	Commercial (mg/kg)
EC 5-6	1.0% SOM	30	740	3,400 (304) [sol]
	2.5% SOM	55	1,700	6,200 (558) [sol]
	6.0% SOM	110	3,900	13,000 (1150) [sol]
EC >6-8	1.0% SOM	73	2,300	8,300 (144) [sol]
	2.5% SOM	160	5,600	18,000 (322) [sol]
	6.0% SOM	370	13,000	42,000 (736) [sol]
EC >8-10	1.0% SOM	19	320	2,100 (78) [sol]
	2.5% SOM	46	770	5,100 (118) [vap]
	6.0% SOM	110	1,700	12,000 (451) [vap]
EC >10-12	1.0% SOM	93 (48) [vap]	2,200	10,000 (48) [sol]
	2.5% SOM	230 (118) [vap]	4,400	24,000 (118) [vap]
	6.0% SOM	540 (283) [vap]	7,300	49,000 (283) [vap]
EC >12-16	1.0% SOM	740 (24) [sol]	11,000	61,000 (24) [sol]
	2.5% SOM	1,700 (59) [sol]	13,000	83,000 (59) [sol]
	6.0% SOM	3,000 (142) [sol]	13,000	91,000 (142) [sol]
EC >16-35	1.0% SOM	45,000 (8.48) [sol]	260,000	1,600,000
	2.5% SOM	64,000 (21) [sol]	270,000	1,800,000
	6.0% SOM	76,000	270,000	1,800,000
EC >35-44	1.0% SOM	45,000 (8.48) [sol]	260,000	1,600,000
	2.5% SOM	64,000 (21) [sol]	270,000	1,800,000
	6.0% SOM	76,000	270,000	1,800,000

Cont'd Overleaf:

General Assessment Criteria For TPH Cont'd

Aromatic		Residential (mg/kg)	Allotments (mg/kg)	Commercial (mg/kg)
EC 5-7	1.0% SOM	65	13	28,000 (1220) [sol]
	2.5% SOM	130	27	49,000 (2260) [sol]
	6.0% SOM	280	57	90,000 (4710) [sol]
EC >7-8	1.0% SOM	120	22	59,000 (869) [vap]
	2.5% SOM	270	51	110,000 (1920) [sol]
	6.0% SOM	611	120	190,000 (4360) [vap]
EC >8-10	1.0% SOM	27	8.6	3,700 (613) [vap]
	2.5% SOM	65	21	8,600 (1500) [vap]
	6.0% SOM	151	51	18,000 (3580) [vap]
EC >10-12	1.0% SOM	69	13	17,000 (364) [sol]
	2.5% SOM	160	31	29,000 (899) [sol]
	6.0% SOM	346	74	34,500 (2150) [sol]
EC >12-16	1.0% SOM	140	23	36,000 (169) [sol]
	2.5% SOM	480	57	37,000
	6.0% SOM	770	130	37,800
EC >16-21	1.0% SOM	250	46	28,000
	2.5% SOM	480	110	28,000
	6.0% SOM	770	260	28,000
EC >21-35	1.0% SOM	890	370	28,000
	2.5% SOM	1,100	820	28,000
	6.0% SOM	1,230	1,600	28,000
EC >35-44	1.0% SOM	890	370	28,000
	2.5% SOM	1,100	820	28,000
	6.0% SOM	1,230	1,600	28,000

General Assessment Criteria For TPH Cont'd

Determinant		Residential (mg/kg)	Allotments (mg/kg)	Commercial (mg/kg)
Aromatic & Aliphatic EC >44 - 70	1.0% SOM	1200	1200	28,000
	2.5% SOM	1300	2100	28,000
	5.0% SOM	1300	3000	28,000

Note: *SOM = Soil Organic Matter Content (%)*
LQM CIEH GAC not set for Allotment land-use

Cont'd Overleaf:

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds			
Contaminant	**Residential (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Chloroalkanes & alkenes			
1,2 Dichloroethane			
1.0% SOM	0.0054	0.0046	0.71
2.5% SOM	0.0080	0.0083	1.00
6.0% SOM	0.014	0.016	1.80
1,1,2,2 Tetrachloroethane			
1.0% SOM	1.4	0.41	290
2.5% SOM	2.9	0.89	580
6.0% SOM	6.3	2.0	1200
1,1,1,2 Tetrachloroethane			
1.0% SOM	0.90	0.79	120
2.5% SOM	2.1	1.9	260
6.0% SOM	4.8	4.4	590
Tetrachloroethene			
1.0% SOM	0.94	1.6	130
2.5% SOM	2.1	3.7	290
6.0% SOM	4.8	8.7	660
1,1,1 Trichloroethane			
1.0% SOM	6.2	48	700
2.5% SOM	13	110	1400
6.0% SOM	28	240	3100
Tetrachloromethene			
1.0% SOM	0.018	0.16	3.0
2.5% SOM	0.039	0.37	6.6
6.0% SOM	0.089	0.85	15
Trichloroethene			
1.0% SOM	0.11	0.43	12
2.5% SOM	0.22	0.95	25
6.0% SOM	0.49	2.2	55
Trichloromethane			
1.0% SOM	0.75	0.36	110
2.5% SOM	1.3	0.70	190
6.0% SOM	2.7	1.5	370
Vinyl Chloride			
1.0% SOM	0.00047	0.00055	0.063
2.5% SOM	0.00064	0.0010	0.081
6.0% SOM	0.00099	0.0018	0.12

Cont'd Overleaf:

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds			
Contaminant	**Residential (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Explosives			
2,4,6 Trinitrotoluene			
1.0% SOM	1.6	0.24	1000
2.5% SOM	3.7	0.58	1000
6.0% SOM	8.0	1.4	1100
RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)			
1.0% SOM	3.5	0.52	6400
2.5% SOM	7.4	1.1	6400
6.0% SOM	16	2.5	6400
HMX (Octogen/1,3,5,7-tetrenitro-1,3,5,7-tetrazacyclo-octane)			
1.0% SOM	5.7	0.86	110,000
2.5% SOM	13	1.9	110,000
6.0% SOM	26	3.9	110,000
Atrazine			
1.0% SOM	0.24	0.037	870
2.5% SOM	0.56	0.085	880
6.0% SOM	1.3	0.20	880
Pesticides			
Aldrin			
1.0% SOM	1.7	1.3	54
2.5% SOM	2.0	2.6	54
6.0% SOM	2.1	4.0	54
Dieldrin			
1.0% SOM	0.69	0.13	90
2.5% SOM	1.4	0.32	91
6.0% SOM	2.2	0.73	92
Dichlorvos			
1.0% SOM	0.29	0.044	942
2.5% SOM	0.6	0.091	972
6.0% SOM	1.3	0.2	983
Alpha - Endosulfan			
1.0% SOM	2.9	0.47	2310 (0.003)^{vap}
2.5% SOM	7.0	1.2	2990 (0.007)^{vap}
6.0% SOM	16	2.7	3390

Cont'd Overleaf:

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds			
Contaminant	**Residential (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Pesticides			
Beta - Endosulfan			
1.0% SOM	2.8	0.44	2580 (0.00007)[vap]
2.5% SOM	6.6	1.1	3160 (0.0002) [vap]
6.0% SOM	15	2.6	3480
Alpha -Hexachlorocyclohexanes			
1.0% SOM	19	3.0	14000
2.5% SOM	46	7.4	14600
6.0% SOM	100	18	14900
Beta -Hexachlorocyclohexanes			
1.0% SOM	1.7	0.26	1120
2.5% SOM	3.9	0.64	1130
6.0% SOM	8.5	1.5	1130
Gamma - Hexachlorocyclohexanes			
1.0% SOM	0.58	0.089	532
2.5% SOM	1.4	0.22	546
6.0% SOM	3.0	0.52	552
Chlorobenzenes			
Chlorobenzene			
1.0% SOM	0.33	5.9	59
2.5% SOM	0.73	14	32
6.0% SOM	59	130	310
1,2-Dichlorobenzene			
1.0% SOM	16	94	2100 (571) [sol]
2.5% SOM	39	230	5100 (1370) [sol]
6.0% SOM	91	540	12000 (3240) [sol]
1,3-Dichlorobenzene			
1.0% SOM	0.29	0.25	32
2.5% SOM	0.70	0.61	77
6.0% SOM	1.7	1.5	180
1,4-Dichlorobenzene			
1.0% SOM	30	15	4500 (224)[vap]
2.5% SOM	72	37	10000 (540)[vap]
6.0% SOM	167	88	22000 (1280)[vap]
1,2,3,-Trichlorobenzene			
1.0% SOM	1.0	4.7	110
2.5% SOM	2.6	12	270
6.0% SOM	6.1	28	620

Cont'd Overleaf:

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds			
Contaminant	**Residential (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Chlorobenzenes			
1,2,4,-Trichlorobenzene			
1.0% SOM	1.8	31	230
2.5% SOM	4.5	75	560
6.0% SOM	11	180	1300
1,3,5,-Trichlorobenzene			
1.0% SOM	0.23	4.7	24
2.5% SOM	0.57	12	57.8
6.0% SOM	1.3	28	140
1,2,3,4,-Tetrachlorobenzene			
1.0% SOM	12	4.4	1800 (122)^{vap}
2.5% SOM	4.5	75	3200 (304)^{vap}
6.0% SOM	11	180	4500 (728)^{vap}
1,2,3,5,- Tetrachlobenzene			
1.0% SOM	0.49	0.38	52 (39.4)^{vap}
2.5% SOM	1.2	0.94	120 (98.1)^{vap}
6.0% SOM	2.8	2.2	250 (235)^{vap}
1,2,4, 5,- Tetrachlobenzene			
1.0% SOM	0.30	0.064	44 (19.7)^{sol}
2.5% SOM	0.68	0.16	73 (49.1)^{sol}
6.0% SOM	1.4	0.37	97
Pentachlrobenzene			
1.0% SOM	5.2	1.2	650 (43.0)^{sol}
2.5% SOM	10	3.1	770 (107)^{sol}
6.0% SOM	17	7.1	830
Hexachlorobenzene			
1.0% SOM	0.59 (0.20)^{vap}	0.18	48 (0.20)^{vap}
2.5% SOM	1.0 (0.50)^{vap}	0.42	53
6.0% SOM	1.4	0.92	55

Cont'd Overleaf:

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds			
Contaminant	**Residential (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Phenols & Chlorophenols			
Chlorophenols (4 Congeners)			
1.0% SOM	0.87	0.13	3500
2.5% SOM	2.0	0.30	4000
6.0% SOM	4.4	0.70	4200
Pentachlorophenols			
1.0% SOM	0.55	0.084	1200
2.5% SOM	1.3	0.21	0.49
6.0% SOM	1200	1300	1400
Others			
Carbon Disulphide			
1.0% SOM	0.10	4.8	12
2.5% SOM	0.20	10	23
6.0% SOM	0.44	23	50
Hexachloro-1,3-Butadiene			
1.0% SOM	0.21	0.25	32
2.5% SOM	0.51	0.61	69
6.0% SOM	1.2	1.4	120

Cont'd Overleaf:

CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Contaminant	**Residential (mg/kg)**	**Residential without plant uptake (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
1,1,2 Trichloroethane				
1.0% SOM	0.6	0.88	0.28	94
2.5% SOM	1.2	1.8	0.61	190
6.0% SOM	2.7	3.9	1.4	400
1,1-Dichloroethane				
1.0% SOM	2.4	2.5	9.2	280
2.5% SOM	3.9	4.1	17	450
6.0% SOM	7.4	7.7	35	850
1,1-Dichloroethene				
1.0% SOM	0.23	0.23	2.8	26
2.5% SOM	0.40	0.41	5.6	46
6.0% SOM	0.82	0.82	12	92
1,2,4-Trimethylbenzene				
1.0% SOM	0.35	0.41	0.38	42
2.5% SOM	0.85	0.99	0.93	99
6.0% SOM	2.0	2.3	2.2	220
1,2-Dichloropropane				
1.0% SOM	0.024	0.024	0.62	3.3
2.5% SOM	0.042	0.042	1.2	5.9
6.0% SOM	0.084	0.085	2.6	12
2,4-Dimethylphenol				
1.0% SOM	19	210	3.1	16000*
2.5% SOM	43	410	7.2	24000*
6.0% SOM	97	730	17	30000*
2,4-Dinitrotoluene				
1.0% SOM	1.5	170*	0.22	3700*
2.5% SOM	3.2	170	0.49	3700*
6.0% SOM	7.2	170	1.1	3800*
2,6-Dinitrotoluene				
1.0% SOM	0.78	78	0.12	1900*
2.5% SOM	1.7	84	0.27	1900*
6.0% SOM	3.9	87	0.61	1900*
2-Chloronapthalene				
1.0% SOM	3.7	3.8	40	390*
2.5% SOM	9.2	9.3	98	960*
6.0% SOM	22	22	230	2200*

Cont'd Overleaf:

CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Contaminant	**Residential (mg/kg)**	**Residential without plant uptake (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Biphenyl				
1.0% SOM	66*	220*	14	18000*
2.5% SOM	160	500*	35	33000*
6.0% SOM	360	980*	83	48000*
Bis (2-ethylhexyl) phthalate				
1.0% SOM	280*	2700*	47*	85000*
2.5% SOM	610*	2800*	120*	86000*
6.0% SOM	1100*	2800*	280*	86000*
Bromobenzene				
1.0% SOM	0.87	0.91	3.2	97
2.5% SOM	2.0	2.1	7.6	220
6.0% SOM	4.7	4.9	18	520
Bromodichloromethane				
1.0% SOM	0.016	0.019	0.016	2.1
2.5% SOM	0.030	0.034	0.032	3.7
6.0% SOM	0.061	0.070	0.068	7.6
Bromoform				
1.0% SOM	2.8	5.2	0.95	760
2.5% SOM	5.9	11	2.1	1500
6.0% SOM	13	23	4.6	3100
Butyl benzyl phthalate				
1.0% SOM	1400*	42000*	220*	940000*
2.5% SOM	3300*	44000*	550*	940000*
6.0% SOM	7200*	44000*	1300*	950000*
Chloroethane				
1.0% SOM	8.3	8.4	110	960
2.5% SOM	11	11	200	1300
6.0% SOM	18	18	380	2100
Chloromethane				
1.0% SOM	0.0083	0.0085	0.066	1.0
2.5% SOM	0.0098	0.0099	0.13	1.2
6.0% SOM	0.013	0.013	0.23	1.6
***Cis* 1,2 Dichloroethene**				
1.0% SOM	0.11	0.12	0.26	14
2.5% SOM	0.19	0.20	0.50	24
6.0% SOM	0.37	0.39	1.0	47

Cont'd Overleaf:

CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Contaminant	**Residential (mg/kg)**	**Residential without plant uptake (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Dichloromethane				
1.0% SOM	0.58	2.1	0.10	270
2.5% SOM	0.98	2.8	0.19	360
6.0% SOM	1.7	4.5	0.34	560
Diethyl Phthalate				
1.0% SOM	120*	1800*	19*	150000*
2.5% SOM	260*	3500*	41*	220000*
6.0% SOM	570*	6300*	94*	290000*
Di-*n*-butyl phthalate				
1.0% SOM	13*	450*	2.0	15000*
2.5% SOM	31*	450*	5.0	15000*
6.0% SOM	67*	450*	12	15000*
Di-*n*-octyl phthalate				
1.0% SOM	2300*	3400*	940*	89000*
2.5% SOM	2800*	3400*	2100*	89000*
6.0% SOM	3100*	3400*	3900*	89000*
Hexachloroethane				
1.0% SOM	0.20	0.22	0.27	22*
2.5% SOM	0.48	0.54	0.67	53*
6.0% SOM	1.1	1.3	1.6	120*
Isopropylbenzene				
1.0% SOM	11	12	32	1400*
2.5% SOM	27	28	79	3300*
6.0% SOM	64	67	190	7700*
Methyl *tert*-butyl ether				
1.0% SOM	49	73	23	7900
2.5% SOM	84	120	44	13000
6.0% SOM	160	220	90	24000
Propylbenzene				
1.0% SOM	34	40	34	4100*
2.5% SOM	82	97	83	9700*
6.0% SOM	190	230	200	21000*
Styrene				
1.0% SOM	8.1	35	1.6	3300*
2.5% SOM	19	78	3.7	6500*
6.0% SOM	43	170	8.7	11000*

Cont'd Overleaf:

CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Contaminant	**Residential (mg/kg)**	**Residential without plant uptake (mg/kg)**	**Allotment (mg/kg)**	**Commercial (mg/kg)**
Total Cresols (2-, 3-, and 4-methylphenol)				
1.0% SOM	80	3700	12	160000
2.5% SOM	180	5400	27	180000*
6.0% SOM	400	6900	63	180000*
***Trans* 1,2 Dichloroethene**				
1.0% SOM	0.19	0.19	0.93	22
2.5% SOM	0.34	0.35	1.9	40
6.0% SOM	0.70	0.71	0.24	81
Tributyl tin oxide				
1.0% SOM	0.25	1.4	0.042	130*
2.5% SOM	0.59	3.1	0.1	180*
6.0% SOM	1.3	5.7	0.24	200*

Notes: *Soil concentration above soil saturation limit
ND – Not Derived.
NA – Not Applicable

Appendix F
Waste Hazard Assessment

Waste Classification Report

9KVFJ-8AUXU-W2VD3

Job name

Hermit Place

Waste Stream

Ground and Water Standard v3

Comments

Project

GWPR1098

Site

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Classified by

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Date:
22/12/2014 20:45
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Ground and Water
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Report

Created by: Williams, Francis
Created date: 22/12/2014 20:45

Job summary

#	Sample Name	Depth [m]	Classification Result	Hazardous properties	Page
1	BH1 @ 0.30m bgl		Non Hazardous		2

Classification of sample: BH1 @ 0.30m bgl

Non Hazardous Waste
Classified as **17 05 04**
in the European Waste Catalogue 2002

Sample details

Sample Name:
BH1 @ 0.30m bgl
Sample Depth:
0 m
Dry Weight Moisture Content:
0%

EWC 2002 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

Additional: Additional Risk Phrases "This is an additional risk phrase and such a risk phrases alone will not cause a waste to be hazardous."

Risk phrases hit:

R33 "Danger of cumulative effects"

Because of determinand:

Lead compounds (with the exception of those listed separately in this Annex): (compound conc.: 0.101%)

Determinands (Dry Weight Moisture Content: 0%)

pH: (Whole conc. entered as: 9.2 pH, converted to conc.:9.2 pH or 9.2 pH)
Cyanides (with the exception of complex cyanides): (Whole conc. entered as: <2 mg/kg or <0.0002%) IGNORED Because: "<LOD"
Arsenic trioxide: (Cation conc. entered: 9 mg/kg, converted to compound conc.:11.883 mg/kg or 0.00119%)
Boron tribromide/trichloride/trifluoride (combined risk phrases): (Cation conc. entered: <1 mg/kg, converted to compound conc.:<13.43 mg/kg or <0.00134%) IGNORED Because: "<LOD"
Cadmium sulphide: (Cation conc. entered: 2 mg/kg, converted to compound conc.:2.57 mg/kg or 0.000257%, Note 1 conc.: 0.0002%)
Chromium(VI) oxide: (Cation conc. entered: <2 mg/kg, converted to compound conc.:<3.846 mg/kg or <0.000385%) IGNORED Because: "<LOD"
Copper (I) oxide: (Cation conc. entered: 103 mg/kg, converted to compound conc.:115.966 mg/kg or 0.0116%)
Lead compounds (with the exception of those listed separately in this Annex): (Cation conc. entered: 669 mg/kg, converted to compound conc.:1010.19 mg/kg or 0.101%, Note 1 conc.: 0.0669%)
Mercury dichloride: (Cation conc. entered: <1 mg/kg, converted to compound conc.:<1.353 mg/kg or <0.000135%) IGNORED Because: "<LOD"
Nickel dihydroxide: (Cation conc. entered: 38 mg/kg, converted to compound conc.:60.021 mg/kg or 0.006%)
Selenium compounds (with the exception of cadmium sulphoselenide and sodium selenite): (Cation conc. entered: <3 mg/kg, converted to compound conc.:<4.5 mg/kg or <0.00045%) IGNORED Because: "<LOD"
Zinc oxide: (Cation conc. entered: 397 mg/kg, converted to compound conc.:494.151 mg/kg or 0.0494%)
Phenol: (Whole conc. entered as: <2 mg/kg or <0.0002%) IGNORED Because: "<LOD"
Naphthalene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Acenaphthylene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Acenaphthene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Fluorene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Phenanthrene: (Whole conc. entered as: 0.31 mg/kg or 0.000031%)
Anthracene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Fluoranthene: (Whole conc. entered as: 0.71 mg/kg or 0.000071%)
Pyrene: (Whole conc. entered as: 0.61 mg/kg or 0.000061%)

Benzo[a]anthracene: (Whole conc. entered as: 0.36 mg/kg or 0.000036%)
Chrysene: (Whole conc. entered as: 0.38 mg/kg or 0.000038%)
Benzo[b]fluoranthene: (Whole conc. entered as: 0.47 mg/kg or 0.000047%)
Benzo[k]fluoranthene: (Whole conc. entered as: 0.16 mg/kg or 0.000016%)
Benzo[a]pyrene; benzo[def]chrysene: (Whole conc. entered as: 0.36 mg/kg or 0.000036%)
Indeno[123-cd]pyrene: (Whole conc. entered as: 0.29 mg/kg or 0.000029%)
Dibenz[a,h]anthracene: (Whole conc. entered as: <0.1 mg/kg or <0.00001%) IGNORED Because: "<LOD"
Benzo[ghi]perylene: (Whole conc. entered as: 0.36 mg/kg or 0.000036%)

Notes utilised in assessment

Additional Risk Phrase Comments, used on:

Test: "Additional on R33" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

C14.3: Step 4, used on:

Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Arsenic trioxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Copper (I) oxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Nickel dihydroxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Zinc oxide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Phenanthrene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Fluoranthene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Pyrene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[a]anthracene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Chrysene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[b]fluoranthene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[k]fluoranthene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[a]pyrene; benzo[def]chrysene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Benzo[ghi]perylene"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Cadmium sulphide"

Note 1, used on:

Test: "H5 on R20, R21, R22, R65" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
Test: "H6 on R23, R24, R25" for determinand: "Cadmium sulphide"
Test: "H7 on R45" for determinand: "Cadmium sulphide"
Test: "H10 on R60, R61" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
Test: "H10 on R62, R63" for determinand: "Cadmium sulphide"
Test: "H11 on R68" for determinand: "Cadmium sulphide"
Test: "H14 on R50, R52, R50/53, R51/53, R53, R52/53" for determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

Determinand notes

Note 1, used on:

determinand: "Cadmium sulphide"
determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

Note A, used on:

determinand: "Lead compounds (with the exception of those listed separately in this Annex)"

Note E, used on:

determinand: "Arsenic trioxide"
determinand: "Cadmium sulphide"

determinand: "Lead compounds (with the exception of those listed separately in this Annex)"
determinand: "Nickel dihydroxide"

Appendix A: User Defined and non CLP Substances

pH

Comments: Appendix C, C4.5
Data source: WM2 - Interpretation of the definition and classification of hazardous waste (Second Edition, version2.2), Environment Agency
Data source date: 30/05/2008
Classification: pH; pH

Boron tribromide/trichloride/trifluoride (combined risk phrases)

Comments: Combines the risk phrases and the average of the conversion factors for Boron tribromide, Boron trichloride and Boron trifluoride
Data source: N/A
Data source date: 10/01/2011
Classification: T+; R26/28, C; R34, C; R35, R14

Acenaphthylene (CAS Number: 208-96-8)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=59285&HarmOnly=no
Data source date: 16/07/2012
Classification: R22, R26, R27, R36, R37, R38

Acenaphthene (CAS Number: 83-32-9)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=133563&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, N; R51/53, R36, R37, R38

Fluorene (CAS Number: 86-73-7)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=81845&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, R53

Phenanthrene (CAS Number: 85-01-8)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=109754&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, R22, R36, R37, R38, R40, R43

Anthracene (CAS Number: 120-12-7)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=101102&HarmOnly=no
Data source date: 08/03/2013
Classification: N; R50/53, R36, R37, R38, R43

Fluoranthene (CAS Number: 206-44-0)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=56375&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, R20, R22, R36

Pyrene (CAS Number: 129-00-0)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=87484&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53, R23

Indeno[123-cd]pyrene (CAS Number: 193-39-5)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=128806&HarmOnly=no
Data source date: 08/03/2013
Classification: R40

Benzo[ghi]perylene (CAS Number: 191-24-2)

Comments: Risk phrase data taken from European Chemicals Agency's Classification & Labelling Inventory
Data source:
http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=15793&HarmOnly=no
Data source date: 16/07/2012
Classification: N; R50/53

Appendix B: Notes

Additional Risk Phrase Comments

from section: Table 2.2 in the document: "WM2 - Hazardous Waste Technical Guidance"

"This is an additional risk phrase and such a risk phrase alone will not cause a waste to be hazardous."

C14.3: Step 4

from section: C14.3 in the document: "WM2 - Hazardous Waste Technical Guidance"

"identify whether any individual ecotoxic substance is present below a cut-off value shown in Table C14.1"

Note 1

from section: 1.1.3.2, Annex VI in the document: "CLP Regulations"

"The concentration stated or, in the absence of such concentrations, the generic concentrations of this Regulation (Table 3.1) or the generic concentrations of Directive 1999/45/EC (Table 3.2), are the percentages by weight of the metallic element calculated with reference to the total weight of the mixture."

Note A

from section: 1.1.3.1, Annex VI in the document: "CLP Regulations"

"Without prejudice to Article 17(2), the name of the substance must appear on the label in the form of one of the designations given in Part 3. In Part 3, use is sometimes made of a general description such as '... compounds' or '... salts'. In this case, the supplier is required to state on the label the correct name, due account being taken of section 1.1.1.4."

Note E

from section: 1.1.3.1, Annex VI in the document: "CLP Regulations"

"Substances with specific effects on human health (see Chapter 4 of Annex VI to Directive 67/548/EEC) that are classified as carcinogenic, mutagenic and/or toxic for reproduction in categories 1 or 2 are ascribed Note E if they are also classified as very toxic (T+), toxic (T) or harmful (Xn). For these substances, the risk phrases R20, R21, R22, R23, R24, R25, R26, R27, R28, R39, R68 (harmful), R48 and R65 and all combinations of these risk phrases shall be preceded by the word 'Also'."

Appendix C: Version

Classification utilises the following:

- WM2 - Hazardous Waste Technical Guidance - 3rd Edition (Aug 2013)
  Hazardous Waste: Interpretation of the definition and classification of hazardous waste (3rd Edition 2013)
- CLP Regulations - Regulation (EC) No 1272/2008 of 16 December 2008
  REGULATION (EC) No 1272/2008 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006
- 1st ATP - Regulation (EC) No 790/2009 of 10 August 2009
  COMMISSION REGULATION (EC) No 790/2009 of 10 August 2009 amending, for the purposes of its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures
- 2nd ATP - Regulation (EC) No 286/2011 of 10 March 2011
  COMMISSION REGULATION (EU) No 286/2011 of 10 March 2011 amending, for the purposes of its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures
- 3rd ATP - Regulation (EU) No 618/2012 of 10 July 2012
  COMMISSION REGULATION (EU) No 618/2012 of 10 July 2012 amending, for the purposes of its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures
- 4th ATP - Regulation (EU) No 487/2013 of 8 May 2013
  COMMISSION REGULATION (EU) No 487/2013 of 8 May 2013 amending, for the purposes of its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures
- Correction to 1st ATP - Regulation (EU) No 758/2013 of 7 August 2013
  COMMISSION REGULATION (EU) No 758/2013 of 7 August 2013 correcting Annex VI to Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures
- 5th ATP - Regulation (EU) No 944/2013 of 2 October 2013
  COMMISSION REGULATION (EU) No 944/2013 of 2 October 2013 amending, for the purposes of its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures
- 6th ATP - Regulation (EU) No 605/2014 of 5 June 2014
  COMMISSION REGULATION (EU) No 605/2014 of 5 June 2014 amending, for the purposes of introducing hazard and precautionary statements in the Croatian language and its adaptation to technical and scientific progress, Regulation (EC) No 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures

HazWasteOnline Engine: WM2 version 3 (Aug 2013)
HazWasteOnline Engine Version: 1.0.2682.5621 (01 Dec 2014)
HazWasteOnline Database: 1.0.2682.5621 (01 Dec 2014)