Site Investigation Report

at: Punters Garage,
New Road, Hillingdon,
UB8 3DX

for: Aquinna Homes Plc.

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leap Environmental Ltd
Thames Valley Regional Office
Wyvols Court, Swallowfield
Reading, RG7 1WY
tel: +44 (0) 1189 882355
fax: +44 (0) 1189 882366
www.leapenvironmental.com
Head Office: The Atrium, Curtis Road, Dorking, Surrey, RH4 1XA
Registered in England no. 4...



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EXECUTIVE SUMMARY

The site comprises an active garage and MOT station which is situated in a primarily residential setting. It is proposed to redevelop the area with 8 residential dwellings (4 x 3-bed houses and 4 x 1-2 bed apartments) with associated roadways, car parking and small landscaped areas

The site has a history of use as a garage and part of a former nursery. The desk study has identified a number of potential sources of contamination associated primarily with the site's current use. The site is not affected by radon gas.

The site is mapped as being underlain by superficial deposits comprising the Boyn Hill Gravel Member (sands and gravels) over bedrock comprising the London Clay Formation (silty clay). Ground conditions were found to comprise made ground to a maximum depth of 1.0m (although around 0.5m was more typical) over sands and gravels to around 7.5m over London Clay. Groundwater was encountered within the sands and gravels at around 4.0m below ground level with some perched water encountered at shallower depth.

The site is not located with a flood risk zone or within a groundwater source protection zone. The Boyn Hill Gravel Member is classified an a secondary (A) aquifer.

An allowable bearing capacity for spread footings of 175kPa is recommended for the sands and gravels at about 1m. Piled foundations bearing in the London Clay may be the preferred option.

Based on the results detailed above, the soils are classified by the BRE as sulphate design class DS-1, and, assuming a mobile groundwater table, the ACEC class is AC-1.

For a piled foundation solution, the test results in the London Clay indicate Sulphate Design Class of DS-2 and, assuming a static groundwater scenario, an ACEC Class of AC-1s has been determined. Pyrite is commonly found in London Clay soils and can produce acidic conditions that are aggressive to concrete, and can cause it to degrade. The appropriate Sulphate Design Class should be chosen to combat any possible degradation.

Based on the falling head tests performed in the boreholes, the results suggest that it could be possible to segregate parts of the site as potentially suitable for shallow soakaways. It must be noted, however, that the test undertaken encompassed a small surface area of the ground conditions encountered and would not ensure that there was a pathway for drainage from it once saturated. It is further noted that the groundwater was encountered in the sands which may limit storage and could impact on the regulatory consent for discharge.

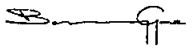
A geo-environmental risk assessment has been carried out. Contamination testing of the soils identified that the made ground soils are impacted with lead. In addition, a single exceedance of the assessment criteria for benzo[a]pyrene was recorded and a single piece of cemented asbestos was found on the underside of the concrete hardstanding.

Recommendations are given for the remediation of contamination on the site. As a minimum, an allowance should be made for the removal of all made ground in areas to become gardens and/or soft landscaping.

As with any redevelopment site, there is always the risk of hitherto undetected contamination, and further investigations should be carried out prior to redevelopment.

A proportion of soils on site will be expected to be classified as hazardous waste and a financial allowance should be made for appropriate disposal.

It is recommended that a brief remediation method statement be prepared.

Signed:	
	Barry Gore BSc MSc DIC CGeol FGS
Countersigned:	
	Richard Brinkworth BEng
Date:	30 August 2017
Revision:	Issue 1

1 INTRODUCTION

1.1 Authority

Leap Environmental Ltd (LEAP) has been appointed by Aquinna Homes to undertake a Desk Study and an intrusive Site Investigation of Punters Garage, New Road, Hillingdon. The instruction was given in an email dated 21st June 2017 signed by John Strange of Aquinna Homes.

1.2 Proposed Development and Investigation Objectives

The site is currently owned by Mr J. Punter and it is proposed to redevelop the area with 8 residential dwellings (4 x 3-bed houses and 4 x 1-2 bed apartments) with associated roadways, car parking and small landscaped areas as per the attached layout in Figure 2. No basements or significant ground level changes are proposed.

The proposed development is currently at a preplanning phase and has been assessed in accordance with BS EN 1997[1], as being a Geotechnical Category 1 structure.

The objectives of this report are to:

- Provide information on the geotechnical and environmental quality of the ground present on the site;
- Assess the potential health and other environmental risks posed by the site to the proposed development and to other specifically identified receptors; and
- Assess the potential for offsite contamination to adversely affect the proposed development.

LEAP is unaware of any previous investigations having been undertaken on the site.

1.3 Scope of Works

The investigation comprised three phases of work.

The first part of this report presents the results of a desk study and site reconnaissance. The following sources of information have been reviewed:

- Envirocheck database report
- Envirocheck historical map search
- British Geological Survey (BGS) mapping
- British Geological Survey website (www.bgs.ac.uk) including historic BGS borehole data

[1] BS EN 1997-1(2004) Eurocode 7: Geotechnical Design - Part 1:General Rules

- Unexploded WWII aerial delivered bomb (UXB) regional risk maps produced by Zetica
- Interrogation of the Environment Agency Web site

A site reconnaissance was carried out on 22nd June 2017 and, together with the information from the desk study, has been used to develop an initial conceptual site model, which forms the basis for the site investigation strategy.

An intrusive investigation was carried out on 13 & 14 July 2017 and was followed by further investigative works on 7 August 2017.

Chemical and geotechnical laboratory testing was carried out and all the data assessed to produce this single interpretative report.

1.4 Limitations

This report has been prepared by LEAP on the basis of information received from a variety of sources which LEAP believes to be accurate. Nevertheless, LEAP cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

LEAP has used all reasonable skill, care and diligence in the design and execution of this report, taking into account the manpower and resources devoted to it in agreement with the Client. Although every reasonable effort has been made to obtain all relevant information, all potential contamination, environmental constraints or liabilities associated with the site may not necessarily have been revealed.

The conclusions reached in this report are necessarily restricted to those which can be determined from the information consulted and may be subject to amendment in the light of additional information becoming available. These conclusions may not be appropriate for alternative schemes.

This report is confidential to the Client, and LEAP accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by LEAP beforehand. Any such party relies upon the report at their own risk.

Full details of the limitations are provided in Appendix A.

2 ENVIRONMENTAL SETTING

2.1 Site Location

The site is in west London at 22 New Road, Hillingdon, UB8 3DX [approximate National Grid Reference 508110, 182020] at an estimated elevation of 45m Above Ordnance Datum (mAOD) and is generally level.

2.2 General Description and Boundaries

The current site location is shown in Figure 1, Appendix B. A walkover survey was carried out and photographs are included in Appendix E.

The site is bounded to the north by residential properties, to the south by Connaught Close (residential), to the west by open playing fields and to the east by New Road (also residential).

The site comprises an active garage and MOT station on an irregular-shaped plot of land accessed via a private track off New Road. A workshop comprising two car servicing bays and a bike service bay with an associated office are located at the western end with a further vehicle service bay and a MOT reception area in the central area. The remainder of the site is laid out to hardstanding (a mix of tarmacadam and concrete in serviceable condition) with the exception of a wooden shed to the east of the MOT service bay. A gas bottle storage cage was located to the north of the MOT bay. A disused above ground storage tank (AST) was located adjacent to the eastern boundary wall of the larger service bay building. The rear of the site could also be accessed through an opening in the wall via Connaught Close to the south.

2.3 Geology

The geology of the site has been determined by reference to the 1:50,000 British Geological Survey sheet 255 Beaconsfield, solid and drift edition, 2005, the BGS website (www.bgs.ac.uk) and the Envirocheck report. The site is mapped as being underlain by superficial deposits comprising the Boyn Hill Gravel Member (sands and gravels) over bedrock comprising the London Clay Formation (silty clay).

The online BGS GeoIndex (http://www.bgs.ac.uk/geoindex/) has been reviewed for detailed local geological and hydrogeological information. Two boreholes have been identified within circa 500m of the site. Borehole ref 576360, located c200m NE of the site indicates ground conditions comprising gravels to at least 7.75m (the base of the well) with groundwater encountered at circa 4.5m. Borehole ref 576351, located c500m NW of the site indicates ground conditions comprising superficial deposits including much gravel to circa 8.8m over London Clay.

2.4 Hydrogeology

The hydrogeology of the site has been determined from the Envirocheck data report and the Environment Agency' 'What's in My Backyard?' website. The source of the data is reported to be the Environment Agency groundwater vulnerability mapping.

The superficial deposits are classified as a secondary (A) aquifer whilst the underlying bedrock is classed as an unproductive stratum.

The site is not situated within a Groundwater Source Protection Zone (SPZ).

The Envirocheck lists two active abstraction licences within 500m of the subject site. The nearest is located 367m to the northwest of the site and is licensed for laundry use. The second (408m SW) is licensed for spray irrigation. The nearest potable abstraction is reported to be 1,125m to the west from the site associated with Hillingdon hospital.

Whilst it cannot be conclusively determined at this stage, it is likely given the location of numerous surface water features to the further west that groundwater flow would be in a westerly direction, towards these features.

2.5 Hydrology and Flooding

There are no surface water features within the site or adjoining the site boundary. The Envirocheck lists the nearest surface water feature as being located 671m to the SW of the site. The Envirocheck report indicates that there are no discharge consents within 500m of the site.

According to the Environment Agency, the site is not located within a flood zone. However, The Envirocheck report indicates that according to the BGS the site is at risk from groundwater flooding at surface.

2.6 Designated Environmentally Sensitive Sites

A review of designated environmentally sensitive sites presented within the Envirocheck report has been carried out. The dataset makes reference to a number of sensitive sites including the following:

- Sites of Special Scientific Interest (SSSI);
- Records of National Nature Reserves (NNR);
- Areas of Special Conservation (SAC);
- Records of Special Protection Areas (SPA);
- Records of Ramsar Sites;
- Records of Local Nature Reserves;
- Ancient Woodland Records.

None have been recorded within 1,000m of the site.

2.7 Ground Workings, Mining, Extraction and Natural Cavities

No current or historical ground workings are reported by the Envirocheck report within 500m of the site and the is not situated within an area affected by coal mining.

2.8 Site History

The contaminative and development history of the site has been established with reference to the Ordnance Survey historical maps provided within the Envirocheck report. The historical Ordnance Survey maps provided span the period from 1865 to present day at scales of 1:10,560, 1:10,000, 1:2,500 and 1:1,250. The maps are included in full in Appendix C.

Table 1: Summary of Historical Map Evidence

Year	On site	Surrounding area
1865	Open fields.	Open fields, residential housing and a public house.
1895	Site forms part of a nursery.	Residential development has expanded to border the northern and eastern site boundaries including the extension of the road (now labelled as New Road) to the immediate east of the site. Nursery to the immediate southeast.
1914-1920	Site remains part of a nursery but the configuration of the buildings has changed.	Depot shown ~150m north(east).
1935	No change on 1:2,500 map. No longer recorded as a nursery on the 1:10,560 map	Land to the west of the site is shown as a recreation ground.
1964-66	No longer shown as a nursery. Nature of buildings present is undisclosed.	Nursery to the southeast has been replaced by residential housing. Connaught Close to the immediate south has been constructed. Undisclosed 'works' shown to the east / northeast immediately beyond New Road. Allotment gardens shown circa 50-75m south(west).

1967-89	No significant changes noted.	'Works' now labelled as 'engineering works'. Allotment gardens replaced by apartments circa 1992.
1999 (aerial photograph)	The layout of the site appears to mirror that of today.	No significant changes noted.

2.8 Current Land Use

The existing buildings are of brick construction and are single storey. There were no signs of cracks or subsidence at the time of the visit. The buildings did not appear to have asbestos roofs. The topography of the site is largely flat. The surface cover comprises almost 100% hardstanding. A large drainage cover was observed to the west of the MOT bay and other drainage infrastructure is indicated on the topographical survey. However, the integrity was not inspected during the site walkover. No invasive species (apart from bindweed on the chain link fence on the western site boundary) or signs of plant stress were observed. This report does not constitute an ecological or asbestos survey, both of which are recommended.

The following features were identified as possible sources of contamination, although no signs of spillage or poor storage / working practice was observed during the site walkover:

- disused AST;
- temporary storage of engine oil in drums within the larger of the two buildings; and
- chemical storage / use (i.e. degreasers).

...which could lead to fuel, oil and engine fluid leaks / spillages.

The following features were identified as possible sources of contamination:

- Former grinding equipment and garage services and an active precision engineering business within 200m of the site.

The Envirocheck report details no fuel stations within 250m of the subject site. Records show two former fuel stations were located 315 and 341m to the NW and E respectively.

2.9 Unexploded Ordnance (UXO)

The Zetica UBX risk map indicates a low risk.

2.10 Waste Planning and Landfill Records

The Environment Agency website and Envirocheck contain details on areas of historic and active landfilling in the vicinity of the site. There are historic or active landfill or waste management treatment facilities listed within 500m of the site although a facility once

authorised to accept asbestos was located 212m east of the site; the license lapsed / was surrendered in 1983.

2.11 Other Regulatory Records

There are no records of potentially infilled land, facilities utilising hazardous substances or pollution incidents to controlled waters within 500m of the site.

2.12 Radon

According to the Envirocheck database search, the site is not within a radon affected area (less than 1% of homes are above the action level for radon).

3 CONCEPTUAL SITE MODEL

3.1 Conceptual Site Model (CSM)

A risk based approach is used to assess contaminated or potentially contaminated land within the UK. For a potential risk to exist, there must be a pollutant linkage in place, i.e. there must be a source of contamination, a potential receptor, and a pathway linking the two.

The purpose of developing the Conceptual Site Model, in this instance, is to identify the potential pollutant linkages by considering, in turn, the potential sources, receptors and pathways.

3.2 Sources

Based on a review of the available site information the following contaminants of concern are proposed:

Table 2: Onsite sources of contamination

Source	Contaminants of Concern
Imported Made Ground	Polycyclic Aromatic Hydrocarbons (PAH), heavy metals, asbestos
Garage activities: Vehicle repair, fuel, oil and chemical storage	Polycyclic Aromatic Hydrocarbons (PAH), petroleum hydrocarbons (PHC), mineral oil, greases, heavy metals, Volatile Organic Compounds (VOC)
Existing Buildings	Asbestos
Former glasshouses (part of former nursey)	Asbestos (rope), glass in shallow soils, fuels associate with heating, pesticides (as heavy metals given date of nursery use)

The desk study has highlighted the following potential off-site sources of contamination:

Table 3: Offsite sources of contamination

Source	Distance from Site (m)	Contaminants of Concern
Grinding equipment and services	68 (NE)	Heavy metals, lube oils, greases
Garage services	161 (NW)	Polycyclic Aromatic Hydrocarbons (PAH), petroleum hydrocarbons (PHC), mineral oil, greases, heavy metals, Volatile Organic Compounds (VOC)
Precision Engineering Services	198 (E)	Heavy metals, lube oils, greases

3.3 Receptors

Potential receptors are those which may be impacted by any of the contaminants of concern identified above, and include the following:

- Future residents
- Construction workers
- Groundwater – Secondary (A) Aquifer within Boyn Hill Gravel Member
- Material construction of buildings and infrastructure
- Neighbouring properties

3.3 Pathways and Potential Pollutant Linkages

The development will include private gardens and some public open space. All potential pollutant linkages involving resident humans and soil contaminants will be active i.e. direct ingestion of soil, ingestion of soil attached to plants as well as via plant uptake, inhalation of indoor and outdoor vapour and of dust tracked back into the house and finally ingestion of water carried by plastic water pipes through contaminated ground.

Ground workers are at risk as a result from all the above, except for those involving edible plants.

The site is underlain by a secondary (A) aquifer of intermediate leaching potential. Hence there is a potential pathway for leachate from soil pollutants and for mobile liquid contaminants to enter the groundwater.

3.4 Initial Qualitative Risk Assessment of Pollutant Linkages

Risk levels within the preliminary CSM are determined on a qualitative basis following review of the available desk-based information. The significance of particular pollutant linkages is dependant both upon the severity and likelihood of the risk.

Given the current site use as a garage, the risks posed to future residents and construction workers from potential contaminants in soil was rated as moderate. The risk from asbestos (potentially present either in buildings or in Made Ground soils) was rated as high based on

the severity of exposure. The risk to groundwater from organic contaminants was rated as moderate given the anticipated permeable shallow natural soils and sensitivity of the aquifer (secondary A).

These risk ratings were used to devise the scope, investigative techniques and the extent of the intrusive ground investigation and also to guide the laboratory testing. These risk ratings are reassessed below based on the results of the investigation.

3.5 Geotechnical Considerations

The preliminary geotechnical assessment for the proposed development is has identified uniform conditions across the site, comprising made ground over sands and gravels over London Clay. Made ground or fill is typically highly variable in both composition and bearing capacity, and can be subject to large differential settlements when loaded. It is therefore generally unsuitable for use as a bearing stratum. In addition, made ground may contain contaminated and/or putrescible material. It can therefore be potential source of contamination and ground gas.

On the basis of the initial review and preliminary risk assessment, the site is given a Geotechnical Classification of Geotechnical Category 1 in accordance with EN1997-1 §2.1(14)-(21).

4 GROUND INVESTIGATION

4.1 Investigation Rationale and Scope

Given the potential for contamination in soils (based on the site's current use) which could pose a risk to future site users and construction workers and also to obtain geotechnical information for foundation design, the site investigation focused on areas of potential ground contamination whilst identifying ground strata characteristics across the site. However, access to all areas was restricted due to the ongoing site activities and the exploratory hole locations were ultimately selected to cause least interference to garage related work; in particular there was no investigation undertaken within the buildings / workshops.

The intrusive investigation comprised;

- 5 nominally 2-3m deep windowless boreholes drilled with a tracked rig;
- 3 small scale soakage tests carried out in boreholes;
- 5 in-situ dynamic cone penetrometer CBR tests;
- 1 cable percussion borehole to 13m;
- Standard Penetrometer Tests in the boreholes;
- Geotechnical Laboratory testing; and
- Chemical Laboratory tests.

The intrusive works were completed by contractors who have been scrutinised and are on LEAP's approved contractor list. The windowless sampling was carried out by Oakland Site Investigation Limited and the cable percussion borehole was completed by Borehole Solutions Ltd. On site works were supervised by a LEAP engineer.

Selected samples of soil were scheduled for laboratory testing. The laboratory testing has been carried out by The Environmental Laboratory Ltd at its laboratories in East Sussex.

Selected soil samples have been classified by laboratory analysis for geotechnical design purposes. The laboratory testing has been carried out by K4 Soils Ltd at its laboratories in Watford.

The site investigation locations are shown on Figure 3, Appendix B. At the time of the investigation the weather was warm and dry.

4.2 Site Works

Each exploratory hole position commenced with a hand-dug inspection pit to a depth of nominally 1m to check for services. Boreholes were drilled using a cable percussion rig and a

windowless sampler rig. A water flush was added as the cable percussion hole progressed. Borehole drilling details are recorded on the borehole logs in Appendix F.

Soil samples were recovered from the boreholes for field screening, logging and sampling. Boreholes were logged in general accordance with the requirements of BS 5930: 1999+A2:2010 and BS EN ISO 14688 Pt 1&2.

Visual and olfactory evidence of contamination was noted if encountered. These observations were used to aid scheduling of samples for chemical laboratory analyses.

Chemical samples were collected with a clean sampling trowel or by hand (using dedicated nitrile gloves for each sampling location). Samples were placed into laboratory supplied sampling containers, specific to the type of analyses required. All sample containers were sealed and labelled with a unique location identity, depth and date of sampling.

Two monitoring wells were installed within the windowless sample boreholes. The monitoring wells were constructed of 50mm diameter HDPE pipe. The response zone was typically targeted to intercept the groundwater surface and was surrounded by washed filter gravel. The near-surface zone was surrounded with bentonite to provide a seal. The monitoring wells were finished with bungs with gas taps and flush mounted steel covers. Monitoring well installations are shown on the borehole logs.

Standard penetration tests were undertaken in the boreholes in granular soils and / alternating with UT100 samples in cohesive soils, in accordance with BS EN ISO 22476-3:2005. Uncorrected blow counts, 'N values', are recorded on the borehole logs in Appendix F. In addition, dynamic penetration tests were conducted in the windowless holes. The results from the tests are presented as plots at the end of Appendix G.

Five in-situ CBR tests have been undertaken across the site using the UK Transport Research Laboratory (TRL) Dynamic Cone Penetrometer, recording blow counts over up to 900mm of penetration from test level. The table presented provides the number of blows required to advance the cone in 50mm increments. The results are attached in Appendix G.

Three falling head tests have been carried out it in boreholes WS01, WS3 and WS05 to determine the ground permeability. The results are attached in Appendix G.

4.3 Laboratory Analysis

4.3.1 Chemical Soil Analysis

Selected samples of soil have been subjected to laboratory testing. Sampling techniques and storage have been undertaken as per BS 10175:2011 Code of Practice for Investigation of Potentially Contaminated Sites. Where available, the tests procedures are UKAS and MCERTS accredited.

The following analyses were completed on selected samples:

- LEAP standard soil suite (metals, speciated PAHs, asbestos)
- Petroleum Hydrocarbons
- Asbestos Quantification

The full laboratory test results are presented in Appendix H.

4.3.2 Geotechnical Laboratory Testing

Selected samples of the soils have been classified by laboratory analysis for geotechnical design purposes. The laboratory testing has been carried out in accordance with BS1377[2]. The sampling technique, type, storage and transport and the number of laboratory tests have been undertaken where possible in accordance with BS EN 1997-2:2007 and EN ISO 22475. The consistency of the cohesive soils (stiff – very stiff) prohibits the use of 'undisturbed Class 1 (Category A)' sampling equipment and conventional U100 sampling techniques have been used. As such, these samples are not suitable for shear strength testing in accordance with Eurocode specification and the results should be used for guidance only. Results are presented in graphical and/or tabular form in Appendix I.

The following laboratory tests have been undertaken:

Table 4 Geotechnical Laboratory Testing

Test	Number of tests		
	Made Ground / Possible Made Ground	River Terrace Gravels	London Clay
Moisture Content	-	2	2
Atterberg Limit Test	-	2	2
Particle Size Distribution Test	-	9	-
Sulphate Determination	1	6	1
pH	1	6	1
Undrained Triaxial Test	-	-	2

[2] BS1377 Parts 1-9:1990 Methods of test for Soils for Civil Engineering Purposes

5 GROUND CONDITIONS

It is intended that this section of this report fulfil the general requirements of the Ground Investigation Report as set out in Section 6 of Eurocode7[1].

5.1 General Ground Conditions

The ground conditions are described in detail in the logs attached in Appendix F. In summary, the soil conditions were as follows:

Table 5: Summary of soils encountered

Depth From (m)	Depth To (m)	Soil Type	Description
GL	0.05 – 0.2	Made Ground	Hard surfacing: tarmac and / or concrete.
0.05 – 0.2	0.4 – 1.0	MADE GROUND	MADE GROUND composed of typically brown silty sand and clay with some brick, chalk, glass, metal and clinker fragments and brick cobbles. Locally possible disturbed natural ground. Locally 'sub-base' type of more granular material.
0.4 - 1.0	7.4	GRAVEL/ SAND	Medium dense – very dense silty sandy fine to medium angular to sub-rounded flint GRAVEL with silty gravelly fine to medium SAND. [RIVER TERRACE DEPOSITS]
7.4	>13.0	CLAY	Stiff buff brown mottled blue grey and orange plastic CLAY with occasional mudstone fragments and selenite crystals. [LONDON CLAY]

This general arrangement of strata accords with that anticipated from the desk study.

Groundwater was encountered in a number of the boreholes at depths of between 0.74m and 3.80m bgl. The shallower water is considered to be perched within the made ground / river

[1] BS EN 1997 Eurocode 7- Geotechnical Design- Part 1: General rules (2004) Part 2: Ground Investigation and Testing (2007)

terrace deposits and it is expected that actual groundwater levels are around 4m, as indicated in the deeper borehole.

5.2 Strata Encountered

Made Ground

The entire site surface is tarmacked or concreted and is directly underlain by a silty gravelly sand / clay with some fragments of brick and concrete and rare roots, rootlets, glass and metal to up to 1m deep but typically around 0.5m. Much of this material appears to be a former topsoil / disturbed ground.

A single sulphate / pH test was conducted on this material:

- Sulphate content (g/l): 0.23%
- pH: 7.03

Sands and Gravels

The made ground was underlain by silty sands and gravels to 7.4m (the base was only confirmed in the cable percussion borehole). The results of the geotechnical laboratory testing are summarised in Table 6 and Table 7 below.

Table 6: Summary of Particle Size Distribution tests for Sand and Gravel

Clay + Silt (%)	Sand (%)	Gravel (%)	Cobbles (%)
0.5 – 32.8	13 – 62.8	16.8 – 64	-

Table 7: Summary of Geotechnical Test Results for Sand/Gravel

Test	Range
SPT 'N value'	11 - >50
Liquid Limit (%)	56 - 63
Plastic Limit (%)	22 – 26
Plasticity Index (%)	34 - 37
Modified Plasticity Index (%)	10 - 12
Sulphate Content (g/l)	0.17 – 0.38
Sulphate Content (g/l) – Characteristic Value	0.36
pH	7.16 – 8.07

The sands and gravels appear to be layered, locally silty or slightly clayey and of variable density (medium dense to very dense). The two Atterberg tests undertaken on the fines from the upper layers indicate the material to be of low plasticity but, as the overall fines content is below 35% and in accordance with NHBC guidance, the material is non-shrinkable.

London Clay

The sands and gravels are underlain by firm to stiff becoming very stiff plastic clays to the maximum depth investigated (13m). The results of the geotechnical laboratory testing are summarised in Table 8 below.

Table 8: Summary of Geotechnical Test Results for London Clay

Test	Range
SPT 'N value'	25 - 28
Moisture Content (%)	24 - 26
Liquid Limit (%)	73 - 75
Plastic Limit (%)	29 – 30
Plasticity Index (%)	44 - 45
Undrained shear strength (kN/m²)	153 - 198
Sulphate Content (g/l)	0.56
pH	8.2

The upper layer of the clay appears firm and sandier but becomes stronger with increasing depth.

5.3 Ground Permeability

3 No. falling head tests were undertaken on site. Given the time constrictions, it was only possible to complete one test at a single depth in each borehole. The results are attached in Appendix G and are summarised below:

Table 9: Summary of falling head tests

Test Location	Depth (m bGL)	Time (mins)	Comments
WS01	0.85 to 1.10	180	Soil Infiltration Rate = 2.665E-07
WS03	0.46 to 0.9	240	Soil Infiltration Rate = 1.709E-05
WS05	0.85 to 1.10	60	Soil Infiltration Rate = 0

5.4 Visual and Olfactory Evidence of Contamination

Fragments of suspected asbestos sheeting was identified embedded in the underside of the concrete surfacing in WS01. Analysis confirmed the presence of Chrysotile cement.

A strong hydrocarbon odour was noted during the boring of WS02 (immediately adjacent to the above ground oil storage tank). Similar odours were not identified elsewhere. Subsequent

testing of the soils from this borehole confirmed the presence of Total Petroleum Hydrocarbons (TPH).

6 GEOTECHNICAL APPRAISAL

This geotechnical appraisal does not constitute a Geotechnical Design Report in accordance with EN1997. The following recommendations are for preliminary design purposes only. For the detailed design, the short and long-term design situations must be considered.

6.1 Foundations

6.1.1 Shallow Foundations

All loads should be transferred beneath the made ground, loose, soft, low strength, desiccated or disturbed soils and transferred onto the medium to very dense sands and gravels at a depth of around 1m. These granular soils are not considered to susceptible to significant volume changes as a result of moisture content variations. For low rise housing, based on local experience and BS8103[4] Table 8, an allowable bearing capacity of 175kPa is recommended for shallow foundations, minimum width 600mm. Based on this allowable bearing capacity settlements should be within typical tolerable limits for the low-rise development proposed.

Where foundations are stepped or span different soil types, allowance should be made for nominal reinforcement.

Foundation excavations should be inspected by a suitably qualified engineer prior to pouring concrete to ensure competent soils, in this case medium dense – dense sands and gravels are encountered at formation level.

6.1.2 Piling

For the ground conditions encountered on site, driven, bored or continuous flight augered (cfa) piles may be considered. However, given the proximity of adjacent buildings surrounding the site, driven piles may be excluded due to the vibrations induced during installation and the effect these may have on existing buildings. Therefore, conventional bored or cfa piles may be more suitable.

It should be noted that for bored or cfa piles in dense granular soils, the method of installation can have a significant effect on the density of the surrounding soils and therefore the angle of shearing resistance that may be used for design. A reduction in angle of shearing resistance of in the region of 10-30% may occur, depending on the drilling techniques selected. The direct use of in-situ testing for design should therefore be carefully considered, particularly in accordance EN1997. The most reliable method to obtain compliance with EN1997 would be to use static load tests to obtain the ULS resistance.

Given the potentially unstable nature of the gravels at depth, particularly below the water table, careful monitoring of the bored piles will be required when withdrawing temporary

[4] BS8103-1:2011 Structural design of low rise buildings BSI

casings or the flight auger, to prevent necking of the pile shafts. This problem should be discussed with the specialist contractor and a program of integrity testing may be required.

Discussions should be held with the specialist piling contractors to assess the technical and financial merits of their various systems for the ground conditions encountered, and the depth and size of pile required, with an adequate safety margin.

The final pile design will be determined by the selected piling contractor as the method of pile formation will affect the bearing capacity.

6.1.3 Floor Slabs

With reference to NHBC Standard 5.2, suspended floor slabs are recommended as the depth of made ground typically exceeds 600mm and this would need to be replaced with compacted fill. Suspended floor slabs would also be required where foundations are piled.

6.2 Sulphates and Buried Concrete

A total of 7 samples of the made / disturbed ground and the sands and gravels were tested for sulphate content and pH. In accordance with the BRE[5] methodology and the number of samples tested, the site has been classified on the site has been classified on the highest measured sulphate content.

Based on the results detailed above, the soils are classified by the BRE as sulphate design class DS-1, and, assuming a mobile groundwater table, the ACEC class is AC-1.

For a piled foundation solution, the test results in the London Clay indicate Sulphate Design Class of DS-2 and, assuming a static groundwater scenario, an ACEC Class of AC-1s has been determined. Pyrite is commonly found in London Clay soils and can produce acidic conditions that are aggressive to concrete, and can cause it to degrade. The appropriate Sulphate Design Class should be chosen to combat any possible degradation.

6.3 Groundwater and Soakaways

Long term groundwater monitoring was beyond the scope of works and would be required to fully assess the groundwater regime. Groundwater at about 4m below ground level should be anticipated based on the findings to date.

Based on the falling head tests performed in the boreholes, the results suggest that it could be possible to segregate regions of the site as suitable for shallow soakaways. It must be noted, however, that the test undertaken encompassed a small surface area of the ground conditions encountered and would not ensure that this region had a pathway for drainage

[5] Building Research Establishment Special Digest 1: 2005. Concrete in aggressive ground. Part 1: Assessing the aggressive chemical environment.

from it once saturated. It is further noted that the groundwater may limit storage. Regulatory consent would be required for any discharge, which may be complicated by the former site use and presence of relatively shallow groundwater.

6.4 Roads

Dynamic cone CBR tests were carried out in five locations across the site. The results were variable but indicate the sands and gravels to have high CBR value. Where made ground is encountered at formation level, proof rolling is recommended and some over excavation may be required (then controlled back filling to formation level with a suitable granular fill).

Further confirmatory testing may be required if the proposed roads are to be adopted.

6.5 Excavations

Excavations in made ground and loose superficial soils are likely to be unstable and subject to collapse.

Excavations in the sands and gravels should be stable in the short term. However, groundwater seepages should be anticipated along the more granular horizons below about 1m. Excavations will therefore be unstable in the long term and should be backfilled as soon as possible. Allowance should be made for light pumping.

Any excavations below the water table at about 4m below ground level, will be unstable in the granular soils. Excavations extending below the water table will require dewatering.

7 GEO-ENVIRONMENTAL APPRAISAL

The preliminary conceptual site model has identified a number of potential pollutant linkages. The final stage in the geo-environmental assessment comprises a quantitative risk assessment and revision of the preliminary Conceptual Site Model. The risk assessment has been carried out generally in accordance with UK industry standards and in particular in accordance with CLR11[4] and BS10175:2011.

7.1 Assessment Criteria

7.1.1 Human Health Assessment Criteria

Pollutant linkages containing human health have been risk assessed by comparing the soil laboratory test results to Tier 1 Generic Assessment Criteria. These are based on published Suitable for Use Levels (S4UL[7]) and Category Four Screening Levels (C4SL[8]) assuming a residential land use.

In accordance with current HPA guidance[9], the assessment of PAHs has been carried out using a surrogate marker approach, whereby the assessment of risk from Benzo(a)Pyrene also captures potential risks from other carcinogenic PAHs that may be present. The threshold PAHs have been assessed individually.

7.1.2 Groundwater and Surface Water Assessment Criteria

Groundwater testing was beyond the scope of this investigation. By way of a preliminary qualitative assessment, consideration has been given to the total soil concentrations and the sensitivity of any potential pollutant linkages involving controlled waters,

7.3 Analytical Test Results – Soils

The test data has been divided into two populations comprising made ground and natural ground. The datasets were insufficiently large to undertake statistical analysis. The data has therefore been compared directly with the screening criteria.

[4] Environment Agency, 2004. Model Procedures for the management of land contamination. Contaminated Land Report 11.

[7] The LQM/CIEH S4ULs for Human Health Risk Assessment, Nathaniel P et al, 2015. Copyright Land Quality Management Ltd, reproduced with permission: Publication Number S4UL3509

[8] CL:AIRE Final Project Report. SP1010 – Development of Category 4 Screening Levels for assessment of land affected by contamination. CL:AIRE, December 2013

[9] HPA Contaminated Land Information Sheet. Risk Assessment Approaches for Polycyclic Aromatic Hydrocarbons (PAHs). Version 3. Health Protection Agency, 2010.

7.3.1 Metals and Non-Metals

The test results for each population have been subject to statistical analysis as described above and the results tabulated below:

Table 10: Summary of soil contamination test results within made ground (5 samples)

Determinant	Maximum (mg/kg)	Tier 1 Generic Assessment Criteria (mg/kg)	No. of samples which exceed GAC
Arsenic	26.9	37	-
Cadmium	1.6	26	-
Chromium (total)	27.8	910	-
Hexavalent Chromium	<0.8	21	-
Copper	73.0	2400	-
Lead	1470	200	5
Mercury	0.7	40[1]	-
Nickel	32.1	130	-
Selenium	1.6	250	-
Zinc	643	3750	-

Notes to table

1. Assessment criterion based on inorganic Mercury

All 5 samples exceeded the GAC for lead. No other exceedances were recorded. No samples of natural ground were tested for metals.

7.3.2 Polyaromatic Hydrocarbons (PAH)

PAH are widespread within made ground and the urban environment generally. They are one of the most common contaminants in made ground and the one that most commonly drives remediation. Benzo(a)Pyrene is a particular problem, being very commonly found in association with tarmac, clinker and any burnt products and also being highly toxic to human

health. The assessment criterion for BaP is close to levels that are found naturally in many topsoils.

The mean Soil Organic Matter (SOM) of the population has been used to determine an appropriate Tier 1 GAC for each population. The results are summarised as follows:

Table 11: Summary of BaP and threshold PAHs in made ground (5 samples)- mean SOM 6%

Determinant	Maximum (mg/kg)	Tier1 Generic Assessment Criteria[1] (mg/kg) Residential with plant uptake 6% SOM	No. of Samples that exceed GAC
Benzo(a)Pyrene	17.2	5.0	1
Naphthalene	0.7	13	-
Acenaphthylene	2.0	920	-
Acenaphthene	0.3	1100	-
Fluorene	0.3	860	-
Phenanthrene	4.1	440	-
Anthracene	1.8	11000	-
Fluoranthene	17.5	890	-
Pyrene	16.1	2000	-

A single sample (WS01, 0.5m) exceeded the GAC for BaP. No other exceedances were recorded. No samples of natural ground were tested for PAHs.

7.3.3 Petroleum Hydrocarbons (PHC)

The PHC testing has been carried out on targeted samples based on visual and olfactory observations made on site. Only samples of natural ground were subjected to TPHCWG analysis. No samples exceeded the GACs. The laboratory data and screening table are presented in Appendix H.

7.3.4 Asbestos

All of the soil samples tested were screened for the presence of asbestos containing materials and/or loose asbestos fibres. No asbestos was detected in any soil sample. A sample of suspected cemented Chrysotile (white) asbestos found on the underside of the hardstanding at WS01 was confirmed to contain asbestos.

7.4 Risk Assessment

7.4.1 Human Health

The works carried out to date have indicated that the made ground is impacted with lead and the PAH compound benzo(a)pyrene.

Whilst the assessment has not found any other significant contamination, access into some areas, including those that may be impacted by on and off-site sources, has not been possible and there remains the possibility that as yet unidentified contamination may be present, particularly beneath currently existing structures such as the fuel tank and the workshops.

The lead and benzo(a)pyrene contamination identified poses a risk to human health, where present in critical areas such as gardens or areas of soft landscaping. Contamination may impact human health through the direct ingestion, inhalation, skin contact and/or plant uptake pathways that would be present in a residential setting. The contaminated ground is considered to pose an unacceptable risk if it is to be retained in the near surface of garden/outdoor soft covered areas where direct human contact is feasible.

The lead and BaP contamination is not considered to pose a risk to incoming water via permeation into supply lines.

7.4.2 Controlled Waters

The site is located above a secondary aquifer, the sands and gravels.

Specific laboratory testing has not been carried out as part of this investigation to enable a detailed quantitative risk assessment in respect of groundwater. The measured levels of potential contaminants within the made ground soils are generally low, with only lead, and benzo(a)pyrene contamination recorded at levels considered to pose a risk to human health. Some elevated concentrations of petroleum hydrocarbons have been detected in the shallow natural ground. However, where present, these comprise heavy end fractions which are less mobile and soluble and hence present a lower risk to controlled waters receptors. The concentrations recorded are considered unlikely to pose a significant risk to groundwater. This assessment should be reconsidered if significant contamination is identified at a later stage.

There are no surface water features on site. The closest surface water feature is some 671m from the site. Based on this information and the recorded concentrations of contaminants the site is not considered to pose a risk to surface water receptors.

7.4.3 Land gases

By way of a preliminary risk assessment we have adopted "the pragmatic approach to ground gas risk assessment" as presented by Card et al 2012[19]. This approach considers the Total Organic Content (TOC) of the made ground as well as the age and depth of the fill.

Although the organic content of the made ground locally is slightly high (especially where this is suspected to be a former topsoil) its overall thickness is minimal and much, if not all, will be removed as part of the development and as such, coupled with the fact that there are no obvious off-site sources, there is not considered to be a risk of ground gas at the site.

7.5 Waste Disposal

It is anticipated that the proposed development will generate waste soils that will need to be removed from site as part of the construction process.

Where soils are to be disposed off-site, it is the duty of the waste producer, in this case Aquinna Homes, to ensure that all waste is disposed of appropriately and that any that is sent to landfill is sent to an appropriately licensed one.

It is considered that some of the soils would be classified as hazardous for waste disposal purposes (primarily due to elevated lead and TPH concentrations), however it is recommended that this is confirmed with a haulier/receiving site. Further testing (comprising Waste Acceptance Criteria – WAC) and inspection of soils will be required to confirm waste classification of material leaving the site. An allowance should be made for these additional costs. It is noteworthy however, that due to the fairy nominal thickness of the made ground that the volume requiring offsite disposal will be fairly low reducing the significance of these additional costs.

7.6 Recommendations for Remediation

Access into some areas of the site was restricted due to buildings and services. It is recommended that once the structures have been demolished and hard standing removed, formation inspections and further intrusive investigations / delineation of contamination be undertaken. The western part of the site, around the oil storage tank should be targeted, together with areas where workshops are currently present and where elevated concentrations of petroleum hydrocarbons were identified during this investigation.

Hardstanding and shallow made ground should be inspected as it is removed and any observed cemented asbestos removed by hand thusly preventing the cross contamination of any crushed material intended for re-use on site.

[19] Card G., Wilson S, Mortimer S. 2012. A pragmatic approach to ground gas risk assessment. CIRIA Research Bulletin RB17.

It is recommended that all made ground beneath areas of garden and public open space / soft landscaping be removed and replaced with a minimum of 600mm of certified clean imported subsoil and topsoil. Imported soils should be tested at source by the supplier. An environmental scientist / validation engineer should then make spot checks as and when necessary once material has been imported.

It is further recommended that an allowance be made for excavation and removal off site of an additional volume of material around the area of the oil storage tank (possibly to a depth of around 2+m). This work should be overseen by a specialist environmental scientist / validation engineer, who should sample the extremities of the excavation to ensure all impacted material has been removed. These samples should be submitted for laboratory analysis.

Provision should also be made for dealing with further localised hotspots of contamination which may come to light during construction. Any such soils should be inspected by the environmental scientist / validation engineers and appropriate remedial action taken as necessary.

Thus, it is recommended that a brief remediation method statement be prepared.

APPENDIX A - LIMITATIONS

Limitations

LIMITATIONS

This report is confidential to the Client, and Leap Environmental Ltd accepts no responsibility whatsoever to third parties to whom this report, or any part thereof, is made known, unless formally agreed by Leap Environmental Ltd beforehand. Any such party relies upon the report at their own risk. Unless explicitly agreed otherwise in writing, this report has been prepared under LEAP's standard terms and conditions, as included in the quotation for this works.

This report has been prepared by Leap Environmental Ltd on the basis of information received from a variety of sources which Leap Environmental Ltd believes to be accurate. Nevertheless, Leap Environmental Ltd cannot and does not guarantee the authenticity or reliability of the information it has obtained from others.

Leap Environmental Ltd has used all reasonable skill, care and diligence in the design and execution of this report, taking into account the manpower and resources devoted to it in agreement with the Client. Although every reasonable effort has been made to obtain all relevant information, all potential contamination, environmental constraints or liabilities associated with the site may not necessarily have been revealed. LEAP cannot be held responsible for any disclosures or changes in regulation that are provided post production of this report, and will not automatically update the report.

The conclusions reached in this report are necessarily restricted to those which can be determined from the information consulted, and may be subject to amendment in the light of additional information becoming available. These conclusions may not be appropriate for alternative schemes.

The extent of the exploratory holes, laboratory testing and monitoring undertaken may have been restricted due to a number of factors including accessibility, the presence of buried or overhead services, current development and site usage, timescales or client/s specification. The exploratory holes only assess a small proportion of the site area with respect to the site as a whole, and as such may only provide an overall assessment of ground conditions on site. The presence of hotspots of undisclosed contamination or exceptional and unforeseen ground conditions cannot be discounted.

Eurocode 7 gives guidance on the type of sampling, sample quality, number and spacing of intrusive investigations, and number of laboratory tests required. It is intended that the Geotechnical Information section of this report will fulfil the general requirements of the Ground Investigation Report as set out in section 6 of Eurocode7[1], although this is subject to the restrictions imposed on the investigation as listed above. For geotechnical design, Eurocode 7 requires the Geotechnical Design Report to address both the geotechnical and

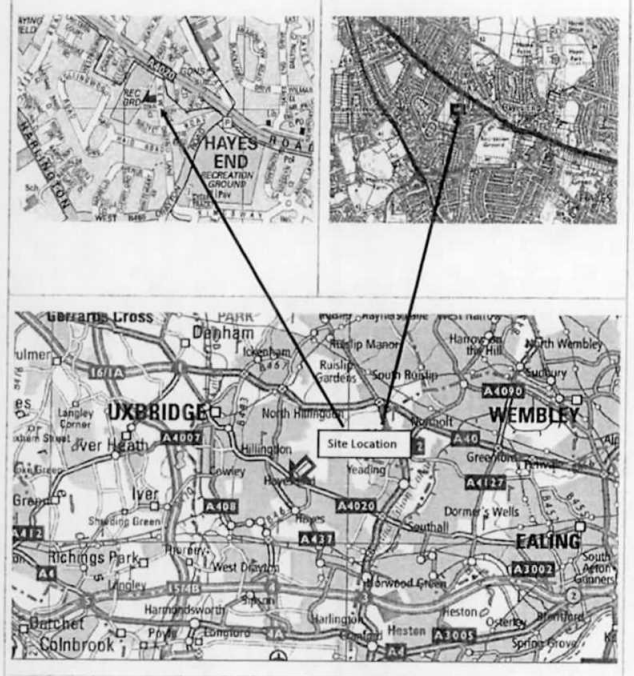
[1] BS EN 1997 Eurocode 7- Geotechnical Design - Part 1: General Rules (2004) and Part 2: Ground Investigation and Testing (2007)

structural aspects of the geotechnical design for both the limit and serviceability states. The Geotechnical Appraisal section of this report will not meet the requirements of a Geotechnical Design Report (GDR), and should therefore be used for preliminary guidance only.

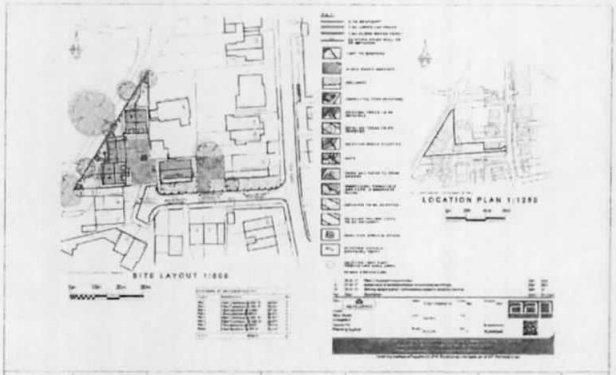
The presence of asbestos may be noted during the site walkover survey, intrusive investigations and/or from the results of contamination testing. However, this report does not constitute an asbestos survey. On this basis, the presence of asbestos on site cannot be discounted and a full asbestos survey should be undertaken.

APPENDIX B - FIGURES

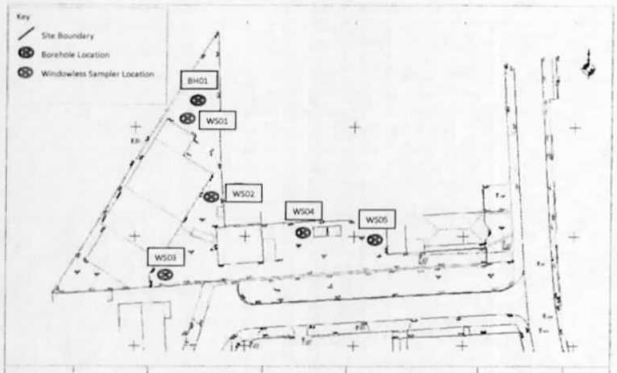
Figures



	Client:	Aquinna Homes	Title:	Site Location Plan	Project: LP1412
	Project:	New Road, Hillingdon	Date:	25/08/2017	Figure No. 1



Client:	Aquinna Homes	Title:	Proposed Site Layout	Project:	LP1412
Project:	New Road, Hillingdon	Date:	25/08/2017	Figure No.	2



Client:	Aquinna Homes	Title:	Borehole Location Plan	Project:	LP1412
Project:	New Road, Hillingdon	Date:	25/08/2017	Figure No.	3

APPENDIX D – QUALITATIVE RISK ASSESSMENT MODEL

Qualitative Risk Assessment Model

QUALITATIVE RISK ASSESSMENT MODEL

The Qualitative Risk Assessment Model used is based upon that developed by the NHBC[1] (2008) which is itself developed from (DOE, 1995) A Guide to Risk Assessment and Risk Management for Environmental Protection; and the Statutory Guidance on Contaminated Land (Defra, September 2006). The methodology is based on that presented in CIRIA[2] C552 2001; but differs in terms of the definitions of classification of consequence, which include a consideration of immediacy of hazards.

The key to the classification is that the designation of risk is based upon the consideration of both:

A) the magnitude of the potential consequence (i.e. severity) [takes into account both the potential severity of the hazard and the sensitivity of the receptor]

B) the magnitude of probability (i.e. likelihood) [takes into account both the presence of the hazard and receptor and the integrity of the pathway]

These are defined in the tables on the following pages:

Table 1 Classification of Consequence

Classification	Definition	Examples
Severe	Highly elevated concentrations **likely** to result in "significant harm" to human health as defined by the EPA 1990 Part 2a, if exposure occurs. Equivalent to **EA Category 1** pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce. Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long term maintenance of the population. Catastrophic damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Major fish kill in surface water from large spillage of contaminants from site. Highly elevated concentrations of List I and II substances present in groundwater close to small potable abstraction (high sensitivity). Explosion, causing building collapse (can also equate to immediate human health risk if buildings are occupied).
Medium	Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990 Part 2A if exposure occurs. Equivalent to **EA Category 2** pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long term maintenance of the population. Significant damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Damage to building rendering it unsafe to occupy e.g. foundation damage resulting in instability. Ingress of contaminants through plastic potable water pipes/

[1] Guidance for the Site Development of Housing on Land Affected by Contamination (NHBC 2008) Phase 4
[2] C552 Contaminated Land Risk Assessment: A Guide to Good Practice

Mild	Exposure to human health **unlikely** to lead to "significant harm"*. Equivalent to **EA Catagory 3** pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change on its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population. Minor damage to crops, buildings or property.	Exposure could lead to slight short-term effects (e.g. mild skin rash). Surface spalling of concrete.
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects or damage to buildings, structures and services.	The loss of plants in a landscaping scheme. Discolouration of concrete.

*For these purposes disease is to be taken to mean an unhealthy condition of the body or a part off it and can include, for example, cancer, liver dysfunction or extensive skin ailments. Mental dysfunction is included only in so far as it is attributable to the effects on the body of the person concerned.

Table 2 Classification of probability

Category	Definition	Examples
High Likelihood	There is pollutant linkage and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.	A) Elevated concentrations of toxic contaminants are present in soils in the top 0.5m in a residential garden. B) Ground/groundwater contamination could be present from chemical works, containing a number of USTs, having been in operation on the same site for over 50 years.
Likely	There is a pollutant linkage and all the elements are present and in the right place which means that it is probably that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long-term.	A) Elevated concentrations of toxic contaminants are present in soils at depths of 0.5 – 1m in a residential garden, or the top 0.5m in public open space. B) Ground/groundwater contamination could be present from an industrial site containing a UST present between 1970 and 1990. The tank is known to be single skin. There is no evidence of leakage although there are no records of integrity tests.
Low Likelihood	There is pollutant linkage and circumstances are possible under which an event could occur. However it is by no means certain that even over a long period such an event would take place, and is less likely in the shorter term.	A) Elevated concentrations of toxic contaminants are present in soils at depths >1m in a residential garden, or 0.5 – 1m in public open space. B) Ground/groundwater contamination could be present on a light industrial unit constructed in the 1990s containing a UST in operation over the last 10 years – the tank is double skinned but there is no integrity testing or evidence of leakage
Unlikely	There is a pollutant linkage but circumstances are such that it is improbably that an event would occur even in the very long-term.	A) Elevated concentrations of toxic contamination are present below hardstanding. B) Light industrial unit <10 yrs old containing a double skinned UST with annual integrity testing results available.

would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.

Very low risk

It is a low possibility that harm could arise to a designated receptor, but it is likely at worst, that this harm if realised would normally be mild or minor.

No potential risk

There is no potential risk if no pollution linkage has been established.

Definitions	
Hazard	A property or situation which in certain circumstances could lead to harm. [The properties of different hazards must be assessed in relation to their potential to affect the various different receptors].
Risk	A combination of the probability or frequency of the occurrences of a defined hazard **AND** the magnitude of the consequence of that occurrence.
Probability	The mathematical expression of the chance of a particular event in a given period of time [e.g. probability of 0.2 is equivalent to 20% or a 1 in 5 chance].
Likelihood	Probability; the state or fact of being likely.
Consequences	The adverse effects (or harm) arising from a defined hazard which impairs the quality of the environment or human health in the short or longer term.
Pollution Linkage	An identified pathway is capable of exposing a receptor to a contaminant and that contaminant is capable of harming the receptor.

Risk is then classified as a product of the magnitude of the potential consequence and the likelihood of it coming about as follows:

Table 3. The classification of risk

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability (Likelihood)	**High likelihood**	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

Description of the classified risks

Very high risk

There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action OR there is evidence there severe harm to a designated receptor is already occurring. Realisation of the risk is likely o present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency and remediation works likely to follow in the short term.

High risk

Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short term and are likely over the longer term.

Moderate risk

It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term.

Low risk

It is possible that harm could arise to a designated receptor from identified hazard, but it is unlikely at worst, that this harm if realised would normally be mild. It is unlikely that the site owner/or occupier

Qualitative Risk Assessment of Pollutant Linkages

Contaminant	Receptor	Route [1]	Pathway [1]	Likelihood of Occurrence [2]	Severity of Consequence [3]	Risk Classification [4]	Notes
Polyaromatic Hydrocarbons, Petroleum Hydrocarbons, Mineral Oil, grease and VOCs	Future Residents	1	Ingestion of soil	Likely	Medium		Pathways involving dermal contact are more likely to occur, though would have less severe consequences. The severity of the consequences is generally related to the levels of concentration present, which has been evaluated from what we have determined about the site from the desk study. Concentrations of PAH compounds are considered likely to be highest and these are likely to be the key risk drivers.
		2	Ingestion of household dust	Likely	Medium		
		3	Ingestion of contaminated vegetables	Likely	Medium		
		4	Ingestion of soil attached to vegetables	Likely	Medium		
		5	Dermal contact with soil	High likelihood	Mild		
		6	Dermal contact with household dust	High likelihood	Mild		
		7	Inhalation of fugitive soil dust	Likely	Medium		
		8	Inhalation of fugitive soil dust infiltration of fugitive household dust	Likely	Medium		
		9	Inhalation of vapours outside	Unlikely	Medium	Low risk	
		10	Inhalation of vapours inside	Likely	Medium		
	Turfgrass Residents and Neighbours		Inhalation of vapours via contaminated groundwater/ plume	Unlikely	Medium	Low risk	Considered to be unlikely as this would require a significant source of contamination below the subject site.
	Construction workers	1	Ingestion of soil	Low likelihood	Severe		The risk posed to construction workers is limited to acute toxicity, which is considered to present a severe risk. However, the presence of contaminants in sufficient quantities to present an acute risk is considered to be low. Any risk would be mitigated
		5	Dermal contact with soil	Low likelihood	Severe		
		7	Inhalation of fugitive soil dust	Low likelihood	Severe		
		9	Inhalation of vapours outside	Unlikely	Severe	Medium or low risk	
	Groundwater		Impregnation flow of free products	Likely	Medium		The consequence of construct workers pollution is considered to be medium due to the sensitivity of receiving groundwater (a secondary A aquifer). The potential for leaching and future contamination of groundwater is considered to be moderate due to the presence of gardens and landscaping / soft standing within the development. Conversely, the risk will be reduced by the likely removal of the majority of the made ground which is likely to be the source of any contamination.
			Rainwater infiltration and leaching of contaminated soil	Likely	Medium		
	Surface water		Rainwater infiltration and leaching, impregnation flow via groundwater or controlled waters	Unlikely	Mild	Very low risk	The nearest surface water body is greater than 500m from the site. Surface runoff over this distance is considered to be highly unlikely.

Contaminant	Receptor	Route [1]	Pathway [1]	Likelihood of Occurrence [1]	Severity of Consequence [1]	Risk Classification [1]	Notes
			Surface water run-off	Unlikely	Mild	Very low risk	
	Material contamination of buildings and infrastructure		Contact of building materials, including water supply pipes with contaminated soils and/or contaminated groundwater	Low likelihood	Mild	Low risk	Underground structures will be in prolonged contact with the ground however the majority of the made ground is likely to be recovered and services will not be in contact with the groundwater as it is present at greater depth.
Heavy Metals	Future Residents	1	Ingestion of soil	Likely	Medium		Pathways involving dermal contact are more likely to occur, though would have less severe consequences. The severity of the consequences is generally related to the levels of contamination present, which has been estimated from what we have determined about the site from the desk study. Given the site history and that of the surrounding land uses heavy metal contamination in the soil cannot be discounted.
		2	Ingestion of household dust	Likely	Medium		
		3	Ingestion of contaminated vegetables	Likely	Medium		
		4	Ingestion of soil attached to vegetables	Likely	Medium		
		5	Dermal contact with soil	High likelihood	Mild		
		6	Dermal contact with household dust	High likelihood	Mild		
		7	Inhalation of fugitive soil dust	Likely	Medium		
		8	Inhalation of fugitive household dust	Likely	Medium		
	Construction workers	1	Ingestion of soil	Low likelihood	Severe		The risk posed to construction workers is considered to be moderate as the potential exposure and dust generation could be high. However, the exposure duration is anticipated to be short and risks could be mitigated through good construction practices and hygiene measures.
		5	Dermal contact with soil	Low likelihood	Severe		
		7	Inhalation of fugitive soil dust	Low likelihood	Severe		
	Groundwater		Rainwater infiltration and leaching of contaminated soil	Low likelihood	Mild	Low risk	Mobilisation of metals is low, except in acidic conditions.
	Surface water		Rainwater infiltration and leaching, intergranular flow via groundwater to controlled waters	Unlikely	Medium	Low risk	Mobilisation of metals is low, except in acidic conditions and the nearest surface water is over 500 m from the site.
			Surface water run-off	Unlikely	Mild	Very low risk	

Contaminant	Receptor	Route [1]	Pathway [1]	Likelihood of Occurrence [1]	Severity of Consequence [1]	Risk Classification [1]	Notes
Asbestos	Future Residents	7	Inhalation of fugitive soil dust	Likely	Severe	[illegible]	Consequences of asbestos inhalation even at very low concentrations have the potential to be severe.
		8	Inhalation of fugitive household dust	Likely	Severe	[illegible]	Asbestos or ACM maybe contained within existing buildings and on Made Ground.
	Construction workers	7	Inhalation of fugitive soil dust	Likely	Severe	[illegible]	Consequences of asbestos inhalation even at very low concentrations have the potential to be severe.

Notes to table:

1. Classification of human exposure pathways (routes) from The CLEA model, Research and Development Publication CLR10.

2. Classification of Probability and Consequence from CIRIA C552 Contaminated land risk assessment, a guide to good practice 2001

3. Risk Classification from DETR Guidelines for Environmental Risk Assessment and Management, 2000

APPENDIX E – SITE PHOTOGRAPHS

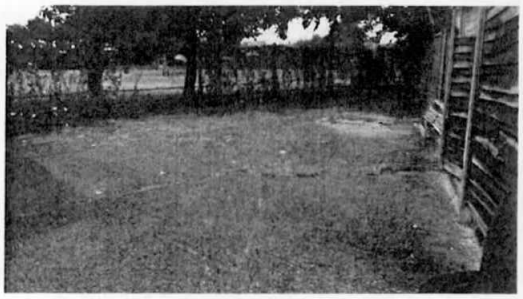
Site Photographs



View looking west into site.



View looking east into eastern region of site.



View looking north into upper northern corner.



South facing view of centre of site.



West facing view of central site.



Oil and chemical storage area within garage



Tyre Storage are to the north of the site.



Former oil storage tank to the north of the site.



Gas canister storage area.



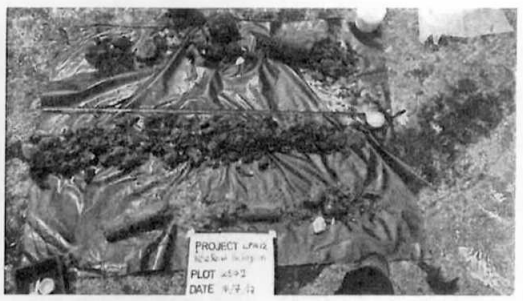
Asbestos cement noted in the base of the concrete.



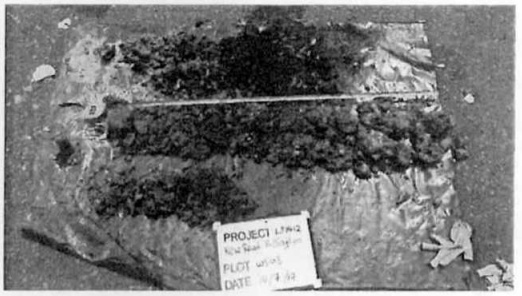
WS01 – 1.00m to 1.40m



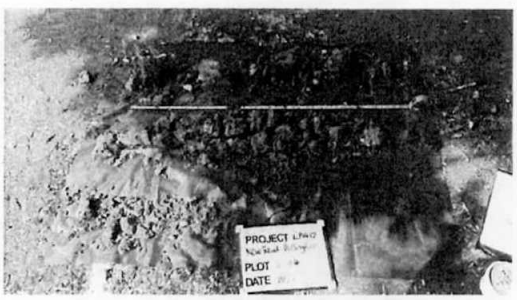
WS01 – 1.40m to 1.75m



WS02 – 0.00m – 2.60m



WS03 – 0.00m to 2.20m



WS04 – 0.00m to 2.20m



WS05 – 0.00m to 2.20m.

APPENDIX F – BOREHOLE LOGS

Borehole Logs

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Dorking, Surrey RH4 1XA
Tel: 01306 646510
www.leapenvironmental.com

Borehole Log

Borehole No. **BH01** Sheet 1 of 2

Project Name:	Punters Garage, Hillingdon	Project No. LP1412	Co-ords: -
Location:	New Road, Hillingdon		Level:
Client:	Aquinna Homes		Dates: 07/08/2017 - 07/08/2017

Hole Type: CP | Scale: 1:50 | Logged By: PA

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.05			MADE GROUND: Concrete.
		0.50	D		0.15			MADE GROUND: Light greyish cream becoming light brown silty sand with fragments of concrete and brick (>60mm) and with rare glass and metal. (Possible former topsoil)
		0.65	B		0.65			
		1.00	B		0.90			MADE GROUND: Brown silty sandy slightly gravelly loam with roots and with rare fragments of brick and metal. Gravel is subrounded to rounded medium of flint. (Possible former topsoil)
		1.00	D					
		1.00		50 (13,/50 for 225mm)	1.50			At 1.15m: root.
								Light brown slightly clayey slightly gravelly SAND with roots. Gravel is angular to rounded fine to coarse of flint.
		2.00	B					
		2.00	D					
		2.00		N=50 (25,/50 for 230mm)				Very dense light brown clayey very sandy GRAVEL. Gravel is angular to rounded fine to coarse of flint.
								Very dense becoming dense light brown clayey very sandy GRAVEL. Gravel is angular to rounded fine to coarse of flint.
		3.00	B					Below 2.50m: damp.
		3.00	D					At 3.00m, band of slightly clayey sand with flint gravel and occasional cobbles.
		3.00		50 (23,/50 for 185mm)				
		4.00	B					At 4.00m, gravel is less frequent.
		4.00	D					
		4.00		N=41 (12,/8,9,11,13)				
		5.00	D					Between 5.00m and 6.00m: sand is medium and coarse with low cobble content. Cobbles are of flint.
		5.00		N=39 (13,/9,8,10,12)				
		6.00	D		6.00			Medium dense light brown clayey very sandy GRAVEL. Gravel is angular to rounded fine to coarse of flint.
		6.50		N=11 (6,/3,3,2,3)				
		7.40	D		7.40			Firm to stiff fissured brown CLAY with pertings of fine orange sand.
		8.00	D		8.00			High and very high strength greyish blue silty CLAY with occasional selenite crystals (<2mm)
		8.00		N=25 (7,/5,6,7,7)				
		9.00	D					
		9.50	U	Ublow=100				
		10.00	D					Continued on next sheet

Remarks
Borehole dry during boring, however, water added to facilitate drilling may have masked any strikes. Driller noted hole collapsed below 4.20m after termination. Groundwater level dipped at 3.80m post removal of casing.

AGS

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The Atrium, Curtis Road
Dorking, Surrey RH4 1XA
Tel: 01306 646510
www.leapenvironmental.com

Borehole Log

Borehole No. **BH01** Sheet 2 of 2

Project Name:	Punters Garage, Hillingdon	Project No. LP1412	Co-ords: -
Location:	New Road, Hillingdon		Level:
Client:	Aquinna Homes		Dates: 07/08/2017 - 07/08/2017

Hole Type: CP | Scale: 1:50 | Logged By: PA

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		11.00	D					
		11.00		N=28 (7,/6,7,7,8)				
		12.50	U	Ublow=100				
		13.00	D		13.00			End of borehole at 13.00 m

Remarks
Borehole dry during boring, however, water added to facilitate drilling may have masked any strikes. Driller noted hole collapsed below 4.20m after termination. Groundwater level dipped at 3.80m post removal of casing.

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Borehole Log

Borehole No. **WS01** Sheet 1 of 1

Project Name:	Punters Garage, Hillingdon	Project No. LP1412	Co-ords: -
Location:	New Road, Hillingdon		Level:
Client:	Aquinna Homes		Dates: 13/07/2017 - 14/07/2017

Hole Type: WS | Scale: 1:20 | Logged By: AFC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.15	ES		0.11			MADE GROUND: Concrete with fragments of brick and sheeting in base.
								MADE GROUND: Brown sandy gravelly clay with roots and rootlets and fragments of brick. Gravel is subangular to rounded fine to coarse of flint. (Possible former topsoil).
		0.50	B		0.40			Soft orangish brown sandy slightly gravelly CLAY with roots and rootlets, iron staining and pockets of coarse sand. (Possibly reworked natural).
		0.85	B		0.80			Very dense orange slightly sandy clayey GRAVEL with pockets of yellow sand and mottles of light grey and bright orange clay.
		1.00	D					
		1.00		N=55 (2,2/4,12,15,24)				
		1.20	D					
		1.40	B		1.40			Orangish brown clayey gravelly SAND with mottles of light grey silty sandy clay and pockets of coarse bright orange sand. Gravel is subangular fine to coarse of flint.
					2.40			End of borehole at 2.40 m

Remarks
Inspection pit was hand dug to 1.00m. CBR performed at 0.50m. Soakaway performed in pit at 1.00m. Borehole progressed with sampler until refusal at 1.40m. Dynamic probe testing from 1.00 - 2.00m. Borehole progressed with sampler again until refusal at 1.75m. Dynamic probe testing 2.00m until refusal at 2.40m.

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Borehole Log

Borehole No. **WS02** Sheet 1 of 1

Project Name:	Punters Garage, Hillingdon	Project No. LP1412	Co-ords: -
Location:	New Road, Hillingdon		Level:
Client:	Aquinna Homes		Dates: 13/07/2017 - 14/07/2017

Hole Type: WS | Scale: 1:20 | Logged By: AFC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
					0.13			MADE GROUND: Concrete.
		0.15	ES					MADE GROUND: Brown sandy clay with roots and rootlets and fragments of brick. (Possible former topsoil).
		0.40	B		0.42			Soft orange with dark orange mottling sandy slightly gravelly CLAY with traces of organic debris. Gravel is of flint. (Possibly reworked natural).
		0.66	B		0.66			Orange clayey very sandy GRAVEL. Gravel is subangular and subrounded fine to coarse of flint.
		0.90	ES		0.92			Between 0.90m to 1.40m: with black staining and hydrocarbon odour decreasing with depth.
		1.00	B					Very dense light orange clayey sandy GRAVEL. Sand is predominantly coarse. Gravel is subangular to subrounded fine to coarse of flint.
		1.00	D					
		1.00		N=63 (5,9/11,14,19,19)				
		1.40	B		1.40			Orange slightly clayey gravelly SAND. Gravel is subangular fine to coarse of flint.
		1.60	B		1.60			Very dense orange slightly clayey very gravelly SAND. Sand is predominantly coarse. Gravel is subangular fine and medium of flint.
		1.80	ES					At 1.80m: thin band of gravel with black staining. Slight hydrocarbon odour.
		2.00		N=64 (9,13/16,17,17,14)				Between 2.00m and 2.40m: sample recovered wet.
					2.40			Orange slightly clayey gravelly SAND. Sand is coarse. Gravel is subangular fine to coarse of flint.
								At 2.40m: with grey sand mottles
					2.90			End of borehole at 2.90 m

Remarks
Inspection pit was hand dug to 0.92m. CBR performed at 0.42m. Borehole progressed with sampler 1.00m - 2.00m. Borehole progressed with sampler from 2.00m until refusal at 2.60m. Dynamic probe testing from 2.60m until refusal at 2.90m.

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Borehole Log

Borehole No. **WS03**
Sheet 1 of 1

Project Name:	Punters Garage, Hillingdon	Project No. LP1412	Co-ords: -
Location:	New Road, Hillingdon		Level:
Client:	Aquinna Homes		Dates: 13/07/2017 - 14/07/2017

Hole Type: WS
Scale: 1:20
Logged By: AFC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.08	ES		0.08			MADE GROUND: Tarmac.
		0.18	ES		0.18			MADE GROUND: Light yellow sand and gravel subbase with lumps of concrete.
								MADE GROUND: Brown sandy clay with fragments of brick, glass and rare chalk. (Possible former topsoil)
		0.46	B		0.46			Brownish yellow sandy clayey GRAVEL with lumps of clay. Gravel is subangular to subrounded fine to coarse of flint.
								Between 0.74m and 1.80m, recovered damp. At 0.75m slow groundwater ingress.
		1.00	B		1.00			Very dense orange slightly clayey gravelly SAND with partings of light grey sand. Sand is predominantly coarse. Gravel is subangular fine to coarse of flint.
		1.00	D					
		1.00		N=51 (5,7/10,14,13,14)				
		1.60	B		1.60			Very dense orange clayey very gravelly SAND. Sand is coarse. Gravel is subangular fine to coarse of flint.
		1.80		61 (9,15/61 for 225mm)				
					2.20			End of borehole at 2.20 m

Remarks
Inspection pit was hand dug to 0.90m. CBR performed at 0.46m. Soakway performed in pit at 0.90m. Borehole progressed with sampler to 1.80m. Borehole progressed with sampler 1.80m to refusal at 2.20m. Dynamic probe testing from 2.00m until refusal at 2.20m.

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Borehole Log

Borehole No. **WS04**
Sheet 1 of 1

Project Name:	Punters Garage, Hillingdon	Project No. LP1412	Co-ords: -
Location:	New Road, Hillingdon		Level:
Client:	Aquinna Homes		Dates: 13/07/2017 - 14/07/2017

Hole Type: WS
Scale: 1:20
Logged By: AFC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.10	ES		0.09			MADE GROUND: Tarmac.
								MADE GROUND: Brown clayey sand with fragments of brick, clinker and concrete.
		0.53	ES		0.53			MADE GROUND: Intermixed soft light orange gravelly clay with pockets of dark brown clay with brick fragments.
		1.00	B		1.00			Medium dense bright orange clayey very gravelly SAND with seams of light grey silty sandy gravelly clay and with pockets of light grey coarse sand. Sand is predominantly medium.
		1.00	D					
		1.00		N=20 (1,2/3,4,6,7)				
		1.90	D		1.90			Very dense light yellow sandy GRAVEL. Sand is predominantly coarse. Gravel is angular fine and medium of flint.
		1.90		55 (9,/55 for 150mm)				
					2.40			End of borehole at 2.40 m

Remarks
Inspection pit was hand dug to 1.10m. CBR performed at 1.10m. Borehole progressed with sampler 1.00m to 1.90m. Borehole progressed with sampler until refusal at 2.20m. Dynamic probe testing from 2.00m until refusal at 2.40m.

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Borehole Log

Borehole No. **WS05**
Sheet 1 of 1

Project Name:	Punters Garage, Hillingdon	Project No. LP1412	Co-ords: -
Location:	New Road, Hillingdon		Level:
Client:	Aquinna Homes		Dates: 13/07/2017 - 14/07/2017

Hole Type: WS
Scale: 1:20
Logged By: AFC

Well	Water Strikes	Samples and In Situ Testing: Depth (m)	Type	Results	Depth (m)	Level (m)	Legend	Stratum Description
		0.09	ES		0.09			MADE GROUND: Tarmac.
		0.20	ES		0.20			MADE GROUND: Concrete / cemented sands and gravels.
		0.35	B		0.35			MADE GROUND: Brown sandy CLAY with fragments of brick. (Possible former topsoil)
								MADE GROUND: Light yellowish brown silty gravelly sand with roots and rootlets and rare fine gravel sized fragments of brick.
		0.85	B		0.85			Orangish brown slightly clayey sandy GRAVEL with pockets of bright orange clayey sand. Gravel is subangular fine to coarse.
		1.00	B		1.00			Medium dense orange clayey gravelly SAND. Sand is predominantly coarse. Gravel is subangular fine to coarse of flint.
		1.00	D					At 1.00m; band of bright orange coarse sand.
		1.00		N=19 (1,4/5,4,4,6)				
		1.50	B		1.50			Very dense light yellowish orange very clayey gravelly SAND with pockets of light green clayey sand and light yellowish sand.
		2.00	ES					
		2.00		N=69 (4,9/11,12,22,24)				
					2.50			End of borehole at 2.50 m

Remarks
Inspection pit was hand dug to 1.10m. CBR performed at 0.85m. Soakway performed in pit at 1.10m. Borehole progressed with sampler to 2.00m. Borehole progressed with sampler 2.00m to refusal at 2.20m. Dynamic probe testing from 2.00m until refusal at 2.50m.

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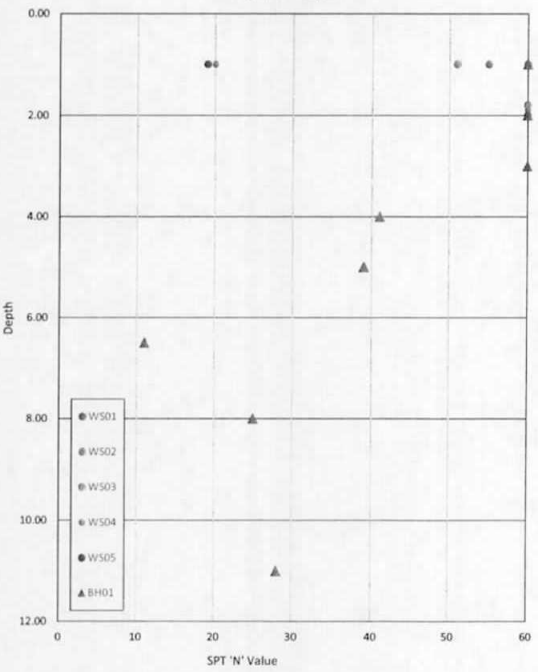
LP1412 Punters Garage, Hillingdon

SPT 'N' Value Against Depth



Remarks
SPT 'N' values exceeding 60 have been plotted at 60 for graphical purposes only

APPENDIX G – FIELD TEST RESULTS

Field Test Results

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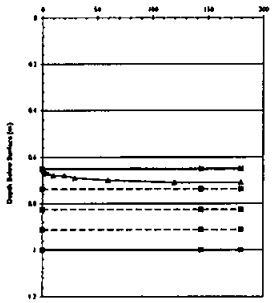
SOIL INFILTRATION TEST

Filling to Max Water Depth (min)



Test Hole No: WS01

Diameter of Borehole (m)	0.30
Depth to End of Borehole Casing (m)	None
Depth to Borehole Base (m)	1.00
Depth to Top of Permeable Soils (m)	0.80
Depth to Groundwater Surface (m)	None
Depth to Top of Granular Fill (m)	N/A
Voids Assumed within Borehole (%)	N/A
Depth of Water at Start of Test (m)	0.65
Max Water Dropdown during Test (m)	0.06
Total Soakage Test Time (min)	180
Mean Internal Discharge Area (m2)	0.2183407
Discharge Rate (ltr/min)	0.0024907
Soakage Rate (ltr/m2/min)	0.0159872
Soil Infiltration Rate (m/sec)	2.665E-07

Comments: Water level did not fall to 75% max water depth, calculations were based on actual fall of water level. Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client:	Aquinna Homes
Site:	New Road, Hillingdon
Tested By:	AFC
Test Date:	13/07/17

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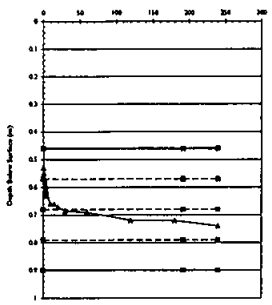
SOIL INFILTRATION TEST

Filling to Max Water Depth (min)



Test Hole No: WS03

Diameter of Borehole (m)	0.30
Depth to End of Borehole Casing (m)	None
Depth to Borehole Base (m)	0.90
Depth to Top of Permeable Soils (m)	0.46
Depth to Groundwater Surface (m)	0.74
Depth to Top of Granular Fill (m)	N/A
Voids Assumed within Borehole (%)	N/A
Depth of Water at Start of Test (m)	0.46
Max Water Dropdown during Test (m)	0.28
Total Soakage Test Time (min)	240
Mean Internal Discharge Area (m2)	0.2199115
Discharge Rate (ltr/min)	0.2255503
Soakage Rate (ltr/m2/min)	1.025643
Soil Infiltration Rate (m/sec)	1.709E-05

Comments: Water level fell to 50% – 25% max water depth, calculations were based on actual fall of water level. Result not compliant with BREMS requirement since water did not fall to 25% max water depth.

Client:	Aquinna Homes
Site:	New Road, Hillingdon
Tested By:	AFC
Test Date:	13/07/17

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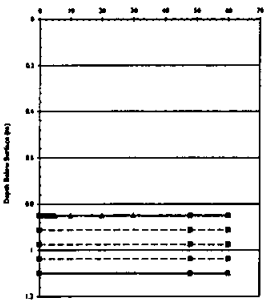
SOIL INFILTRATION TEST

Filling to Max Water Depth (min)



Test Hole No: WS05

Diameter of Borehole (m)	0.18
Depth to End of Borehole Casing (m)	None
Depth to Borehole Base (m)	1.10
Depth to Top of Permeable Soils (m)	0.85
Depth to Groundwater Surface (m)	None
Depth to Top of Granular Fill (m)	N/A
Voids Assumed within Borehole (%)	N/A
Depth of Water at Start of Test (m)	0.85
Max Water Dropdown during Test (m)	0
Total Soakage Test Time (min)	60
Mean Internal Discharge Area (m2)	0.1668186
Discharge Rate (ltr/min)	0
Soakage Rate (ltr/m2/min)	0
Soil Infiltration Rate (m/sec)	0

Comments: Water level did not fall to 75% max water depth, calculations were based on actual fall of water level. Result not compliant with BRE365 requirement since water did not fall to 25% max water depth.

Client:	Aquinna Homes
Site:	New Road, Hillingdon
Tested By:	AFC
Test Date:	13/07/17

Dynamic Cone CBR Test

Nr Blows	S Blows	Penetration mm	S Pen. mm
1	1	50	50
1	2	50	100
0	2	50	150
1	3	50	200
0	3	50	250
1	4	50	300
2	6	50	350
5	11	50	400
10	21	50	450

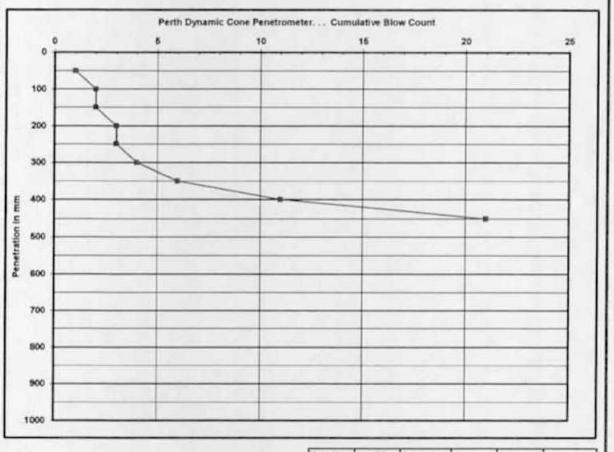
Punters Garage, Hillingdon Test Reference: - WS01

Job Nr LP1412 Date 13-Jul-17

Remarks Test start depth = 0.50m bgl.

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
50	250	1	3	100.0	2.3	1.2	1.2
250	350	3	6	33.3	7.4	4.8	4.8
350	450	6	21	6.7	40.7	37.8	37.8



Tested by	AFC	Checked		Approved	

Site: Punters Garage, Hillingdon	Client: Aquinna Homes	Date: 13/07/2017
	Job No: LP1412	Test No: WS01

Dynamic Cone CBR Test

Nr Blows	S Blows	Penetration mm	S Pen. mm
1	1	50	50
0	1	50	100
1	2	50	150
0	2	50	200
1	3	50	250
3	6	50	300
6	12	50	350
6	18	50	400
5	23	50	450
7	30	50	500
15	45	50	550

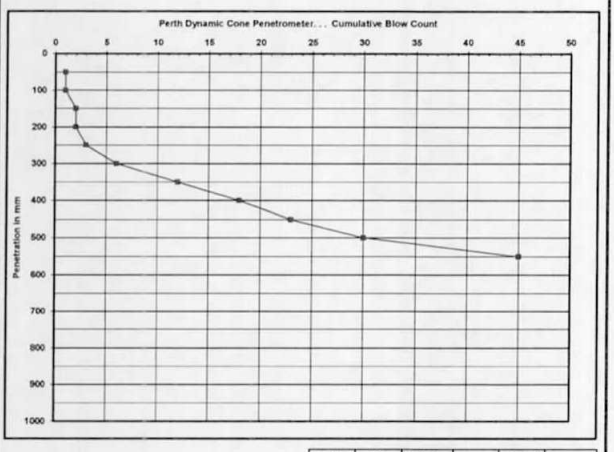
Punters Garage, Hillingdon Test Reference: - WS02

Job Nr LP1412 Date 13-Jul-17

Remarks Test start depth = 0.42m bgl.

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
50	300	1	6	50.0	4.8	2.9	2.9
300	500	6	30	8.3	32.1	28.4	28.4
500	550	30	45	3.3	84.6	91.8	84.6



Tested by	AFC	Checked		Approved	

Site: Punters Garage, Hillingdon	Client: Aquinna Homes	Date: 13/07/2017
	Job No: LP1412	Test No: WS02

Dynamic Cone CBR Test

Nr Blows	S Blows	Penetration mm	S Pen. mm
3	3	50	50
5	8	50	100
6	14	50	150
5	19	50	200
6	25	50	250
5	30	50	300
6	36	50	350
5	41	50	400
5	46	50	450
5	51	50	500

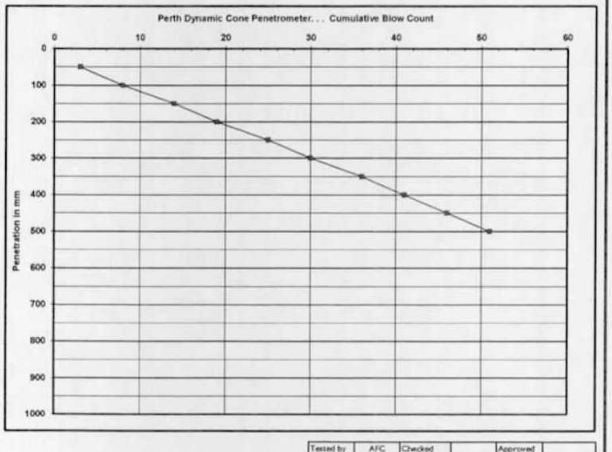
Punters Garage, Hillingdon Test Reference: - WS03

Job Nr LP1412 Date 13-Jul-17

Remarks Test start depth = 0.46m bgl.

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
50	500	3	51	9.4	28.4	24.4	24.4



Tested by	AFC	Checked		Approved	

Site: Punters Garage, Hillingdon	Client: Aquinna Homes	Date: 13/07/2017
	Job No: LP1412	Test No: WS03

Dynamic Cone CBR Test

Nr Blows	S Blows	Penetration mm	S Pen. mm
2	2	50	50
1	3	50	100
1	4	50	150
2	6	50	200
1	7	50	250

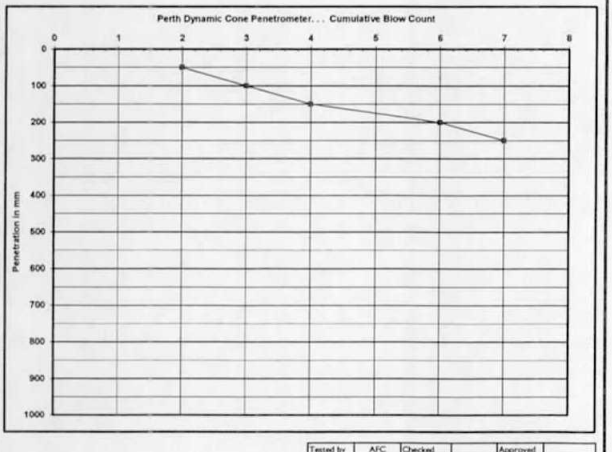
Punters Garage, Hillingdon Test Reference: - WS04

Job Nr LP1412 Date 13-Jul-17

Remarks Test start depth = 1.10m bgl.

CBR VALUE CALCULATIONS

Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KVH	CBR Value (%)
50	150	2	4	50.0	4.8	2.9	2.9
150	200	4	6	25.0	10.1	7.0	7.0
200	250	6	7	50.0	4.8	2.9	2.9



Tested by	AFC	Checked		Approved	

Site: Punters Garage, Hillingdon	Client: Aquinna Homes	Date: 13/07/2017
	Job No: LP1412	Test No: WS04

Dynamic Cone CBR Test

Nr Blows	S Blows	Penetration mm	S Pen. mm
5	5	50	50
4	9	50	100
8	17	50	150
4	21	50	200
2	23	50	250
11	34	50	300
21	55	50	350

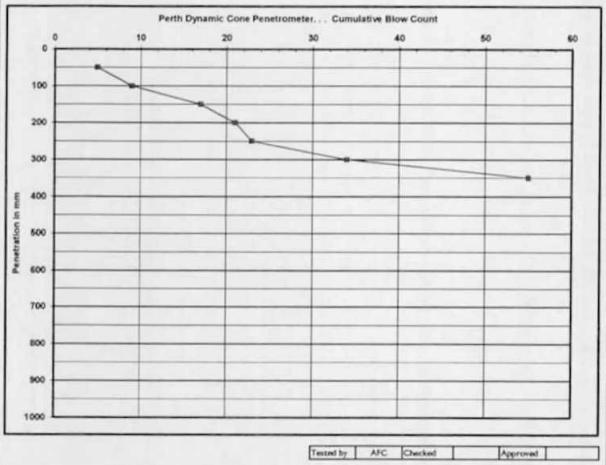
Punters Garage, Hillingdon Test Reference: - WS05

Job Nr LP1412 Date 13-Jul-17

Remarks Test start depth = 0.85m bgl.

CBR VALUE CALCULATIONS

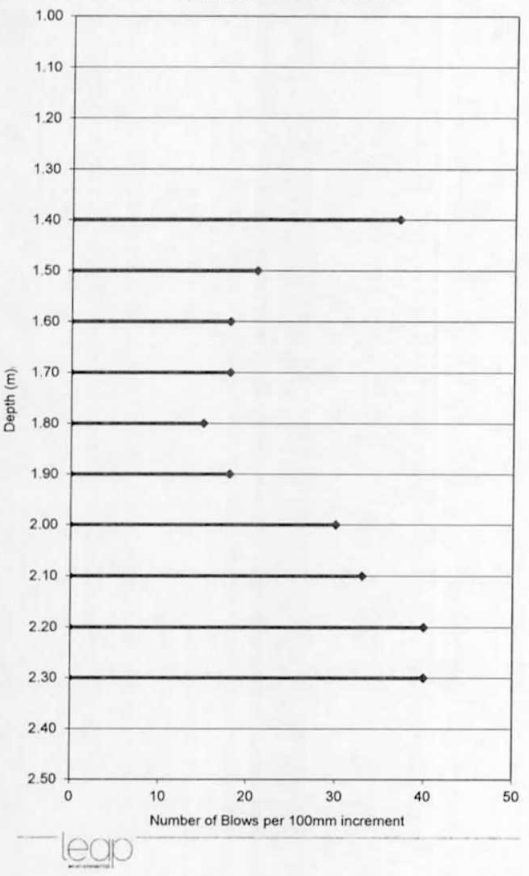
Initial S Pen mm	Final S Pen mm	Initial S Blows	Final S Blows	Pen/Blow mm	CBR TRRL	CBR KYH	CBR Value (%)
50	350	5	17	8.3	32.1	28.4	**28.4**
150	250	17	23	16.7	15.4	11.7	11.7
250	350	23	55	3.1	90.6	99.7	**90.6**



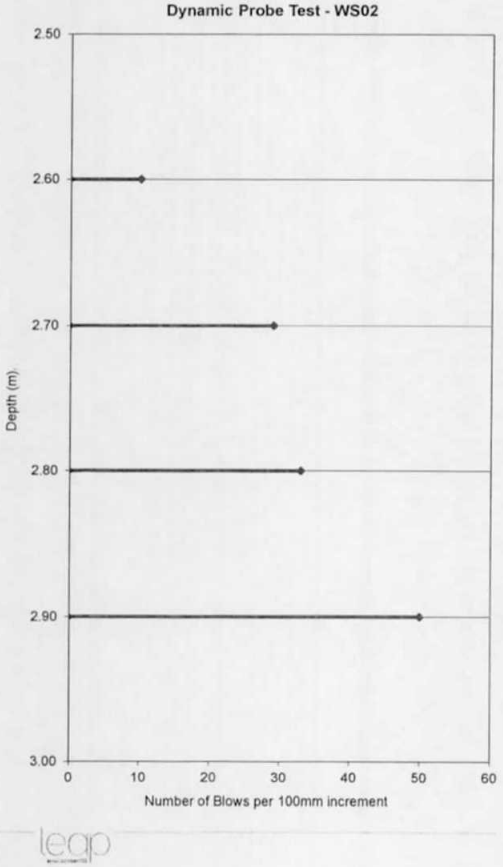
Tested by	AFC	Checked		Approved	

Site: Punters Garage, Hillingdon	**Client:** Aquinna Homes	**Date:** 13/07/2017
	Job No: LP1412	**Test No:** WS05

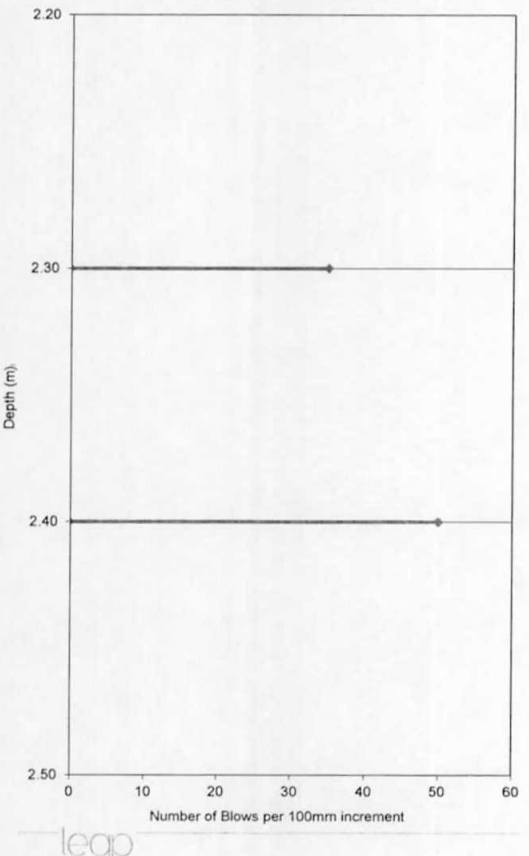
Dynamic Probe Test - WS01

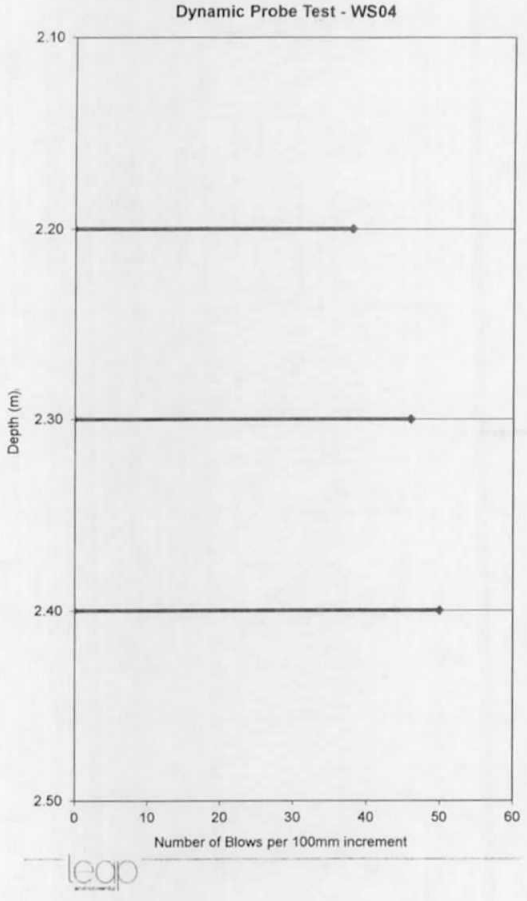


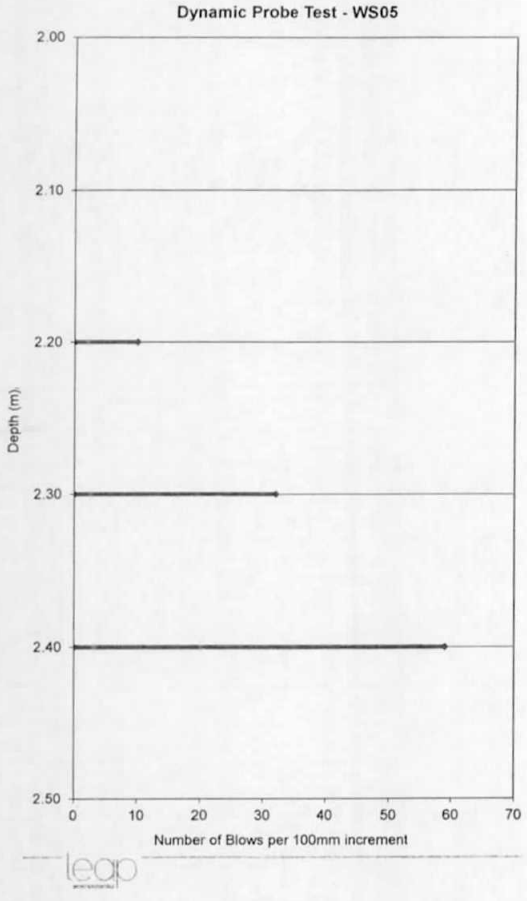
Dynamic Probe Test - WS02



Dynamic Probe Test - WS03

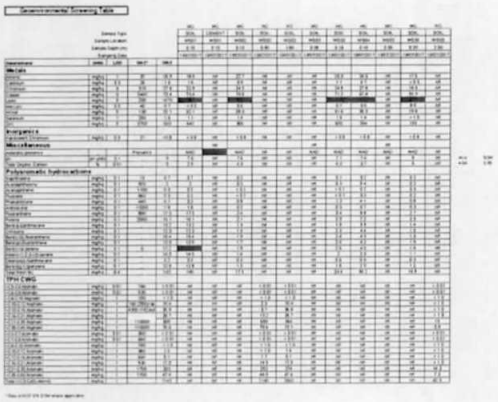






APPENDIX H – CHEMICAL LABORATORY TEST RESULTS

Chemical Laboratory Test Results



ELAB

2683

Unit A2
Windmill Road
Ponswood Industrial Estate
St Leonards on Sea
East Sussex
TN38 9BY
Telephone: (01424) 718618
Facsimile: (01424) 729911
info@elab-uk.co.uk

THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 17-13142

Issue: 1

Date of Issue: 24/07/2017

Contact: Barry Gore

Customer Details: Leap Environmental Ltd
The Atrium
Curtis Road
Dorking
SurrevRH4 1X4

Quotation No: Q14-00063

Order No: LPO6331

Customer Reference: LP1412

Date Received: 18/07/2017

Date Approved: 24/07/2017

Details: New Road, Hillingdon

Approved by:

John Wilson, Operations Manager

Any comments, opinions or interpretations expressed herein are outside the scope of UKAS accreditation (Accreditation Number 2683

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Sample Summary

Report No.: 17-13142

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
106481	WS01 0.15	13/07/2017	18/07/2017	Silty loam	
106482	WS01 Fragment 0.15	13/07/2017	18/07/2017		
106483	WS02 0.15	13/07/2017	18/07/2017	Silty loam	
106484	WS02 0.90	13/07/2017	18/07/2017	Silty loam	
106485	WS02 1.80	13/07/2017	18/07/2017	Sandy loam	
106486	WS03 0.18	13/07/2017	18/07/2017	Silty loam	
106487	WS03 0.06	13/07/2017	18/07/2017		
106488	WS04 0.10	13/07/2017	18/07/2017	Silty loam	
106489	WS04 0.53	13/07/2017	18/07/2017		
106490	WS05 0.20	13/07/2017	18/07/2017	Sandy silty loam	
106491	WS05 0.00	13/07/2017	18/07/2017		
106492	WS05 2.00	13/07/2017	18/07/2017	Sandy silty loam	
106493	mix WS01 to WS05 0.15 - 0	13/07/2017	18/07/2017		

ELAB

Results Summary

Report No.: 17-13142

	ELAB Reference	106481	106483	106484	106485
	Customer Reference				
	Sample ID				
	Sample Type	SOIL	SOIL	SOIL	SOIL
	Sample Location	WS01	WS02	WS02	WS02
	Sample Depth (m)	0.15	0.15	0.90	1.80
	Sampling Date	13/07/2017	13/07/2017	13/07/2017	13/07/2017
Determinand	Codes / Units / LOD				
Metals					
Arsenic	M mg/kg 1	18.8	22.7	nt	nt
Cadmium	M mg/kg 0.5	1.6	0.9	nt	nt
Chromium	M mg/kg 5	22.9	24.5	nt	nt
Copper	M mg/kg 5	73.4	70.8	nt	nt
Lead	M mg/kg 5	465	677	nt	nt
Mercury	M mg/kg 0.5	< 0.5	0.6	nt	nt
Nickel	M mg/kg 5	32.1	28.3	nt	nt
Selenium	M mg/kg 1	1.1	1.4	nt	nt
Zinc	M mg/kg 5	643	300	nt	nt
Inorganics					
Hexavalent Chromium	N mg/kg 0.8	< 0.8	< 0.8	nt	nt
Miscellaneous					
pH	M pH units 0.1	7.6	7.6	nt	nt
Total Organic Carbon	N % 0.01	2.9	4.3	nt	nt
Polyaromatic hydrocarbons					
Naphthalene	M mg/kg 0.1	0.7	0.2	nt	nt
Acenaphthylene	M mg/kg 0.1	2.0	0.2	nt	nt
Acenaphthene	M mg/kg 0.1	0.2	< 0.1	nt	nt
Fluorene	M mg/kg 0.1	0.2	< 0.1	nt	nt
Phenanthrene	M mg/kg 0.1	3.3	0.8	nt	nt
Anthracene	M mg/kg 0.1	1.8	0.2	nt	nt
Fluoranthene	M mg/kg 0.1	17.5	2.4	nt	nt
Pyrene	M mg/kg 0.1	16.1	2.1	nt	nt
Benzo(a)anthracene	M mg/kg 0.1	13.2	1.3	nt	nt
Chrysene	M mg/kg 0.1	12.3	1.5	nt	nt
Benzo (b) fluoranthene	M mg/kg 0.1	15.4	1.9	nt	nt
Benzo(k)fluoranthene	M mg/kg 0.1	13.9	1.7	nt	nt
Benzo (a) pyrene	M mg/kg 0.1	17.2	1.9	nt	nt
Indeno (1,2,3-cd) pyrene	M mg/kg 0.1	14.5	1.4	nt	nt
Dibenzo(a,h)anthracene	M mg/kg 0.1	3.2	0.3	nt	nt
Benzo(g,h,i)perylene	M mg/kg 0.1	12.8	1.3	nt	nt
Total PAH(16)	M mg/kg 0.4	145	17.3	nt	nt
TPH CWG					
>C5-C6 Aliphatic	N mg/kg 0.01	nt	nt	< 0.01	< 0.01
>C6-C8 Aliphatic	N mg/kg 0.01	nt	nt	< 0.01	< 0.01
>C8-C10 Aliphatic	N mg/kg 1	nt	nt	< 1.0	< 1.0
>C10-C12 Aliphatic	N mg/kg 1	nt	nt	2.3	10.4
>C12-C16 Aliphatic	N mg/kg 1	nt	nt	3.7	36.8
>C16-C21 Aliphatic	N mg/kg 1	nt	nt	13.2	28.7
>C21-C35 Aliphatic	N mg/kg 1	nt	nt	695	595
>C35-C40 Aliphatic	N mg/kg 1	nt	nt	78.6	73.1
>C5-C7 Aromatic	N mg/kg 0.01	nt	nt	< 0.01	< 0.01
>C7-C8 Aromatic	N mg/kg 0.01	nt	nt	< 0.01	< 0.01
>C8-C10 Aromatic	N mg/kg 1	nt	nt	< 1.0	< 1.0
>C10-C12 Aromatic	N mg/kg 1	nt	nt	< 1.0	1.6
>C12-C16 Aromatic	N mg/kg 1	nt	nt	1.7	9.1
>C16-C21 Aromatic	N mg/kg 1	nt	nt	14.5	17.9
>C21-C35 Aromatic	N mg/kg 1	nt	nt	293	274
>C35-C40 Aromatic	N mg/kg 1	nt	nt	44.9	47.4
Total (>C5-C40) AliAro	N mg/kg 1	nt	nt	1140	1080

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The Environmental Laboratory Ltd. Reg. No. 3862193

ELAB

Results Summary

Report No.: 17-13142

	ELAB Reference	106486	106488	106490	106492
	Customer Reference				
	Sample ID				
	Sample Type	SOIL	SOIL	SOIL	SOIL
	Sample Location	WS03	WS04	WS05	WS05
	Sample Depth (m)	0.18	0.10	0.20	2.00
	Sampling Date	13/07/2017	13/07/2017	13/07/2017	13/07/2017
Determinand	Codes / Units / LOD				
Metals					
Arsenic	M mg/kg 1	26.9	24.6	17.5	nt
Cadmium	M mg/kg 0.5	1.1	0.7	< 0.5	nt
Chromium	M mg/kg 5	24.6	27.8	18.5	nt
Copper	M mg/kg 5	71.2	67.4	56.3	nt
Lead	M mg/kg 5	1470	873	315	nt
Mercury	M mg/kg 0.5	0.7	0.5	0.5	nt
Nickel	M mg/kg 5	31.8	30.3	19.8	nt
Selenium	M mg/kg 1	1.6	1.4	< 1.0	nt
Zinc	M mg/kg 5	605	334	133	nt
Inorganics					
Hexavalent Chromium	N mg/kg 0.8	< 0.8	< 0.8	< 0.8	nt
Miscellaneous					
pH	M pH units 0.1	7.1	7.4	9.0	nt
Total Organic Carbon	N % 0.01	4.3	3.7	5.0	nt
Polyaromatic hydrocarbons					
Naphthalene	M mg/kg 0.1	0.1	0.2	0.2	nt
Acenaphthylene	M mg/kg 0.1	0.3	0.4	0.2	nt
Acenaphthene	M mg/kg 0.1	< 0.1	0.2	0.3	nt
Fluorene	M mg/kg 0.1	< 0.1	0.3	0.2	nt
Phenanthrene	M mg/kg 0.1	1.3	4.1	0.8	nt
Anthracene	M mg/kg 0.1	0.3	0.7	0.3	nt
Fluoranthene	M mg/kg 0.1	3.4	8.8	2.7	nt
Pyrene	M mg/kg 0.1	2.9	7.2	2.3	nt
Benzo(a)anthracene	M mg/kg 0.1	1.9	3.9	1.4	nt
Chrysene	M mg/kg 0.1	2.3	4.4	1.5	nt
Benzo (b) fluoranthene	M mg/kg 0.1	2.4	4.3	1.3	nt
Benzo(k)fluoranthene	M mg/kg 0.1	2.4	4.2	1.5	nt
Benzo (a) pyrene	M mg/kg 0.1	2.8	4.5	1.5	nt
Indeno (1,2,3-cd) pyrene	M mg/kg 0.1	2.0	3.3	1.1	nt
Dibenzo(a,h)anthracene	M mg/kg 0.1	0.6	0.9	0.3	nt
Benzo(g,h,i)perylene	M mg/kg 0.1	1.6	2.9	1.2	nt
Total PAH(16)	M mg/kg 0.4	24.4	50.2	16.9	nt
TPH CWG					
>C5-C6 Aliphatic	N mg/kg 0.01	nt	nt	nt	< 0.01
>C6-C8 Aliphatic	N mg/kg 0.01	nt	nt	nt	< 0.01
>C8-C10 Aliphatic	N mg/kg 1	nt	nt	nt	< 1.0
>C10-C12 Aliphatic	N mg/kg 1	nt	nt	nt	< 1.0
>C12-C16 Aliphatic	N mg/kg 1	nt	nt	nt	< 1.0
>C16-C21 Aliphatic	N mg/kg 1	nt	nt	nt	< 1.0
>C21-C35 Aliphatic	N mg/kg 1	nt	nt	nt	15.0
>C35-C40 Aliphatic	N mg/kg 1	nt	nt	nt	5.9
>C5-C7 Aromatic	N mg/kg 0.01	nt	nt	nt	< 0.01
>C7-C8 Aromatic	N mg/kg 0.01	nt	nt	nt	< 0.01
>C8-C10 Aromatic	N mg/kg 1	nt	nt	nt	< 1.0
>C10-C12 Aromatic	N mg/kg 1	nt	nt	nt	< 1.0
>C12-C16 Aromatic	N mg/kg 1	nt	nt	nt	< 1.0
>C16-C21 Aromatic	N mg/kg 1	nt	nt	nt	< 1.0
>C21-C35 Aromatic	N mg/kg 1	nt	nt	nt	14.3
>C35-C40 Aromatic	N mg/kg 1	nt	nt	nt	7.3
Total (>C5-C40) AliAro	N mg/kg 1	nt	nt	nt	42.5

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ELAB

Unit A2 Wingfield Road Ferrowed Industrial Estate St Leonards on Sea, East Sussex TN38 9PY
Tel +44 (0)1424 719510 Email info@elab-uk.co.uk Web www.elab-uk.co.uk

Results Summary

Report No.: 17-13142

Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any deviations, opinions or interpretations marked (I) in this report are outside UKAS accreditation (Accreditation No.2683). They are supportive comments only which must be verified by the client

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)
106481	0.15	WS01	Brown soil with stones,brick,clinker	No asbestos detected	n/t	n/t	n/t	n/t
106482	0.15	WS01 Fragment	Cement pieces	Chrysotile (Cement)	n/t	n/t	n/t	n/t
106483	0.15	WS02	Brown soil with stones,glass,clinker	No asbestos detected	n/t	n/t	n/t	n/t
106486	0.18	WS03	Brown soil with stones,brick,clinker	No asbestos detected	n/t	n/t	n/t	n/t
106487	0.08	WS03	Brown soil with stones,clinker,concrete	No asbestos detected	n/t	n/t	n/t	n/t
106488	0.10	WS04	Brown soil with stones,brick,clinker	No asbestos detected	n/t	n/t	n/t	n/t
106490	0.20	WS05	Brown soil with stones,brick,clinker	No asbestos detected	n/t	n/t	n/t	n/t
106491	0.09	WS05	Stones,clinker,concrete	No asbestos detected	n/t	n/t	n/t	n/t

ELAB

2683

Method Summary

Report No.: 17-13142

Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
Hexavalent chromium	N	As submitted sample	19/07/2017	110	Colorimetry
pH	M	Air dried sample	19/07/2017	113	Electromeric
Aqua regia extractable metals	M	Air dried sample	19/07/2017	116	ICPMS
PAH (GC-FID)	M	As submitted sample	19/07/2017	133	GC-FID
Total organic carbon/Total sulphur	N	Air dried sample	20/07/2017	210	IR
Aliphatic hydrocarbons in soil	N	As submitted sample	19/07/2017	214	GC-FID
Aliphatic/Aromatic hydrocarbons in soil	N	As submitted sample	21/07/2017	214	GC-FID
Aromatic hydrocarbons in soil	N	As submitted sample	19/07/2017	214	GC-FID
Low range Aliphatic hydrocarbons soil	N	As submitted sample	20/07/2017	214	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	20/07/2017	214	GC-MS
Asbestos Identification	U	As submitted sample	19/07/2017	PMAN	Microscopy

Tests marked N are not UKAS accredited

ELAB

2683

Report Information

Report No.: 17-13142

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"

Soil sample results are expressed on an air dried basis (dried at < 30°C)
Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
PCB congener results may include any coeluting PCBs
Uncertainty of measurement for the determinands tested are available upon request

Deviation Codes

a	No date of sampling supplied
b	No time of sampling supplied (Waters Only)
c	Sample not received in appropriate containers
d	Sample not received in cooled condition
e	The container has been incorrectly filled
f	Sample age exceeds stability time (sampling to receipt)
g	Sample age exceeds stability time (sampling to analysis)

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month
All water samples will be retained for 7 days following the date of the test report
Charges may apply to extended sample storage

APPENDIX I – GEOTECHNICAL LABORATORY TEST RESULTS

Geotechnical Laboratory Test Results

Unconsolidated Undrained Triaxial Compression tests without measurement of pore pressure
Summary of Results

Tests carried out in accordance with BS1377:Part 7 : 1990 clause 8 or 9 as appropriate to test

Job No.	Project Name	Programme	
23202	New Rd, Hillingdon	Samples received	09/08/2017
Project No.	Client	Schedule received	08/08/2017
LP1412	Leap Environmental	Project started	10/08/2017
		Testing Started	22/08/2017

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	Test Type	Density bulk (Mg/m3)	Density dry (Mg/m3)	w %	Length mm	Diameter mm	σ3 kPa	At failure: Axial strain %	At failure: σ1 - σ3 kPa	At failure: cu kPa	At failure: Mode	Remarks
BH1	-	9.50	-	U	Very high strength fissured dark grey silty CLAY	UU	2.07	1.66	25	196	102	190	9.1	306	153	B	
BH1	-	12.50	-	U	Very high strength slightly fissured dark grey silty CLAY	UU	2.07	1.65	26	196	102	250	6.1	396	196	B	

Legend: UU - single stage test (single and multiple specimens); UUM - Multistage test on a single specimen; suffix R - remoulded or recompacted; σ3 Cell pressure; σ1 - σ3 Maximum corrected deviator stress; cu Undrained shear strength, ½ (σ1 - σ3); Mode of failure: B - Brittle, P - Plastic, C - Compound

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: james@k4soils.com

Checked and Approved
Initials: J.P
Date: 23/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R7b

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

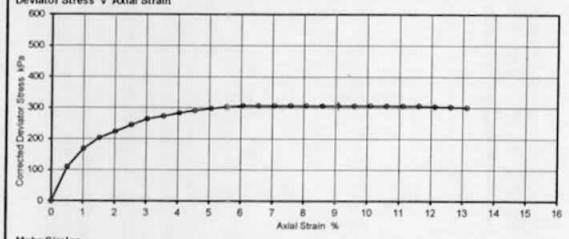
Site Name	New Rd, Hillingdon			Job Ref	23202
Project No.	LP1412	Client	Leap Environmental	Borehole/Pit No.	BH1
Soil Description	Very high strength fissured dark grey silty CLAY			Sample No.	-
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen			Depth Top	9.50 m
				Depth Base	- m
				Sample Type	U
				Samples received	09/08/2017
				Schedules received	08/08/2017
				Date of test	22/08/2017

Remarks

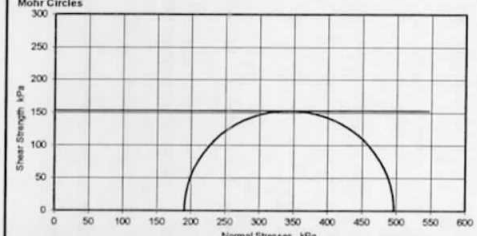
Position within sample

Test Number	1	
Length	196.0	mm
Diameter	102.0	mm
Bulk Density	2.07	Mg/m3
Moisture Content	25	%
Dry Density	1.66	Mg/m3
Rate of Strain	2.0	%/min
Cell Pressure	190	kPa
Axial Strain	9.1	%
Deviator Stress, (σ1 - σ3)f	306	kPa
Undrained Shear Strength, cu	153	kPa ½(σ1 - σ3)f
Mode of Failure	Brittle	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

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

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved
Initials: J.P
Date: 23/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5 R7

Unconsolidated Undrained Triaxial Compression Test without measurement of pore pressure - single specimen

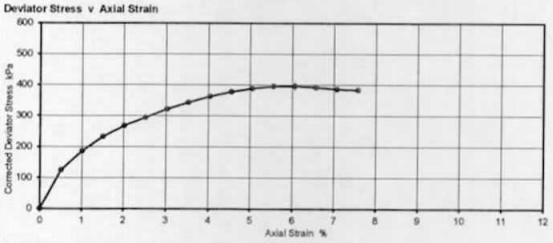
Site Name	New Rd, Hillingdon			Job Ref	23202
Project No.	LP1412	Client	Leap Environmental	Borehole/Pit No.	BH1
Soil Description	Very high strength slightly fissured dark grey silty CLAY			Sample No.	-
Test Method	BS1377 : Part 7 : 1990, clause 8, single specimen			Depth Top	12.50 m
				Depth Base	- m
				Sample Type	U
				Samples received	09/08/2017
				Schedules received	08/08/2017
				Date of test	22/08/2017

Remarks

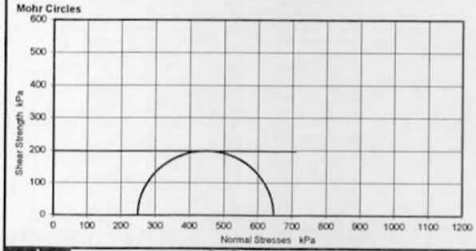
Position within sample

Test Number	1	
Length	196.0	mm
Diameter	102.0	mm
Bulk Density	2.07	Mg/m3
Moisture Content	26	%
Dry Density	1.65	Mg/m3
Rate of Strain	2.0	%/min
Cell Pressure	250	kPa
Axial Strain	6.1	%
Deviator Stress, (σ1 - σ3)f	396	kPa
Undrained Shear Strength, cu	198	kPa ½(σ1 - σ3)f
Mode of Failure	Brittle	

Deviator Stress v Axial Strain



Mohr Circles



Deviator stress corrected for area change and membrane effects

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Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved
Initials: J.P
Date: 23/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5 R7

Sulphate Content (Gravimetric Method) for 2:1 Soil: Water Extract and pH Value - Summary of Results
Tested in accordance with BS1377 : Part 3 : 1990, clause 5.3 and clause 9

Job No.	Project Name	Programme	
23202	New Rd, Hillingdon	Samples received	09/08/2017
Project No.	Client	Schedule received	08/08/2017
LP1412	Leap Environmental	Project started	10/08/2017
		Testing Started	21/08/2017

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil description	Dry Mass passing 2mm %	SO3 Content g/l	SO4 Content g/l	pH	Remarks
BH1	-	1.00	1.50	B	Brown clayey very sandy GRAVEL with occasional roots (gravel is fine and angular to rounded)	45	0.28	0.34	7.75	
BH1	-	3.00	3.50	B	Brown clayey very sandy GRAVEL (gravel is fine and angular to rounded)	36	0.14	0.17	8.07	
BH1	-	9.50	-	U	Very high strength fissured dark grey silty CLAY	100	0.47	0.56	8.20	

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved
Initials: J.P
Date: 23/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R29

Sulphate Content (Gravimetric Method) for 2:1 Soil: Water Extract and pH Value - Summary of Results

Tested in accordance with BS1377 : Part 3 : 1990, clause 5.3 and clause 9

Job No	Project Name	Programme	
23126	New Road, Hillingdon	Samples received	18/07/2017
		Schedule received	20/07/2017
Project No	Client	Project started	21/07/2017
LP1412	Leap Environmental	Testing Started	02/08/2017

Hole No	Sample Ref	Sample Top	Sample Base	Sample Type	Soil description	Dry Mass passing 2mm %	SO3 Content g/l	SO4 Content g/l	pH	Remarks
WS01	-	0.50	-	B	Orangish brown slightly sandy slightly gravelly CLAY (gravel is fmc and sub-angular to sub-rounded)	78	0.19	0.23	7.03	
WS01	-	0.85	-	B	Brown silty sandy clayey GRAVEL (gravel is fmc and sub-rounded to sub-angular)	42	0.14	0.17	7.36	
WS02	-	1.00	-	B	Light brown clayey very sandy GRAVEL (gravel is fmc and sub-angular to sub-rounded)	38	0.32	0.38	7.16	
WS03	-	0.46	-	B	Brown slightly sandy clayey GRAVEL (gravel is fmc and sub-angular to sub-rounded)	30	0.24	0.28	7.79	
WS05	-	1.00	-	B	Orangish brown slightly gravelly clayey SAND (gravel is fmc and sub-angular to sub-rounded)	92	0.21	0.25	7.22	

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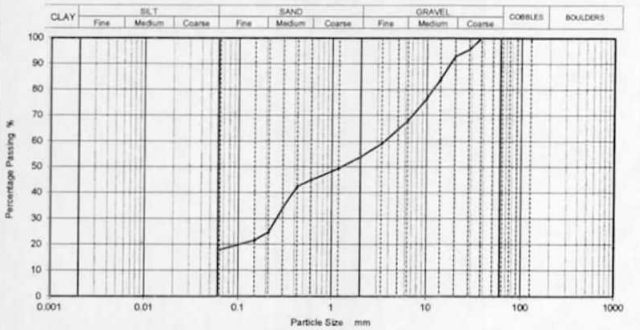
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved
Initials J.P
Date: 08/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R29

PARTICLE SIZE DISTRIBUTION

Site Name	New Rd, Hillingdon			Job Ref	23202
				Borehole/Pit No.	BH1
Project No.	LP1412	Client	Leap Environmental	Sample No.	-
Soil Description	Orangish brown clayey very sandy GRAVEL (gravel is fmc and angular to rounded)			Depth Top	2.00 m
				Depth Base	2.50 m
				Sample Type	B
				Samples received	01/09/1989
Test Method	BS1377:Part 2: 1990, clause 9.0			Schedules received	08/08/2017
				Project started	10/08/2017
				Date tested	22/08/2017



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	96		
20	93		
14	84		
10	77		
6.3	68		
5	65		
3.35	59		
2	54		
1.18	49		
0.6	45		
0.425	42		
0.3	34		
0.212	25		
0.15	22		
0.063	18		

Dry Mass of sample, g: 3186

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	46.3
Sand	35.8
Fines <0.063mm	17.8

Grading Analysis		
D100	mm	
D60	mm	3.63
D30	mm	0.258
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks
Preparation and testing in accordance with BS1377 unless noted below

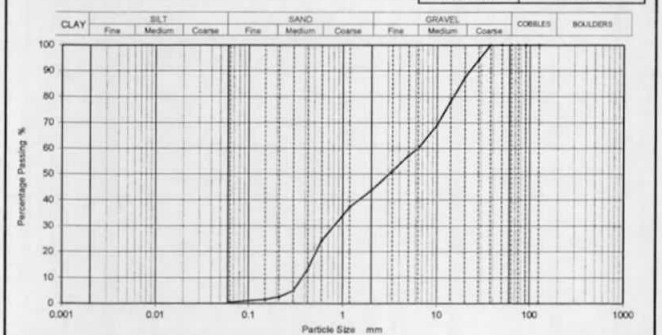
K4 Soils Laboratory
Unit 8, Olds Close, Watford, Herts, WD18 9RU
Email: james@k4soils.com
Tel: 01923 711288

Checked and Approved
Initials: J.P
Date: 23/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R3

PARTICLE SIZE DISTRIBUTION

Site Name	New Rd, Hillingdon			Job Ref	23202
				Borehole/Pit No.	BH1
Project No.	LP1412	Client	Leap Environmental	Depth Top	4.00 m
Soil Description	Brown very sandy GRAVEL (gravel is fmc and angular to rounded)			Depth Base	4.50 m
				Sample Type	B
				Samples received	01/09/1989
Test Method	BS1377:Part 2: 1990, clause 9.0			Schedules received	06/08/2017
				Project started	10/08/2017
				Date tested	22/08/2017



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	94		
20	88		
14	78		
10	69		
6.3	60		
5	57		
3.35	51		
2	44		
1.18	37		
0.6	24		
0.425	13		
0.3	5		
0.212	3		
0.15	2		
0.063	1		

Dry Mass of sample, g: 5299

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	56.3
Sand	43.2
Fines <0.063mm	0.5

Grading Analysis		
D100	mm	
D60	mm	6.34
D30	mm	0.81
D10	mm	0.372
Uniformity Coefficient		17
Curvature Coefficient		0.28

Remarks
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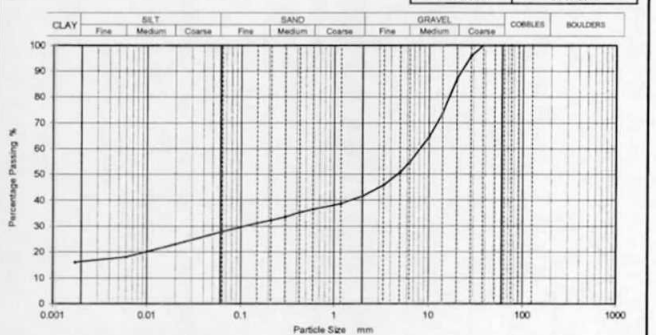
K4 Soils Laboratory
Unit 8, Olds Close, Watford, Herts, WD18 9RU
Email: james@k4soils.com
Tel: 01923 711288

Checked and Approved
Initials: J.P
Date: 23/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R3

PARTICLE SIZE DISTRIBUTION

Site Name	New Road, Hillingdon			Job Ref	23126
				Borehole/Pit No.	WS01
Project No.	LP1412	Client	Leap Environmental	Sample No.	-
Soil Description	Brown silty sandy clayey GRAVEL (gravel is fmc and sub-rounded to sub-angular)			Depth Top	0.85 m
				Depth Base	- m
				Sample Type	B
				Samples received	18/07/2017
Test Method	BS1377:Part 2: 1990, clause 9.0			Schedules received	20/07/2017
				Project started	21/07/2017
				Date tested	31/07/2017



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100	0.0200	23
90	100	0.0060	18
75	100	0.0017	16
63	100		
50	100		
37.5	100		
28	96		
20	87		
14	74		
10	64		
6.3	55		
5	51		
3.35	46		
2	42		
1.18	39		
0.6	37	Particle density (assumed)	
0.425	35	2.70 Mg/m3	
0.3	34		
0.212	32		
0.15	31		
0.063	28		

Dry Mass of sample, g: 1330

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	58.4
Sand	13.7
Silt	12.0
Clay	15.9

Grading Analysis		
D100	mm	
D60	mm	8.11
D30	mm	0.109
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks
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K4 Soils Laboratory
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Email: james@k4soils.com
Tel: 01923 711288

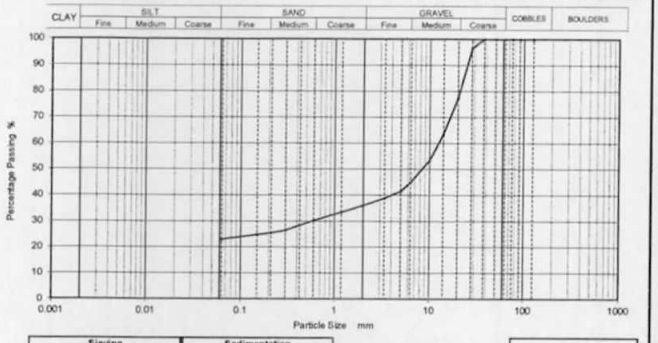
Checked and Approved
Initials: J.P
Date: 08/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R3

PARTICLE SIZE DISTRIBUTION

Site Name	New Road, Hillingdon		
Project No.	LP1412	Client	Leap Environmental
Soil Description	Brown sandy very clayey GRAVEL (gravel is fmc and sub-rounded to sub-angular)		
Test Method	BS1377:Part 2: 1990, clause 9.0		

Job Ref	23126
Borehole/Pit No.	WS02
Sample No.	-
Depth Top	0.66 m
Depth Base	- m
Sample Type	B
Samples received	18/07/2017
Schedules received	20/07/2017
Project started	21/07/2017
Date tested	31/07/2017



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	97		
20	77		
14	63		
10	53		
6.3	45		
5	42		
3.35	39		
2	36		
1.18	33		
0.6	30		
0.425	28		
0.3	26		
0.212	25		
0.15	25		
0.063	23		

Dry Mass of sample, g: 1574

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	64.0
Sand	13.0
Fines <0.063mm	22.9

Grading Analysis		
D100	mm	
D60	mm	12.5
D30	mm	0.575
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks
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K4 Soils Laboratory
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Email: james@k4soils.com
Tel: 01923 711288

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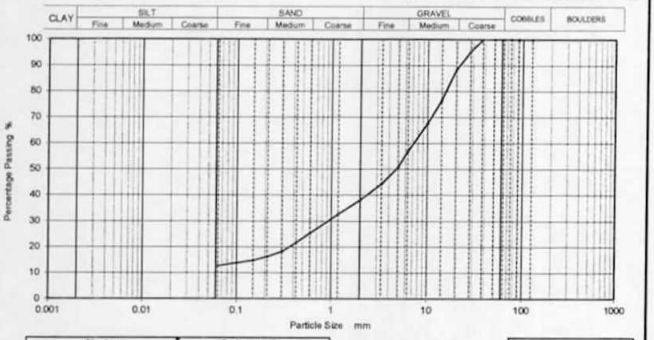
2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R3

PARTICLE SIZE DISTRIBUTION

Site Name	New Road, Hillingdon		
Project No.	LP1412	Client	Leap Environmental
Soil Description	Light brown clayey very sandy GRAVEL (gravel is fmc and sub-angular to sub-rounded)		
Test Method	BS1377:Part 2: 1990, clause 9.0		

Job Ref	23126
Borehole/Pit No.	WS02
Sample No.	-
Depth Top	1.00 m
Depth Base	- m
Sample Type	B
Samples received	18/07/2017
Schedules received	20/07/2017
Project started	21/07/2017
Date tested	31/07/2017



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	96		
20	88		
14	77		
10	68		
6.3	57		
5	51		
3.35	44		
2	38		
1.18	33		
0.6	25		
0.425	22		
0.3	18		
0.212	16		
0.15	15		
0.063	13		

Dry Mass of sample, g: 1773

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	62.0
Sand	25.3
Fines <0.063mm	12.7

Grading Analysis		
D100	mm	
D60	mm	7.2
D30	mm	0.93
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks
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K4 Soils Laboratory
Unit 8, Olds Close, Watford, Herts, WD18 9RU
Email: james@k4soils.com
Tel: 01923 711288

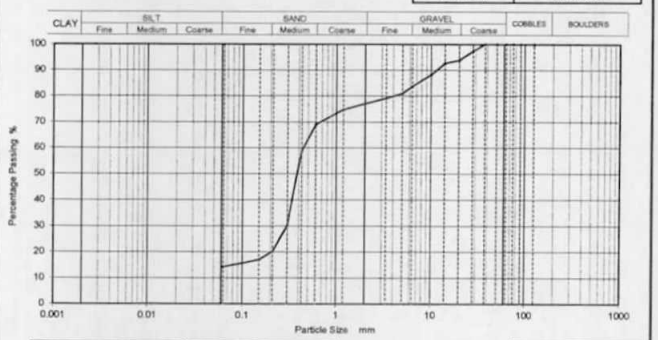
Checked and Approved
Initials: J.P
Date: 08/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R3

PARTICLE SIZE DISTRIBUTION

Site Name	New Road, Hillingdon		
Project No.	LP1412	Client	Leap Environmental
Soil Description	Orangish brown clayey very gravelly SAND (gravel is fmc and sub-angular to sub-rounded)		
Test Method	BS1377:Part 2: 1990, clause 9.0		

Job Ref	23126
Borehole/Pit No.	WS02
Sample No.	-
Depth Top	1.60 m
Depth Base	- m
Sample Type	B
Samples received	18/07/2017
Schedules received	20/07/2017
Project started	21/07/2017
Date tested	31/07/2017



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	97		
20	94		
14	93		
10	88		
6.3	84		
5	81		
3.35	79		
2	77		
1.18	75		
0.6	69		
0.425	59		
0.3	30		
0.212	20		
0.15	17		
0.063	14		

Dry Mass of sample, g: 1706

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	23.0
Sand	62.8
Fines <0.063mm	14.2

Grading Analysis		
D100	mm	
D60	mm	0.446
D30	mm	0.298
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks
Preparation and testing in accordance with BS1377 unless noted below

K4 Soils Laboratory
Unit 8, Olds Close, Watford, Herts, WD18 9RU
Email: james@k4soils.com
Tel: 01923 711288

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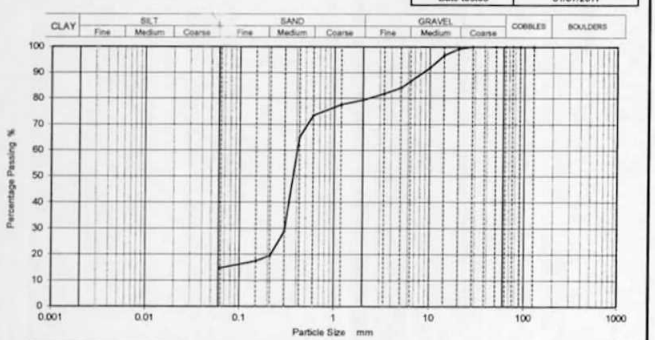
Initials: J.P
Date: 08/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R3

PARTICLE SIZE DISTRIBUTION

Site Name	New Road, Hillingdon		
Project No.	LP1412	Client	Leap Environmental
Soil Description	Orangish brown and bluish grey clayey very gravelly SAND (gravel is fmc and sub-rounded to sub-angular)		
Test Method	BS1377:Part 2: 1990, clause 9.0		

Job Ref	23126
Borehole/Pit No.	WS03
Sample No.	-
Depth Top	1.60 m
Depth Base	- m
Sample Type	B
Samples received	18/07/2017
Schedules received	20/07/2017
Project started	21/07/2017
Date tested	31/07/2017



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	99		
14	97		
10	92		
6.3	87		
5	84		
3.35	82		
2	79		
1.18	78		
0.6	73		
0.425	65		
0.3	29		
0.212	20		
0.15	17		
0.063	15		

Dry Mass of sample, g: 1181

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	20.7
Sand	64.7
Fines <0.063mm	14.7

Grading Analysis		
D100	mm	
D60	mm	0.405
D30	mm	0.303
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks
Preparation and testing in accordance with BS1377 unless noted below

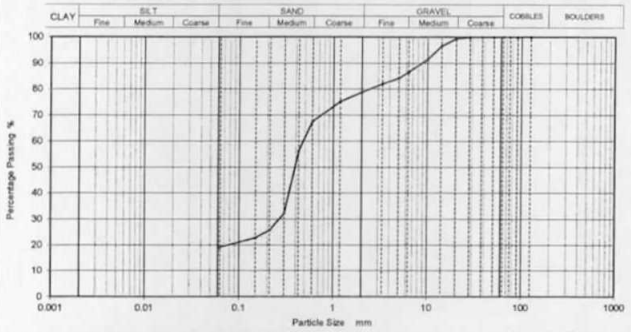
K4 Soils Laboratory
Unit 8, Olds Close, Watford, Herts, WD18 9RU
Email: james@k4soils.com
Tel: 01923 711288

Checked and Approved
Initials: J.P
Date: 08/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R3

PARTICLE SIZE DISTRIBUTION

Site Name	New Road, Hillingdon			Job Ref	23126
Project No.	LP1412	Client	Leap Environmental	Borehole/Pit No.	WS04
Soil Description	Orangish brown and bluish grey clayey very gravelly SAND (gravel is fmc and sub-angular to sub-rounded)			Sample No.	-
Test Method	BS1377:Part 2: 1990, clause 9.0			Depth Top	1.00 m
				Depth Base	- m
				Sample Type	B
				Samples received	18/07/2017
				Schedules received	20/07/2017
				Project started	21/07/2017
				Date tested	31/07/2017



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	99		
14	97		
10	91		
6.3	87		
5	84		
3.35	82		
2	79		
1.18	75		
0.6	68		
0.425	56		
0.3	32		
0.212	26		
0.15	23		
0.063	19		

Dry Mass of sample, g: 1584

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	21.3
Sand	59.5
Fines <0.063mm	19.2

Grading Analysis		
D100	mm	
D60	mm	0.479
D30	mm	0.268
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks
Preparation and testing in accordance with BS1377 unless noted below

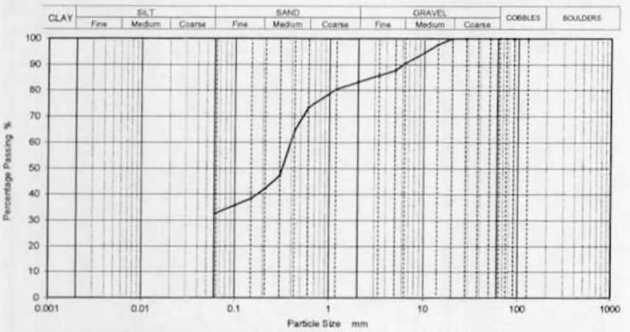
K4 Soils Laboratory
Unit 8, Olds Close, Watford, Herts, WD18 9RU
Email: james@k4soils.com
Tel: 01923 711288

Checked and Approved
Initials: J.P
Date: 08/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R3

PARTICLE SIZE DISTRIBUTION

Site Name	New Road, Hillingdon			Job Ref	23126
Project No.	LP1412	Client	Leap Environmental	Borehole/Pit No.	WS05
Soil Description	Orangish brown and bluish grey gravelly very clayey SAND (gravel is fm and sub-angular to sub-rounded)			Sample No.	-
Test Method	BS1377:Part 2: 1990, clause 9.0			Depth Top	1.50 m
				Depth Base	- m
				Sample Type	B
				Samples received	18/07/2017
				Schedules received	20/07/2017
				Project started	21/07/2017
				Date tested	31/07/2017



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	98		
10	95		
6.3	90		
5	88		
3.35	86		
2	83		
1.18	80		
0.6	74		
0.425	64		
0.3	47		
0.212	42		
0.15	36		
0.063	33		

Dry Mass of sample, g: 875

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	16.8
Sand	50.4
Fines <0.063mm	32.8

Grading Analysis		
D100	mm	
D60	mm	0.30
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks
Preparation and testing in accordance with BS1377 unless noted below

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Summary of Natural Moisture Content, Liquid Limit and Plastic Limit Results

Job No.	Project Name	Programme	
23202	New Rd, Hillingdon	Samples received	08/08/2017
		Schedule received	08/08/2017
Project No.	Client	Project started	10/08/2017
LP1412	Leap Environmental	Testing Started	22/08/2017

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	NMC %	Passing 425µm %	LL %	PL %	PI %	Remarks
BH1	-	9.50	-	U	Very high strength fissured dark grey silty CLAY	24	100	73	29	44	
BH1	-	12.50	-	U	Very high strength slightly fissured dark grey silty CLAY	26	100	75	30	45	

Test Methods: BS1377: Part 2: 1990:
Natural Moisture Content : clause 3.2
Atterberg Limits: clause 4.3, 4.4 and 5.0

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved
Initials: J.P
Date: 23/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R1

Summary of Natural Moisture Content, Liquid Limit and Plastic Limit Results

Job No.	Project Name	Programme	
23126	New Road, Hillingdon	Samples received	18/07/2017
		Schedule received	20/07/2017
Project No.	Client	Project started	21/07/2017
LP1412	Leap Environmental	Testing Started	04/08/2017

Hole No.	Sample Ref	Sample Top	Sample Base	Sample Type	Soil Description	NMC %	Passing 425µm %	LL %	PL %	PI %	Remarks
WS01	-	0.85	-	B	Brown silty sandy clayey GRAVEL (gravel is fmc and sub-rounded to sub-angular)	13	35	56	22	34	Sample washed to obtain test fraction
WS02	-	0.66	-	B	Brown sandy very clayey GRAVEL (gravel is fmc and sub-rounded to sub-angular)	12	28	63	26	37	Sample wahed to obtain test fraction

Test Methods: BS1377: Part 2: 1990:
Natural Moisture Content : clause 3.2
Atterberg Limits: clause 4.3, 4.4 and 5.0

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Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

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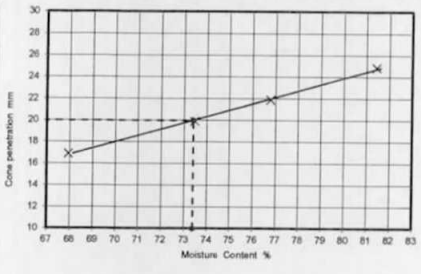
Date: 08/08/2017

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr) MSF-5-R1

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

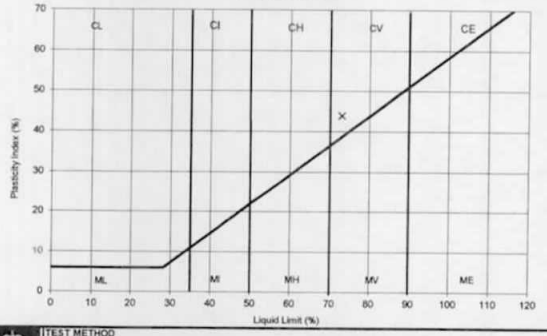
Site Name	New Rd, Hillingdon			Job No.	23202
				Borehole/Pit No.	BH1
Project No.	LP1412	Client	Leap Environmental	Sample No.	-
				Depth Top	9.50 m
Soil Description	Very high strength fissured dark grey silty CLAY			Depth Base	- m
				Sample Type	U
				Samples received	09/08/2017
				Schedules received	08/08/2017
				Project Started	10/08/2017
				Date Tested	22/08/2017



NATURAL MOISTURE CONTENT	24	%
% PASSING 425µm SIEVE	100	%
LIQUID LIMIT	73	%
PLASTIC LIMIT	29	%
PLASTICITY INDEX	44	%

Remarks

PLASTICITY INDEX



TEST METHOD
BS1377: Part 2 :Clause 4.4 : 1990 Determination of the liquid limit by the cone penetrometer method
BS1377: Part 2 :Clause 5.0 : 1990: Determination of the plastic limit and plasticity index
BS1377: Part 2 :Clause 3.2 : 1990:Determination of the moisture content by the oven drying

Checked and Approved
Initials: J.P
Date: 23/08/2017

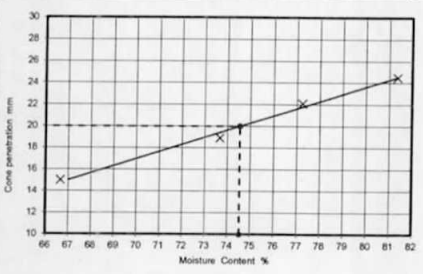
Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU
Tel: 01923 711 288 Email: James@k4soils.com

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

M3F-5 R2

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

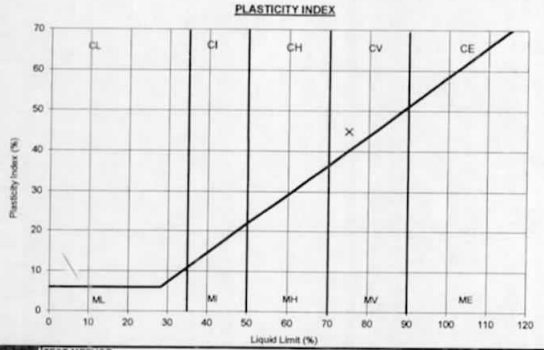
Site Name	New Rd, Hillingdon			Job No.	23202
				Borehole/Pit No.	BH1
Project No.	LP1412	Client	Leap Environmental	Sample No.	-
				Depth Top	12.50 m
Soil Description	Very high strength slightly fissured dark grey silty CLAY			Depth Base	- m
				Sample Type	U
				Samples received	09/08/2017
				Schedules received	08/08/2017
				Project Started	10/08/2017
				Date Tested	22/08/2017



NATURAL MOISTURE CONTENT	26	%
% PASSING 425µm SIEVE	100	%
LIQUID LIMIT	75	%
PLASTIC LIMIT	30	%
PLASTICITY INDEX	45	%

Remarks

PLASTICITY INDEX



TEST METHOD
BS1377: Part 2 :Clause 4.4 : 1990 Determination of the liquid limit by the cone penetrometer method
BS1377: Part 2 :Clause 5.0 : 1990: Determination of the plastic limit and plasticity index
BS1377: Part 2 :Clause 3.2 : 1990:Determination of the moisture content by the oven drying

Checked and Approved
Initials: J.P
Date: 23/08/2017

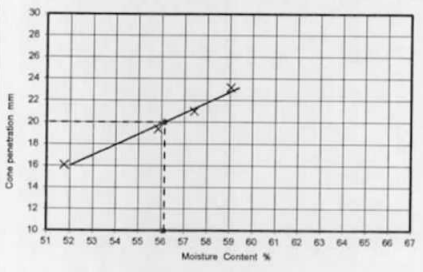
Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU
Tel: 01923 711 288 Email: James@k4soils.com

2519 Approved Signatories: K.Phaure (Tech.Mgr) J.Phaure (Lab.Mgr)

M3F-5 R2

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

Site Name	New Road, Hillingdon			Job No.	23126
				Borehole/Pit No.	WS01
Project No.	LP1412	Client	Leap Environmental	Sample No.	-
				Depth Top	0.85 m
Soil Description	Brown silty sandy clayey GRAVEL (gravel is fmc and sub-rounded to sub-angular)			Depth Base	- m
				Sample Type	B
				Samples received	18-07-2017
				Schedules received	20-07-2017
				Project Started	21-07-2017
				Date Tested	04-08-2017

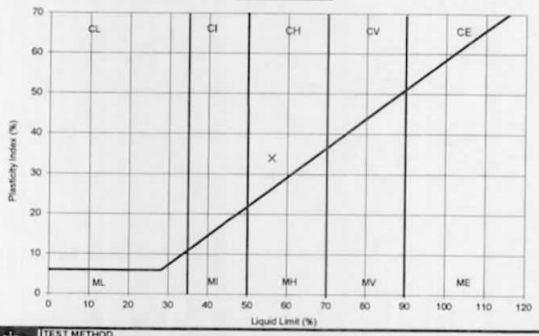


NATURAL MOISTURE CONTENT	13	%
% PASSING 425µm SIEVE	35	%
LIQUID LIMIT	56	%
PLASTIC LIMIT	22	%
PLASTICITY INDEX	34	%

Remarks

Sample washed to obtain test fraction

PLASTICITY INDEX



TEST METHOD
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BS1377: Part 2 :Clause 5.0 : 1990: Determination of the plastic limit and plasticity index
BS1377: Part 2 :Clause 3.2 : 1990:Determination of the moisture content by the oven drying

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Test Report by K4 SOILS LABORATORY Unit 8 Olds Close Olds Approach Watford Herts WD18 9RU
Tel: 01923 711 288 Email: James@k4soils.com

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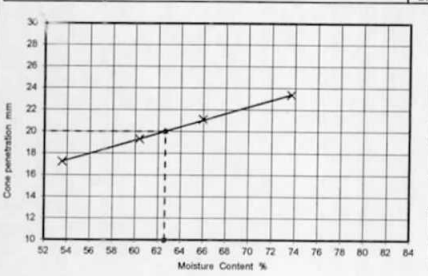
M3F-5 R2

LIQUID LIMIT, PLASTIC LIMIT AND PLASTICITY INDEX

Site Name	New Road, Hillingdon			Job No.	23126
				Borehole/Pit No.	WS02
Project No.	LP1412	Client	Leap Environmental	Sample No.	-
				Depth Top	0.66 m
Soil Description	Brown sandy very clayey GRAVEL (gravel is fmc and sub-rounded to sub-angular)			Depth Base	- m
				Sample Type	B
				Samples received	18-07-2017
				Schedules received	20-07-2017
				Project Started	21-07-2017
				Date Tested	04-08-2017

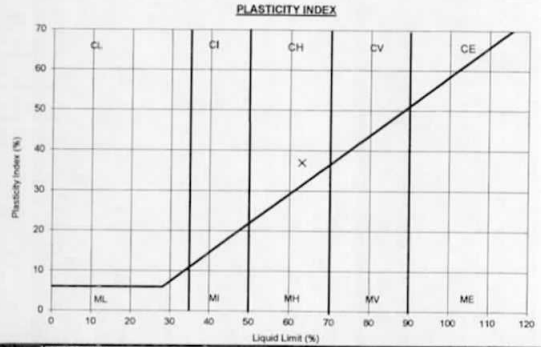


NATURAL MOISTURE CONTENT	12	%
% PASSING 425µm SIEVE	28	%
LIQUID LIMIT	63	%
PLASTIC LIMIT	26	%
PLASTICITY INDEX	37	%

Remarks

Sample wahed to obtain test fraction

PLASTICITY INDEX



TEST METHOD
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BS1377: Part 2 :Clause 5.0 : 1990: Determination of the plastic limit and plasticity index
BS1377: Part 2 :Clause 3.2 : 1990:Determination of the moisture content by the oven drying

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M3F-5 R2