

PHASE 2 GROUND INVESTIGATION

Lidl Great Britain Ltd
Purbrook Way, Havant

Client: Lidl Great Britain Limited

Remada Ltd
www.remada.co.uk

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Executive Summary

Remada Ltd was commissioned by Lidl Great Britain Ltd to undertake a Phase 2 Ground Investigation at Purbrook Way, Havant, PO9 3QJ at the location indicated in **Figure 1**.

Site Setting & History

The site is irregular in shape and with boundaries that are parallel with Purbrook Way the south and the adjacent B&Q store to the east. The western and northern boundary is curved and formed by the access road to B&Q. The topography of the site is obscured by impenetrable dense vegetation in central and southern parts however the northern is grassy and slopes down to the access road that serves B&Q.

The site has not been previously developed but its present-day topography and historic maps indicated that is formed of a spoil heap of surplus soils. The source of spoil heap (made ground) is not known but may be due to construction of either the B&Q store or adjacent roads (Purbrook Way and/or A3(M)).

Published Geology & Hydrogeology

Published geological maps indicate that the site is directly underlain by London Clay of thickness 77 to 120m which is designated as unproductive strata, overlying Reading Beds and a sequence of chalks.

The investigation comprised 3 No cable tool boreholes to target 10m depth and 5 No window sample holes to 5m depth. Due to dense vegetation and restraints imposed by the ecologist, it was not possible to access all window sample locations with the proposed car park. Made Ground was observed at all exploratory locations as firm to stiff orange/brown grey slightly gravelly clay to a maximum depth of 5.0m in CP1 and CP2 beneath the store footprint. At CP3A and CP3B the fill material contained concrete boulders and concrete kerbstones that were removed by excavator and the exploratory hole was advanced as a trial pit. WS2 was also obstructed by a concrete boulder within the fill material that was subsequently removed by excavator and the exploratory hole was advanced as a trial pit.

Bedrock was encountered in all of the exploratory holes as stiff to very stiff micaceous blue grey CLAY considered to be representative of London Clay. Due to the change in topographical elevation between the perimeter of the site and central area beneath the proposed store footprint, the depth to bedrock varied from 0.25m at WS1 to 5.0m in CP1 and CP2.

Human Health Assessment

The results of soil chemical analysis were compared to Human Health Generic Assessment Criteria for commercial land use. None of the analytes tested were detected at concentrations that exceeded the human health GAC protective of on-site workers.

Water Resources Assessment

The results of the soil chemical analysis undertaken has identified that concentrations of metals and inorganic contaminants are within the range of typical made ground. Detectable concentrations of TPH and PAHs were encountered WS2 however BGS Sheet 316 indicates that the London Clay extends to a minimum of 77m and it is therefore considered to be protective of the underlying groundwater source protection zone. There are no watercourses within close proximity of site.

Waste Classification

Additional sampling and analyses were undertaken on the made ground fill at between 0.5m and 3.5m bgl to enable an assessment of potential waste disposal classification as it anticipated that ground will be reduced to enable the development. The concentrations of metals and organic contaminants were generally in the range of inert soils and in general, the results of the chemical analysis indicates that the material would generally be classified as inert however due to concentration of Total Organic Carbon it may necessary to discuss the results with potential receive site to ensure that the surplus is removed as an inert material.



Geotechnical Considerations

The proposed site layout is indicated in **Figure 3** with the Lidl store zone being in the east of the site and parallel with the retaining wall to B&Q. The proposed car park and delivery access is indicated to be from the access road that links B&Q to Purbrook Way and through which ground levels reduce from 43.5m AOD at the junction of Purbrook Way to 36.5m AOD in the B&Q car park. The site is retained at 39.5m AOD by the retaining to B&Q but ground levels increase through the landscape area to 43.5m AOD. Consequently, it is anticipated that existing ground levels would be reduced by at least 2m to enable an at grade access with the Purbrook Way and to have a similar elevation to the retaining wall.

Piled foundations end bearing within the underlying stiff to very stiff blue grey clay is a potential solution and potential pile capacities have been estimated. However, due to the known concrete obstruction in the fill material it may necessary to proof dig all pile locations.

Ground improvement of the fill material in the vibro piling is not considered appropriate due to undrained shear strength of the fill material and the known concrete obstructions that would require removal to enable the vibro poker to penetrate.

A plain slab or stiffened edge raft bearing directly on compacted fill material of minimum specified bearing capacity is a potential alternative to a piled foundation. However, as it was not possible to investigate the entire building footprint there may zones of soft fill material present that have not yet been detected.

Recommendations

It is recommended that following vegetation clearance, additional ground investigation is undertaken ensure that there are no pockets of waste within the fill material and that soil strengths are consistent through the fill material beneath the proposed store footprint. The investigation should comprise a grid of dynamic probing on a 5m x 5m basis to profile relative soil strengths beneath the store footprint. The dynamic probing would also potentially identify locations of additional concrete obstructions with the fill material. The dynamic probing should be supplemented with window samples to obtain soils for laboratory geotechnical testing. In addition, it would also be beneficial to carry out additional window samples with the car park area. It would also be beneficial to carry out additional plate bearing tests at the proposed formation level when this known.

A Design Sulphate Class DS-2 is considered appropriate for buried concrete and an ACEC Class of AC-1s is considered appropriate for the location.

The results of four rounds of gas monitoring visits placed the site into Characteristic Situation 2 and therefore ground gas protection measures will be required within the proposed store.



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Issue No /	Date	Prepared By	Technical Review	Authorised
01	30.09.2020	G Jones 	P Dickinson 	G Jones 
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1 INTRODUCTION

Remada Ltd was commissioned by Lidl Great Britain Ltd to undertake a Phase 2 Ground Investigation at Purbrook Way, Havant, PO9 3QJ at the location indicated in **Figure 1**.

1.1 Objectives

The objectives of this assessment are as follows:

- to examine whether there have been any potentially contaminative uses on the site or nearby land;
- to develop a conceptual model of the site to identify plausible pollutant linkages;
- to assess ground conditions in relation to the proposed development in relation to construction design issues including the presence, nature, likely severity and extent of soil and groundwater contamination, which may be present, its potential environmental impact and likely requirement for further work; and
- Provide preliminary foundation design recommendations for the proposed development.

1.2 Scope of Work

The scope of the investigation is generally in accordance with BS10175:2011+A2 2017 and layout of this report has been designed with the Environment Agency's CLR11⁽¹⁾ in mind and guidance issued by the Environment Agency for land contamination reports.

The original scope of work comprised:

- 3 No cable tool boreholes inclusive of Standard Penetration Tests (SPTs) to a depth of 10m beneath the proposed store footprint;
- 4 No window sample boreholes inclusive of SPTs to target depths of 6m including SPTs beneath the proposed store footprint and car park (5 No were proposed but access was not possible);
- 3 No combined groundwater and gas monitoring standpipes installed with window sample boreholes;
- 4 No 600mm diameter plate bearing tests;
- 4 No California Bearing Ratio (CBR) tests;
- Suite of geotechnical classification and strength tests;
- 5 No soil sample suites for chemical analysis of CLEA metals, asbestos, speciated hydrocarbons, cyanide and phenols to further delineate soil contamination;
- 4 No ground gas and groundwater monitoring visits to satisfy planning requirements; and
- Combined Factual & Interpretative Geoenvironmental Report.

The scope of work was then increased to enable waste classification of potentially surplus soils and comprised an additional:

- 6 No soil sample suites for chemical analysis of CLEA metals, asbestos, speciated hydrocarbons, cyanide and phenols; and
- 3 No soil samples for the analysis of waste acceptance criteria (WAC).



1.3 Previous Reports

The following Phase 1 Desk Study had been previously prepared for the site:

- Phase 1 Site Investigation & Preliminary Risk Assessment. Remada Ltd Report 770.01.01 August 2018.

1.4 Limitations

The comments given in this report and the opinions expressed are based on the information reviewed and observations during site work. However, there may be conditions pertaining to the site that have not been disclosed by this assessment and therefore could not be taken into account.



2 SUMMARY OF PHASE 1 DESK STUDY

The Executive Summary and Conceptual Site Model presented within the Phase 1 Desk Study are reproduced below:

Site Setting

*The site is irregular in shape and with boundaries that are parallel with Purbrook Way the south and the adjacent B&Q store to the east as indicated in **Figure 2**. The western and northern boundary is curved and formed by the access road to B&Q. The topography of the site is obscured by impenetrable dense vegetation in central and southern parts however the northern is grassy and slopes down to the access road that serves B&Q. The boundary to B&Q is formed by a retaining wall that retains the site at approximately 3m above the adjacent car park. The southern boundary of the site also reduces in level to form a low-lying abandoned track adjacent to Purbrook Way.*

Site History

The site has not been previously developed but its present-day topography and historic maps indicated that is formed of a spoil heap of surplus soils. The source of spoil heap (made ground) is not known but may be due to construction of either the B&Q store or adjacent roads (Purbrook Way and/or A3(M)).

Published Geology / Hydrogeology

Published geological maps indicate that the site is directly underlain by London Clay of thickness 77 to 120m which is designated as unproductive strata.

Recommendations

Environmental

The desk study has identified a number of on-site and off-site potential sources of contamination that would require further investigation. The following is recommended:

- *Investigation of the lateral and vertical extent of made ground/fill beneath the proposed store footprint;*
- *Collection of soil and groundwater samples from the areas identified above for contaminants of concern; and*
- *Ground gas monitoring.*

Geotechnical

It is recommended that a ground investigation is undertaken to enable preliminary foundation design.



Potential Source Areas	Potential Contaminant of Concern	Pathways	Potential Receptor	Exposure Route (Human unless otherwise stated)	Potential Identified Linkage (unmitigated)	Findings of Ground investigation	Risk (Un-mitigated)	Proposed Remediation (Mitigation) Measures	Residual Risk Estimation
On-site Sources				• Direct Ingestion Soil	Yes	To be assessed (TBA)	Potential risk	(To be assessed (TBA)	(To be assessed (TBA)
Earthworks spoil heap		Disturbance due to construction plant causing direct contact, dusts, vapours.	Occupants of the development / building fabric	• Indoor ingestion Dust	Yes	As above	Potential risk	TBA	TBA
				• Skin Contact with Soils	Yes	As above	Potential risk	TBA	TBA
				• Skin Contact with Dust	Yes	As above	Potential risk	TBA	TBA
Off-site Sources				• Inhalation of Outdoor Dust	Yes	As above	Potential risk	TBA	TBA
Adjacent B&Q store	Asbestos / Metals As, Be, Cd, Cu, Cr (VI), Cr (III) Hg, Ni, Se, Va, Zn, Boron, TPH /PAH.	Direct Contact with occupants of the proposed development		• Inhalation of Outdoor Vapours	Yes	As above	Potential risk	TBA	TBA
Highways		Inhalation of fibres / vapours / gases by occupants of proposed development	Adjacent residents during construction	• Inhalation of Indoor Vapours	Yes	As above	Potential risk	TBA	TBA
Nearby Petrol station				• Inhalation of ground gas	Yes	As above	Potential risk	TBA	TBA
				• Inhalation of radon gas	No	N/A	Negligible	Negligible	Negligible
		Permeation of water supply pipework		• Ingestion via permeated water supply pipework	Yes	As above	Potential risk	TBA	TBA
				• Direct contact with Bedrock – Unproductive Strata	No	As above	Negligible	Negligible	Negligible
		Leachate	N/A	• Groundwater Source Protection Zone (Beneath London Clay)	No	N/A	Negligible	Negligible	Negligible

Table 1: Outline Conceptual Site Model

Direct contact with subsurface soil and/or groundwater during redevelopment works are not assessed as part of the CSM. It is considered that risks to workers will be managed as part of any the redevelopment works at the site through the application of health and safety procedures, where required.

3 ENVIRONMENTAL & GEOTECHNICAL INVESTIGATION METHODOLOGY

3.1 Investigation Strategy

The access road from Purbrook Way to the B&Q store adjacent to the proposed Lidl site reduces in level from 43.5m to 36.5m in the B&Q car park. Purbrook Way is formed from an earthworks embankment and original ground levels at the site location appeared to be similar to that of the B&Q car park. The site is also retained from the B&Q car park at a level of 39.5m AOD. Consequently, due to the potential depth of landscape fill, the scope of the ground investigation was varied from Lidl's standard 04.2018 to include three (3 No.) cable tool boreholes inclusive of SPTs beneath the store footprint to a depth of 10m to prove natural ground.

Lidl had arranged for BlueJay Ecology to supervise vegetation clearance to the borehole and window sample positions; however, it was not possible to gain access to proposed location WS4. The vegetation comprised impenetrable brambles, hawthorn, gorse, and blackberry. Vegetation clearance was undertaken on the 10th & 11th August 2020 and 4 No window samples inclusive of SPTs were bored on the 11th August 2020. Due to the vegetation clearance, the cable tool rig was postponed until 17th August 2020. In addition to the above, 2 No plate bearing tests and 4 No CBR tests were carried out on the fill material at accessible locations on 11th August 2020.

Following strimming of vegetation, a tracked excavator then cleared ground level vegetation to enable access to exploratory positions. The excavator was also used to create level working platforms at positions WS1 and WS5 on the slope of the landscape bund.

All exploratory holes were logged by a suitably qualified Geo-environmental Engineer in general accordance with the recommendations of BS5930:2015. Detailed descriptions, together with relevant comments, are given in the Exploratory Hole Logs.



Slope levelled to enable window sampler at WS1. The ground level at the window sample position was reduced by approximately 1m.



Slope levelled to enable window sampler at WS5. A ramp was formed to the right of WS5 to enable access to exploratory positions at the top of the fill.



Vegetation clearance to give access to WS2



Vegetation cleared to give access to WS3



Access route through cleared vegetation to
Cabletool Holes (CP1 & CP2)



Concrete obstruction being removed from location
of WS2



Location of CP3 following excavation of concrete
obstruction



Location of WS3 following excavation of concrete
obstruction



3.2 Investigation & Sampling Methodology

Cable tool holes CP1, CP2 & CP3, and window sample WS1 were bored within the proposed store footprint. WS2, WS3 and WS5 were bored within the proposed car park but location WS4 was not accessible as the dense vegetation could not be cleared. All holes fully penetrated the made ground landscape fill to prove the depth to the underlying London Clay.

Combined Groundwater and Ground Gas monitoring standpipes were installed in CP03, WS02 and WS05.

Standard Penetration Tests (SPTs) in the window samples were carried out at 1.0m intervals as recorded on the borehole logs to assess the relative density and consistency of soils.

SPTs were conducted in accordance with BS EN ISO 22476-3 and the recorded SPT N-values are summarised on the borehole logs and the SPT Calibration Certificates are presented at **Appendix A**.

3.2.1 CBR Tests

Four (4 No.) CBR tests were carried out in the proposed car park and the test results are presented at **Appendix B**.

3.2.2 Plate Bearing Tests

Two (2 No) plate bearing tests were carried out adjacent to locations CP02 and CP03 on the landscape fill material using a 600 mm diameter plate to a test pressure of 300 kPa. The test results are presented at **Appendix C**.

3.3 Soil Sampling

3.3.1 Environmental

Made ground and natural soils were selected by visual and olfactory means for subsequent analysis. Samples for chemical laboratory testing purposes were collected in amber glass jars, amber glass vials and plastic tubs and retained in a cool box for transport to the laboratory.

Soil samples were scheduled for a minimum standard suite of chemical analysis that comprised quantitative asbestos, fraction of organic carbon, pH, CLEA metals, TPHCWG, PAH(16) & (17), BTEX, phenols, sulphates and chlorides.

3.3.2 Geotechnical

Geotechnical samples were collected at depths indicated on the logs with samples retrieved either from the excavator bucket or from within a sleeve line. Disturbed samples were placed in sealed and correctly labelled plastic tubs or bags as appropriate. All geotechnical samples were dispatched to the laboratory for testing with a completed chain of custody.

Soil samples were scheduled for geotechnical classification and strength testing as appropriate to recovered soils.

3.4 Gas and Groundwater Monitoring

3.4.1 Installations

Combined ground gas and groundwater monitoring standpipes were installed in WS01, WS03 & WS05, to depths of between 2.5 and 4.5m bgl with 50mm diameter slotted HDPE pipe and packed with gravel surround as recorded on the exploratory logs. Wells were completed with 0.5-1m of plain HDPE pipe and bentonite seal, with a gas bung and tap being installed at the top of the pipe.



3.4.2 Monitoring

Ground gas monitoring was undertaken using Geotech GA5000 gas analyser for the parameters reported below. Groundwater levels were measured with a GeoSense OWP30 oil water interface probe.

Permanent ground gas monitoring involved the measurement of the following in the prescribed order:

- Pressure difference between the monitoring well and the atmosphere,
- Peak and steady flow rates of gas into or out of the monitoring well;
- Peak and steady concentrations of carbon dioxide, methane, oxygen (minimum and steady recorded), carbon monoxide, hydrogen sulphide; and
- Depth to groundwater.

In total four monitoring visits were undertaken on the 3rd, 9th, 16th and 23rd September 2020. The results are presented on **Table 2**.

3.5 Quality Assurance and Quality Control

All samples were submitted to a United Kingdom Accredited Laboratory (UKAS) under a completed chain of custody. The laboratory carried out its own QA/QC programme to ensure that the quality of the analytical data conformed to the appropriate test method protocols.

3.6 Laboratory Testing

3.6.1 Soil Chemical Analysis

Ten (10 No) soil samples were scheduled for the analysis of asbestos, arsenic, barium, beryllium, cadmium, chromium (III & VI), copper, mercury, nickel, lead, selenium, zinc, fraction of organic carbon, Total Petroleum Hydrocarbons (TPHCWG), Polyaromatic Hydrocarbons (PAH), BTEX compounds (benzene, toluene, ethylbenzene and xylene) and phenols.

Three (3 No) samples were scheduled for the analysis of Waste Acceptance Criteria.

The results of laboratory chemical analyses are presented at **Appendix D**.

3.6.2 Geotechnical

Samples recovered from the boreholes were submitted to an accredited laboratory for the following analyses in general accordance with BS1377:1990:

- 10 No Natural Moisture Contents
- 10 No Atterburg Limits
- 1 No Particle Size Distribution tests
- 6 No Quick Undrained Triaxial Compression Tests
- 4 No BRE SD1 suites; and

The results of the geotechnical testing are presented at **Appendix E**.



4 GEOTECHNICAL & ENVIRONMENTAL INVESTIGATION FINDINGS

4.1 Ground Conditions

A brief description of the published geology is provided together with a summary of the ground conditions encountered during the intrusive investigation. Exploratory logs are presented at the end of the report.

4.1.1 Published Geology

Bedrock beneath the site is formed of London Clay and designated as unproductive strata. However, a Principal Aquifer associated with a sequence of chalk members is recorded approximately 2000m to the south. BGS Map 316 indicates that the site is underlain by London Clay to a depth of 77 to 120m, overlying Reading Beds and the following sequence of chalk members: Portsdown, Spetisbury, Tarrant, Newhaven, Seaford and Lewes etc.

4.1.2 Made Ground

Made Ground was observed at all exploratory locations as firm to stiff orange/brown grey slightly gravelly clay to a maximum depth of 5.0m in CP1 and CP2 beneath the store footprint. At CP3A and CP3B the fill material contained concrete boulders and concrete kerbstones that were removed by excavator and the exploratory hole was advanced as a trial pit.

4.1.3 Superficial Deposits

No superficial deposits were positively identified underlying the study site during Remada's investigation.

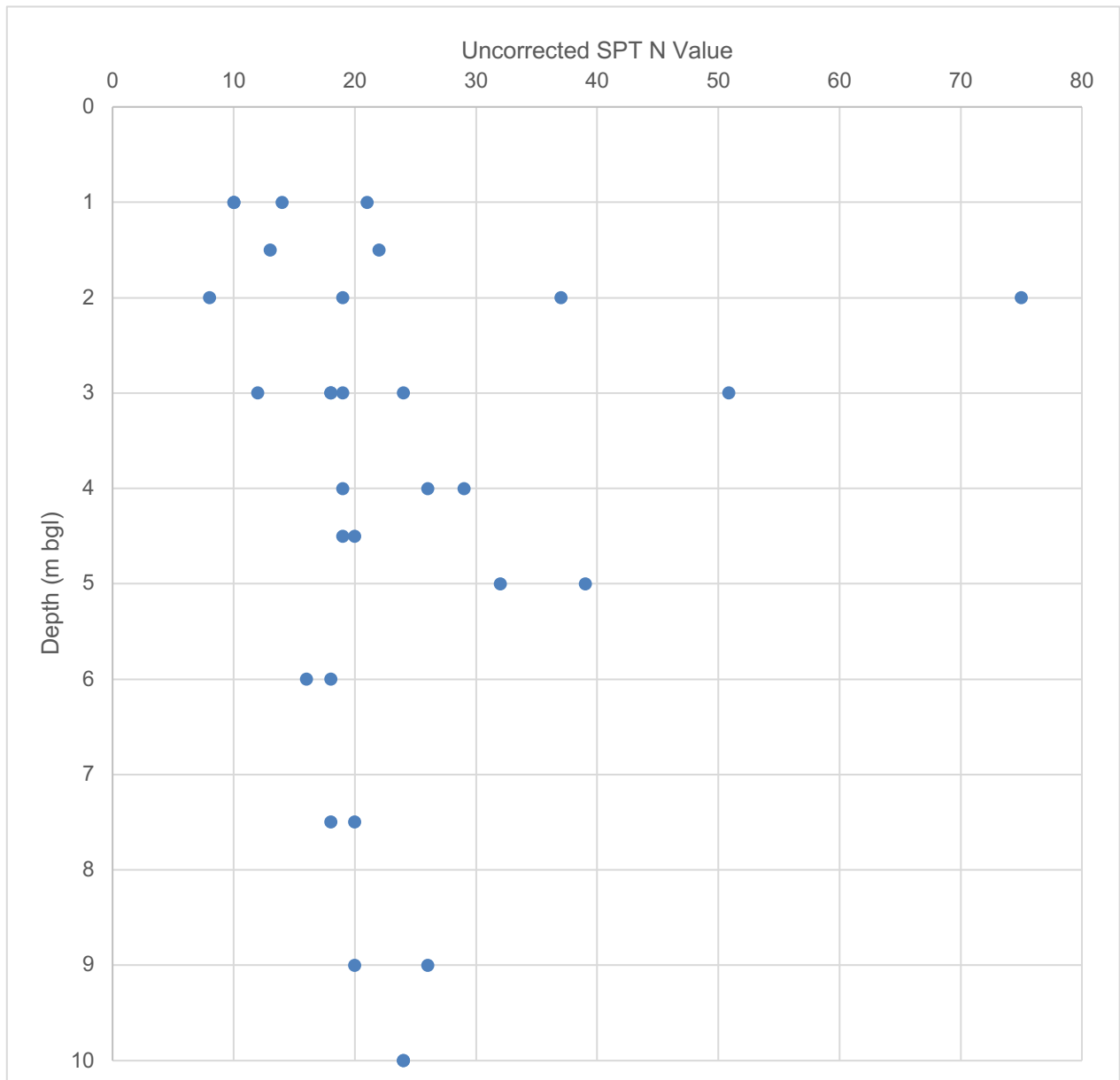
4.1.4 Bedrock

Bedrock was encountered in all of the exploratory holes as stiff to very stiff micaceous blue grey CLAY considered to be representative of London Clay. Due to the change in topographical elevation between the permitted of the site and central area beneath the proposed store footprint, the depth to bedrock varied from 0.25m at WS1 to 5.0m in CP1 and CP2. The topographical elevation of the stiff to very stiff micaceous blue grey CLAY reduced from 37.9m AOD beneath the north of the site at WS1 to 35.3m AOD at CP2 adjacent to the retaining wall beneath the southern end of the proposed store footprint.

4.2 In-situ Testing

4.2.1 Standard Penetration Tests (SPTs)

In-situ SPTs were undertaken to assist with the interpretation of strata encountered and the results of uncorrected N-values versus depth are plotted in the graph below. It should be noted that the SPTs that refused within the made ground and the weathered bedrock have not been included in the graph.



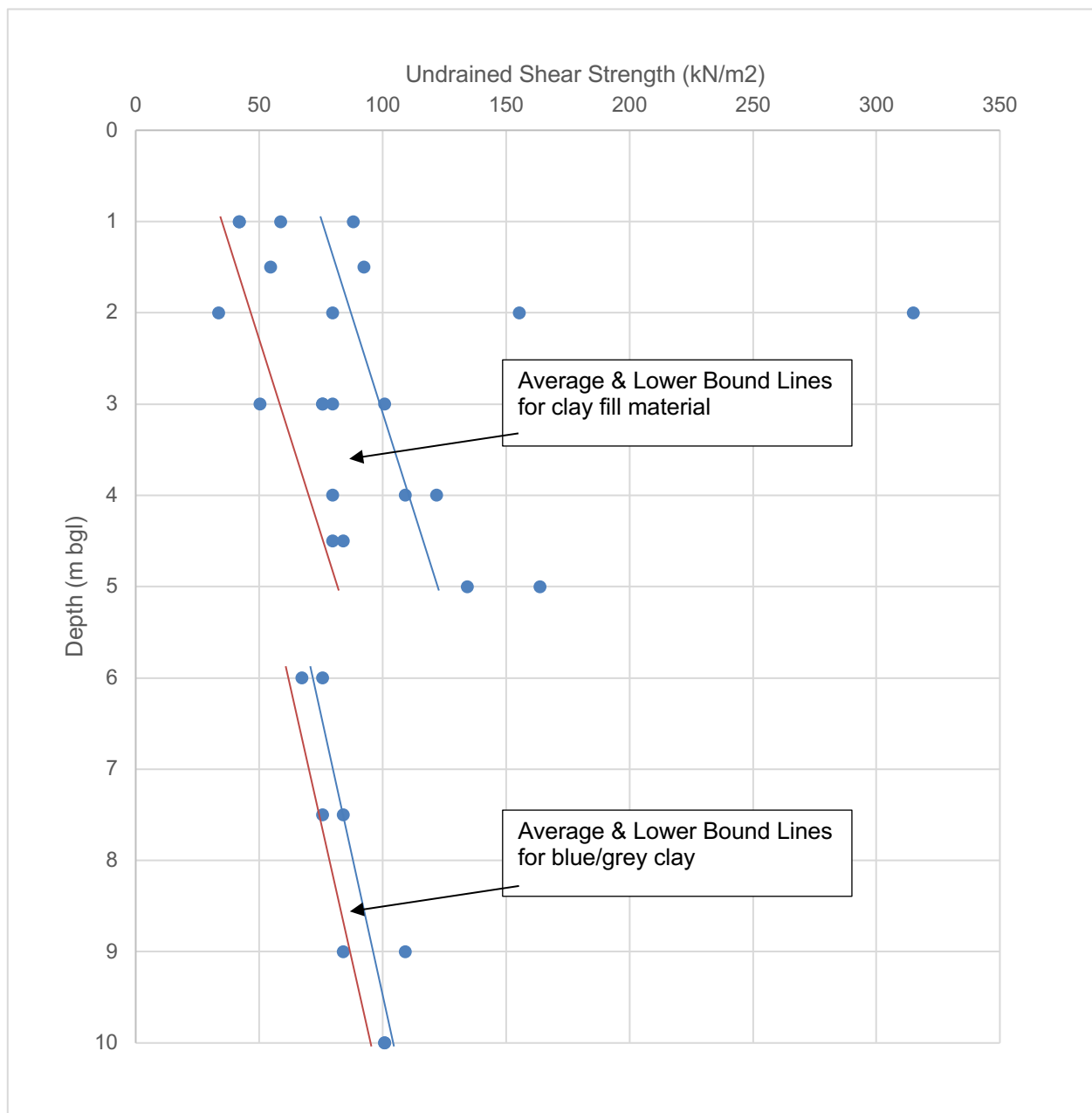
Graph 1: Plot of Corrected SPT N-Values Versus Depth

Undrained shear strengths have been estimated from SPT N values using the relationship developed by Stroud (*The standard penetration test in incentive clays and soft rocks*) and summarised in Tomlinson where:

$$\text{Mass shear strength} = f_1 \times N$$

Where f_1 is based on the plasticity index.

A Plasticity Index of 30% has been assumed (based on geotechnical laboratory testing) which equates to an f_1 factor of 4.5.



Graph 2: Plot of Mass Shear Strength Versus Depth

4.2.2 Hand Shear Vane

Due to the friable nature of the recovered soils from the fill material it was not possible to undertake Hand Shear Vane tests on the majority of recovered samples from the majority of trial pits. Hand Shear Vane results were WS2 @ 2.75m (fill) = 50 kPa, WS2 & 4.5m (London Clay) = 90 kPa WS5 @ 0.75m (fill) = 90 kPa.

4.2.3 CBR Tests

3 No. CBR tests were carried out using TRL Dynamic Cone Penetrometer method at the locations indicated on **Figure 3** and the results are presented at **Appendix B**. Results indicate values of 5 to 10% at CBR 1 within the upper 500mm, 5 to 10% at CBR 2 but obstructed at 500mm, and 5 to 10% at CBR 3 but obstructed at 450mm.

4.2.4 Plate Bearing Tests

Two (2 No) plate bearing tests (PBT1 & PBT2) were undertaken within the proposed store footprint at the locations indicated on **Figure 3** and the results are presented at **Appendix C**. Each test was carried out using a 600mm diameter plate to a test pressure of 300 kPa and produced the following results:

	PBT 1	PBT2
Equivalent CBR Value (%)	11.15	7.21
Maximum Applied Stress (kPa)	293.35	293.35
Maximum Settlement (mm)	3.98	5.98
Bearing Pressure at 1.25mm Settlement	90.0	70.0
K762 (at 1.25mm settlement) kN/m ² /m	58.53	45.5

Summary of Plate Bearing Test Results

4.3 Soil Observations

At WS02 a hydrocarbon odour was observed within the orange/brown grey clay fill material between 1.0m and 2.75m bgl. The fill material contained boulders of concrete and kerbstones that prevent percussive drilling but there were no visible indicators of contamination including asbestos with the made ground.

4.4 Groundwater Observations

No groundwater seepages were observed whilst advancing the boreholes/trial pits, however resting groundwater was recorded at 3.2m bgl in WS1.

4.5 Chemical Analysis

Results of the soil chemical analysis are presented in **Table 3** at the end of the report and full laboratory certificates are presented in **Appendix D**. Results of the chemical analyses are summarised as follows. The average FOC and pH were 0.06 and 8.2 respectively. Asbestos was not detected in the samples analysed.

Detectable concentrations of metals were identified, although these are generally within the range that would typically be expected for made ground. Concentrations of TPH, PAH & BTEX were not detected above method detection limit (MDL) except within the fill material at WS2.

4.6 Geotechnical Testing

Results of the geotechnical testing are summarised as follows and full laboratory certificates are presented in **Appendix E**.

Laboratory test results produced:

- CP3B 1.50 to 2.00m Brown fine to medium gravelly sandy silty CLAY of low to intermediate plasticity Acid Soluble Sulphate = 0.33%, Aqueous Extract Sulphate 0.04 g/l, pH = 7.56, total sulphur 0.13%.
- WS2 2.00 to 2.75m Brown sandy silty CLAY of intermediate plasticity
- WS5 0.5 to 1.0m Brown sandy silty CLAY of intermediate plasticity
- WS1 0.5 – 1.0m Grey sandy silty CLAY of intermediate plasticity
- CP2 2.0 to 2.5m estimated Cu= 170 kPa



- CP2 7.45 to 8.0m Brown sandy silty CLAY of intermediate plasticity
- CP1 3.0 to 3.5 Brown sandy silty CLAY of intermediate plasticity
- CP1 4.45 to 4.5m, estimated Cu = 230 kPa.
- CP1 7.0 to 7.5m Grey sandy silty CLAY of intermediate plasticity, Acid Soluble Sulphate = 0.29%, Aqueous Extract Sulphate 0.04 g/l, pH = 7.56, total sulphur 0.13%.
- CP1 7.0 to 7.5m estimated Cu = 175 kPa
- CP1 5.5 to 5.6m Brown sandy silty CLAY of intermediate plasticity
- CP1 6.0 to 7.0m Grey sandy silty CLAY of intermediate plasticity

4.7 Ground Gas Monitoring Results

The results of four gas monitoring visits are presented in **Table 2** and summarised below:

Methane was recorded at a maximum steady state concentration of <0.1% on all four monitoring events;

Carbon dioxide was recorded at a maximum steady state concentration of 14.0% v/v in WS1 on 23rd September 2020 having risen on consecutive monitoring events;

Oxygen was recorded at a minimum steady state concentration of 11.4 % v/v in WS2 on 3rd September 2020;

Ground gas flow rates were recorded at a maximum of 0.5 litres per hour (l/hr) in CP2 on 23rd September 2018.

Atmospheric pressure at the time of sampling varied between a high of 1020 millibar (mbar) on 9th & 16th September 2020 and a low of 996 mbar on 23rd September 2020.



5 GENERIC QUANTITATIVE RISK ASSESSMENT

5.1 Human Health Risk Assessment

In order to provide an up to date assessment of the risks to human health, Remada has adopted the most recent Generic Assessment Criteria (GAC) published by LQM/CIEH (S4ULs) and CL:AIRE/EIC/AGS for the assessment of potential risks to human health. The derivation of GAC, methodology, input parameters and technical guidance (CLEA) may be obtained on request.

Default parameters have been adopted for sandy loam of pH 7 and commercial land use. The maximum FOC value was less than 0.02 giving a Soil Organic Matter (SOM) 2.58%. In order to present a conservative assessment, the SOM content of 2.5% has been adopted for the assessment.

The depth to potential sources of contamination for indoor air pathways has been assumed to be 0.5m below building foundation level. The source has been conservatively assumed to be at ground level for outdoor air and direct contact pathways.

For commercial land use the CLEA version 1.06 critical receptor is conservatively modelled as a female working adult with an exposure duration of 49 years. In accordance with the default parameters it was assumed that employees spend most of their time indoors and that 80% of outdoor area is covered by hardstanding. As such, the potential exposure pathways have been assumed to be:

- Direct Soil and Indoor Dust Ingestion;
- Skin contact with soils and dusts;
- Inhalation of indoor and outdoor dusts and vapours.

Where GAC values for individual TPH fractions are not exceeded, the potential additive effect has been assessed by calculating overall TPH hazard index for each sample.

5.2 Comparison of Soil Analysis Results with Human Health GAC

A comparison of soil chemical analysis with GAC is presented as **Table 3**.

TPH, PAH & BTEX

None of the analytes tested were detected at concentrations that exceeded the human health GAC protective of on-site workers.

Metals & Inorganics Excluding Asbestos

None of the analytes tested were detected at concentrations that exceeded the human health GAC protective of on-site workers.

Asbestos

There was no asbestos detected in the samples selected for analysis.

5.3 Controlled Waters Risk Assessment

Made ground was observed to be a natural orange/brown grey clay with occasional concrete that had been placed as fill material directly over blue/grey London Clay. The results of the soil chemical analysis undertaken has identified that concentrations of metals and inorganic contaminants are within the range of typical made ground. Detectable concentrations of TPH and PAHs were encountered WS2 however, BGS Sheet 316 indicates that the London Clay extends to a minimum of 77m and it is therefore considered to be protective of the underlying groundwater source protection zone. There are no watercourses within close proximity of site.



5.4 Ground Gas Assessment

In order to understand the gassing regime at the site, a Characteristic Situation (as defined in CIRIA C665 and BS8576:2013) is determined for the site. CIRIA C665 and BS8576 provides definitions for each Characteristic Situation based on Gas Screening Values (GSV) which are calculated as follows:

$$\text{GSV} = \text{Gas Concentration (\% v/v)} \times \text{Measured Borehole Flow Rate (l/hr)}$$

BS8576 makes a distinction between the GSV and the Hazardous Gas Flow Rate (Q_{hg}) which is also calculated using the above calculation. BS8576 states that Q_{hg} is calculated for each individual borehole for each monitoring visit, whereas the GSV is taken as the representative value for the site or site zone.

As a worst-case assessment, the GSV for the site is therefore taken as the maximum steady state carbon dioxide/methane concentration recorded in the boreholes which is multiplied by the maximum flow rate recorded during the same monitoring event.

Methane GSV = 0.1 % x 0.5 l/hr = 0.0005 l/hr (methane concentration taken as equal to the instrument detection limit of 0.1%).

Carbon Dioxide GSV = 14.0 % x 0.5 l/hr = 0.07 l/hr

The calculated GSV for methane and carbon dioxide places the site into Characteristic Situation 2. BS8485 states that gas protection measures should be considered for the proposed development.

For a commercial building of this type (Type C) at a site classified as Characteristic Situation 2 the required minimum gas protection score for a low risk site in accordance with BS 8485:2015 (Table 4) is 2.5. Appropriate forms of floor and substructure designs are listed Table 5 of BS 8485:2015; it is likely that structural barriers, ventilation and a ground gas membrane would comprise suitable mitigation measures.

5.5 Revised Conceptual Site Model

A revised Conceptual Site Model is presented as **Table 4** below.

5.6 Waste Classification

It is anticipated that the finished floor level of the proposed store would be at a lower level than the current ground level in order to be at grade with the proposed car park access and retaining wall to B&Q. Consequently, for every one metre that ground levels are reduced there would a surplus volume of approximately 5500m³ of soil requiring off-site disposal.

Additional sampling and analyses were undertaken on the made ground fill at between 0.5m and 3.5m bgl to enable an assessment of potential waste disposal classification.

The assessment has included determination of the fraction of organic carbon (foc) which can be converted to TOC by multiplying the result by 100. The maximum value of TOC for 11 No samples submitted for analysis of the orange/brown grey clay fill was 2.58 % as reported in the laboratory total analysis summarised at **Table 3**. However, three samples were also submitted for the analysis of Waste Acceptance Criteria (WAC) and the corresponding results were:

- CP1 0.5 to 0.5m bgl, TOC reported in total determinands = 1.72 % whereas WAC test produced = 5.2%
- CP2 0.5 to 0.7m bgl, TOC reported in total determinands = 1.26%, whereas WAC test produced = 3.0%



- CP3 1.5m to 2.0m bgl reported in total determinands = 0.98% whereas WAC test produced = 4.9%

The pH values reported for all three samples in both the total determinand and WAC analysis were > 8 and < 9.

A TOC limit of 3% is placed on waste destined for disposal in an inert landfill. With respect to pH there is no limit for inert waste but for non-hazardous waste pH >6.

The concentrations of metals and organic contaminants were generally in the range of inert soils and in general, the results of the chemical analysis indicate that the material would generally be classified as inert however it may be necessary to discuss the above TOC results with potential disposal facilities.

5.7 Health & Safety Considerations

To ensure direct exposure of construction workers involved in the site redevelopment to any impacted contaminated shallow soils is minimised, the guidance stated in HSG 66 "Protection of Workers and the General Public During Redevelopment of Contaminated Land" should be followed.



Potential Source Areas	Potential Contaminant of Concern	Pathways	Potential Receptor	Exposure Route (Human unless otherwise stated)	Potential Identified Linkage (unmitigated)	Findings of Ground investigation	Risk (Un-mitigated)	Proposed Remediation (Mitigation) Measures	Residual Risk Estimation
On-site Sources				• Direct Ingestion Soil	Yes	<GAC	N/A	N/A	Negligible
Earthworks spoil heap		Disturbance due to construction plant causing direct contact, dusts, vapours.		• Indoor ingestion Dust	Yes	<GAC	N/A	N/A	Negligible
				• Skin Contact with Soils	Yes	<GAC	N/A	N/A	Negligible
				• Skin Contact with Dust	Yes	<GAC	N/A	N/A	Negligible
Off-site Sources				• Inhalation of Outdoor Dust	Yes	<GAC	N/A	N/A	Negligible
Adjacent B&Q store	Asbestos / Metals As, Be, Cd, Cu, Cr (VI), Cr (III) Hg, Ni, Se, Va, Zn, Boron, TPH /PAH.	Direct Contact with occupants of the proposed development	Occupants of the development / building fabric	• Inhalation of Outdoor Vapours	Yes	<GAC	N/A	N/A	Negligible
Highways		Inhalation of fibres / vapours / gases by occupants of proposed development		• Inhalation of Indoor Vapours	Yes	<GAC	N/A	N/A	Negligible
Nearby Petrol station			Adjacent residents during construction	• Inhalation of ground gas	Yes	CS2	Potential risk	Protection Measures to BS8475	Negligible
				• Inhalation of radon gas	No	N/A	Negligible	Negligible	Negligible
		Permeation of water supply pipework		• Ingestion via permeated water supply pipework	Yes	<GAC	N/A	N/A	Negligible
				• Direct contact with Bedrock – Unproductive Strata	No	As above	Negligible	Negligible	Negligible
		Leachate	N/A	• Groundwater Source Protection Zone (Beneath London Clay)	No	N/A	Negligible	Negligible	Negligible

Table 4: Refined Conceptual Site Model

Direct contact with subsurface soil and/or groundwater during redevelopment works are not assessed as part of the CSM. It is considered that risks to workers will be managed as part of any the redevelopment works at the site through the application of health and safety procedures, where required.



6 GEOTECHNICAL SITE ASSESSMENT

6.1 Geotechnical Considerations

The proposed site layout is indicated in **Figure 3** with the Lidl store zone being in the east of the site and parallel with the retaining wall to B&Q. The proposed car park and delivery access is indicated to be from the access road that links B&Q to Purbrook Way and through which ground levels reduce from 43.5m AOD at the junction of Purbrook Way to 36.5m AOD in the B&Q car park. The site is retained at 39.5m AOD by the retaining to B&Q but ground levels increase through the landscape area to 43.5m AOD. Consequently, it is anticipated that existing ground levels would be reduced by at least 2m to enable an at grade access with Purbrook Way and to have a similar elevation to the retaining wall.

The investigation found that landscape fill material was in general formed from firm to very stiff ferruginous red/brown clay fill possibly arising from construction of the B&Q store, Purbrook Way or nearby A3(M). The landscape fill area was formed directly onto a stiff to very stiff micaceous blue grey CLAY considered to be representative of London Clay.

Details of the proposed permanent and variable design loads (actions) are not currently known although an indicative column load of 400kN has been provided.

6.2 Design Approach

Piled foundations end bearing within the underlying stiff to very stiff blue grey clay is a potential solution and potential pile capacities are tabulated below. A plain slab or stiffened edge raft bearing directly on compacted fill material of minimum specified bearing capacity is a potential alternative to a piled foundation. However, as it was not possible to investigate the entire building footprint there may zones of soft fill material present that have not yet been detected. In addition, in the absence of development levels it is not known whether a raft would increase loadings on the existing retaining wall to the B&Q boundary.

Design calculations in accordance with BS EN 1997-1: 2004 require the establishment of design values for actions, ground properties and ground resistances, definition of the limits that must not be exceeded (usually a serviceability limit state), the setting up of calculation models for the relevant ultimate or serviceability limit state, and the showing by such calculation that these limits will not be exceeded.

Design values for such calculations are derived by applying partial factors to characteristic values for actions, ground properties and ground resistances, and based upon the geotechnical model and following requirements of Design Approach 1, Combination 2 calculations have been undertaken. **Table 5** provides a summary of the partial factors applied to actions, soil parameters and resistance factors. To satisfy the serviceable limit state settlement has been limited to 25mm.



Geotechnical parameter			Symbol	Combination 1		Combination 2	
Partial factors ¹ on actions (γ_F) or effects of actions (γ_E)	Permanent	Unfavourable ²	γ_G	A1	1.35	A2	1.0
		Favourable ³			1.0		1.0
	Variable ⁴	Unfavourable	γ_Q		1.5		1.3
		Favourable ⁵			0		0
Partial factors on soil parameters (γ_M)	Angle of shearing resistance ⁶		$\gamma_{\phi'}$	M1	1.0	M2	1.25
	Effective cohesion		$\gamma_{c'}$		1.0		1.25
	Undrained shear strength		γ_{cu}		1.0		1.4
	Unconfined strength		γ_{qu}		1.0		1.4
	Weight density		$\gamma_{\gamma'}$		1.0		1.0
Partial resistance factors (γ_R) for spread foundations	Bearing		$\gamma_{R,v}$	R1	1.0	R1	1.0
	Slidings		$\gamma_{R,h}$		1.0		1.0

¹These factors are given for buildings only. Different factors apply to bridges and other structures

²In this case the upper characteristic value ($G_{k,sup}$) of the permanent action is used

³In this case the lower characteristic value ($G_{k,inf}$) of the permanent action is used

⁴There may be more than one variable action. The partial factor is applied to the leading variable action and modified (reduced) values

⁵The UK National Annex states that when variable actions are favourable Q_k is zero, rather than g_Q is zero

⁶This is applied to $\tan\phi'$ or $\tan\phi_{cv}'$ although it might be more appropriate to determine the design value ϕ_{cv} directly

Table 5: Summary of Partial Factors Applied to Actions, Soil Parameters and Resistance Factors

Preliminary calculations indicate that for a raft downstand of 1.8 x 1.8m bearing on the reduced level formation of existing compacted firm to stiff orange brown gravelly clay of minimum undrained shear strength = 100 kN/m² a design bearing resistance of 180kN/m² will be appropriate in order to satisfy the ultimate and serviceable limit states. This is only applicable for foundations with loads that are applied vertically and centrally. To satisfy the serviceable limit state settlement has been limited to 25mm. However, it recommended that additional ground investigation in the form of a grid of dynamic probing and window sampling is carried out to ensure that there are no pockets of waste within the fill material and that the assumed soil strengths are valid.

In the absence of design loads the bearing capacity assessment has been undertaken for Design Approach 1, Combination 2 only, and a further assessment taking account of anticipated loadings (permanent and variable) will be required during detailed design in order to confirm the limit states are satisfied. All foundations will need to fully penetrate any made ground and be founded a minimum of 150mm into the founding stratum.

6.3 Ground Improvement

Ground improvement in the form of vibro piling is generally used for soft clays that can be penetrated by vibro poke for installation of stone columns. The undrained shear strength of the existing clay fill is greater than would generally be considered for vibro stone columns and the identified concrete obstructions with the fill would be a barrier to poker penetration.

6.4 Piled Foundations

If a piled foundation solution is adopted, then either driven or continuous flight auger (CFA) piles could be utilised. Driven piles have the advantage of improving the density of the ground whereas CFA piles could potentially loosen the granular deposits and thus result in a reduced safe working load. The main disadvantage of driven piles is that they can cause unacceptable amounts of vibration that could potentially damage nearby above and underground structures. If driven piles are used then assurances will need to be sought from the piling contractor that damage will not be caused to nearby structures, such as the retaining wall to B&Q.

Pile clearance excavations may also be required to remove known concrete obstructions within the fill material.

Remada has undertaken a preliminary assessment of potential safe working loads for pile design based upon the following idealised soil profile based on the intrusive work and the following assumptions:

Depth (m)	Ground Conditions	Assumptions
Existing GL to - 2.0m	N/A	Assumed to be removed to reduce levels on site
-2.0m (formation level) to - 5m	Firm to stiff orange/brown grey slightly gravelly clay Fill	Assume cohesive for skin friction component. N values and cu values taken from Remada's design lines as shown on Graphs 1 and 2 as follows: - Average N value of 15 taken at 3 to 4m depth for driven piles, reduced by 15% for CFA piles. - Lower bound cu value of 60kN/m² taken at 3 to 4m depth.
>6.0	Stiff blue / grey clay	Assume cohesive for skin friction and end-bearing component. N values and cu values taken from Remada's design lines as shown on Graphs 1 and 2 as follows: - Average N value of 20 taken at 7 to 9m depth for driven piles, reduced by 15% for CFA piles. - Lower bound cu value of 75kN/m² taken at 7 to 9m depth.

Table 6: Soil Profile for Pile Estimates

Groundwater has been assumed to be at >10mbgl.

The following table provides a summary of the preliminary estimated safe working loads base on the assumptions detailed above:

Pile Type	CFA	CFA	CFA	Driven	Driven	Driven
Pile Toe Depth (m)	8	8	8	8	8	8
Pile Diameter (m)	0.2	0.3	0.4	0.2	0.3	0.4
Safe Working Load (kN)	145	224	307	163	251	343

Table 7: Preliminary Estimated Safe Working Loads

The safe working load has been calculated by two different methods. In the first method a factor of safety of 2.5 is applied to both the end bearing and skin friction components. In the second method a factor of safety of 3.0 is applied to the end bearing component and 1.5 to the skin friction component. The safe working load is calculated by both methods and the lower of the two adopted.

The estimated safe working load is indicative only and specialist piling contractors should be consulted with regard to the design and performance of their piled foundations.

The calculated safe working load has been calculated for a single isolated pile. The effect of group action has not been taken into consideration. In addition, negative skin friction in the made ground have not been taken into consideration.

It should be noted that the depth to bedrock is likely to vary across the site and therefore, piles of differing lengths are likely to be required. If driven piles are adopted then provisions should be made to enable



pile lengths to be easily varied. In addition, several of the exploratory holes encountered obstructions within the made ground. Provision should be allowed for pre-probing of pile locations.

6.5 Floor Slab

If the site is to be piled then a suspended floor would be required.

6.6 Excavations and Temporary Works

Trial pits were excavated within the firm to stiff orange/brown and grey clay fill to remove shallow obstructions to boreholes and remained dry and open for the period of the excavation. Side slopes within the Made Ground fill and should be being battered back to a safe slope gradient. A detailed inspection of the side slopes should be made during excavation and a risk assessment carried out to fully assess the support measures required.

6.7 External Car Park Construction

CBR values estimated from the DCP tests indicated that the upper 0.5m of clay fill material produced values of 5 to 10% but as it is anticipated that ground levels will be reduced, it may be appropriate to carry out additional CBR tests at the proposed formation level.

6.8 Protection of Buried Concrete

In accordance with BRE SD1 for buried concrete in a brownfield site with static groundwater, analyse of selected samples for water soluble sulphate returned values of up to 0.04 g/l and pH >7.4. A total potential sulphate value of 0.42% was also calculated from the total sulphur results. Therefore, a Design Sulphate Class DS-2 is considered appropriate for buried concrete and an ACEC Class of AC-1s is considered appropriate for the location.

6.9 General Construction Advice

All formations should be cleaned, and subsequently inspected, by a suitably qualified engineer prior to placing concrete. Should any soft, compressible or otherwise unsuitable materials be encountered they should be removed and replaced by blinding concrete.

Foundation concrete, or alternatively, a blinding layer of concrete, should be placed immediately after excavation and inspection in order to protect the formation against softening and disturbance.

Generally, all formations should be placed wholly within the same material type, unless specific geotechnical inspection and assessment have been undertaken.

Where applicable ground beneath the proposed building footprint and potentially car parking may require to be stripped to reveal localised areas of made ground and structures. Excavations should be backfilled with suitably re-compacted materials to achieve formation level.

During foundation excavation works arisings should be constantly monitored for the presence of contamination.



7 CONCLUSIONS & RECOMENDATIONS

7.1 Conclusions

The following conclusions have been made based on the findings of this investigation.

7.1.1 Phase 2 Site Investigation

Site Setting

The site has not been previously developed but its present-day topography and historic maps indicated that is formed of a spoil heap of surplus soils. The source of spoil heap (made ground) is not known but may be due to construction of either the B&Q store or adjacent roads (Purbrook Way and/or A3(M)).

Published Geology & Hydrogeology

Published geological maps indicate that the site is directly underlain by London Clay of thickness 77 to 120m which is designated as unproductive strata, overlying Reading Beds and a sequence of chalks.

Intrusive Investigation

The investigation comprised 3 No cable tool boreholes to target 10m depth and 5 No window sample holes to 5m depth. Due to dense vegetation and restraints imposed by the ecologist, it was not possible to access all window sample locations with the proposed car park. Made Ground was observed at all exploratory locations as firm to stiff orange/brown grey slightly gravelly clay to a maximum depth of 5.0m in CP1 and CP2 beneath the store footprint. At CP3A and CP3B the fill material contained concrete boulders and concrete kerbstones that were removed by excavator and the exploratory hole was advanced as a trial pit. WS2 was also obstructed by a concrete boulder within the fill material that was subsequently removed by excavator and the exploratory hole was advanced as a trial pit.

Bedrock was encountered in all of the exploratory holes as stiff to very stiff micaceous blue grey CLAY considered to be representative of London Clay. Due to the change in topographical elevation between the perimeter of the site and central area beneath the proposed store footprint, the depth to bedrock varied from 0.25m at WS1 to 5.0m in CP1 and CP2.

7.1.2 Human Health Risk Assessment Retail Zone

The results of soil chemical analysis were compared to Human Health Generic Assessment Criteria for commercial land use. None of the analytes tested were detected at concentrations that exceeded the human health GAC protective of on-site workers.

7.1.3 Water Resources Risk Assessment

The results of the soil chemical analysis undertaken has identified that concentrations of metals and inorganic contaminants are within the range of typical made ground. Detectable concentrations of TPH and PAHs were encountered WS2 however, BGS Sheet 316 indicates that the London Clay extends to a minimum of 77m and it is therefore considered to be protective of the underlying groundwater source protection zone. There are no watercourses within close proximity of site.

7.1.4 Waste Classification

Additional sampling and analyses were undertaken on the made ground fill at between 0.5m and 3.5m bgl to enable an assessment of potential waste disposal classification as it anticipated that ground will be reduced to enable the development. The concentrations of metals and organic contaminants were generally in the range of inert soils and in general, the results of the chemical analysis indicates that the material would generally be classified as inert however due to concentration of Total Organic Carbon it may necessary to discuss the results with potential receiving site to ensure that the surplus is removed as an inert material.

7.1.5 Geotechnical Considerations

An indicative site layout is indicated in **Figure 3** with the Lidl store zone being in the east of the site and parallel with the retaining wall to B&Q. The proposed car park and delivery access is indicated to be from the access road that links B&Q to Purbrook Way and through which ground levels reduce from 43.5m AOD at the junction of Purbrook Way to 36.5m AOD in the B&Q car park. The site is retained at 39.5m AOD by the retaining to B&Q but ground levels increase through the landscape area to 43.5m AOD. Consequently, it is anticipated that existing ground levels would be reduced by at least 2m to enable an at grade access with the Purbrook Way and to have a similar elevation to the retaining wall.

Piled foundations end bearing within the underlying stiff to very stiff blue grey clay is a potential solution and potential pile capacities have been estimated. However, due the known concrete obstruction in the fill material it may necessary to proof dig all pile locations.

Ground improvement of the fill material in the vibro piling is not considered appropriate due to undrained shear strength of the fill material and the known concrete obstructions that would require removal to enable the vibro poker to penetrate.

A plain slab or stiffened edge raft bearing directly on compacted fill material of minimum specified bearing capacity is a potential alternative to a piled foundation. However, as it was not possible to investigate the entire building footprint there may zones of soft fill material present that have not yet been detected.

7.2 Recommendations

It is recommended that following vegetation clearance, additional ground investigation is undertaken ensure that there are no pockets of waste within the fill material and that soil strengths are consistent through the fill material beneath the proposed store footprint. The investigation should comprise a grid of dynamic probing on a 5m x 5m basis to profile relative soil strengths beneath the store footprint. The dynamic probing would also potentially identify locations of additional concrete obstructions with the fill material. The dynamic probing should be supplemented with window samples to obtain soils for laboratory geotechnical testing. In addition, it would also be beneficial to carry out additional window samples with the car park area. It would also be beneficial to carry out additional plate bearing tests at the proposed formation level when this known.

A Design Sulphate Class DS-2 is considered appropriate for buried concrete and an ACEC Class of AC-1s is considered appropriate for the location.

7.3 Ground Gas

The results of four rounds of gas monitoring visits placed the site into Characteristic Situation 2 and therefore ground gas protection measures will be required within the proposed store.

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STUDY LIMITATIONS

IMPORTANT. This section should be read before reliance is placed on any of the information, opinions, advice, recommendations or conclusions contained in this report.

1. This report has been prepared by Remada, Ltd with all reasonable skill, care and diligence within the terms of the Appointment and with the resources and manpower agreed with (the 'Client'). Remada does not accept responsibility for any matters outside the agreed scope.

2. This report has been prepared for the sole benefit of the Client unless agreed otherwise in writing.

3. Unless stated otherwise, no consultations with authorities or funders or other interested third parties have been carried out. Remada is unable to give categorical assurance that the findings will be accepted by these third parties as such bodies may have published, more stringent objectives. Further work may be required by these parties.

4. All work carried out in preparing this report has used, and is based on, Remada's professional knowledge and understanding of current relevant legislation. Changes in legislation or regulatory guidance may cause the opinion or advice contained in this report to become inappropriate or incorrect. In giving opinions and advice pending changes in legislation, of which Remada is aware, have been considered. Following delivery of the report Remada has no obligation to advise the Client or any other party of such changes or their repercussions.

5. This report is only valid when used in its entirety. Any information or advice included in the report should not be relied upon until considered in the context of the whole report.

6. Whilst this report and the opinions made are to the best of Remada's belief, Remada cannot guarantee the accuracy or completeness of any information provided by third parties.

7. This report has been prepared based on the information reasonably available during the project programme. All information relevant to the scope may not have received.

8. This report refers, within the limitations stated, to the condition of the site at the time of the inspections. No warranty is given as to the possibility of changes in the condition of the site since the time of the investigation.

9. The content of this report represents the professional opinion of experienced environmental consultants. Remada does not provide specialist legal or other professional advice. The advice of other professionals may be required.

10. Where intrusive investigation techniques have been employed they have been designed to provide a reasonable level of assurance on the conditions. Given the discrete nature of sampling, no investigation technique is capable of identifying all conditions present in all areas. In some cases the investigation is further limited by site operations, underground obstructions and above ground structures. Unless otherwise stated, areas beyond the boundary of the site have not been investigated.

11. If below ground intrusive investigations have been conducted as part of the scope, service tracing for safe location of exploratory holes has been carried out. The location of underground services shown on any drawing in this report has been determined by visual observations and electromagnetic techniques. No guarantee can be given that all services have been identified. Additional services, structures or other below ground obstructions, not indicated on the drawing, may be present on site.

12. Unless otherwise stated the report provides no comment on the nature of building materials, operational integrity of the facility or on any regulatory compliance issues.

13. Unless otherwise stated, samples from the site (soil, groundwater, building fabric or other samples) have NOT been analysed or assessed for waste classification purposes.



TABLES

Table 2: Gas Groundwater Monitoring Data

GAS & GROUNDWATER MONITORING DATA													Remada						
SITE		Purbrook Way, Hampshire, PO9 3QJ																	
PROJECT No.		770.02			Atmospheric & Ground Conditions														
Carried Out by:		Idris Shafqat			Atmospheric Pressure Variations During Visit								Ground Surface Conditions						
Date:		03.09.2020			1013mb								Dry						
Instrument Details	GA 5000 G501261			Atmospheric Pressure Trend Over Previous 48hrs								Weather Conditions							
				Falling								Cloudy, windy							
Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH ₄ (% v/v)		CH ₄ Steady LEL (%)	CO ₂ (% v/v)		O ₂ (% v/v)		Duration (secs)*	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AOD)	Depth of Pipe (m bgl)	Comments
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady					
WS1	38.180	50	0.0	0.0	0.0	11.7	8.8	11.3	16.0	60	0.1	0.49	-	-	1013	3.200	34.980	4.000	
CP2	40.530	50	0.1	0.0	0.0	1.8	0.8	19.6	20.5	60	0.2	0.51	-	-	1013	Dry	DRY	4.000	
WS2	42.120	50	0.1	0.0	0.0	6.0	6.8	12.5	11.4	60	0.1	0.48	-	-	1013	Dry	DRY	4.000	

Notes: NR = Not Recorded ^ For measurement of gas concentrations > = Above LEL WST = Water Sample Taken GL = Ground Level

GAS & GROUNDWATER MONITORING DATA													Remada								
SITE		Purbrook Way, Hampshire, PO9 3QJ																			
PROJECT No.		770.02		Atmospheric & Ground Conditions																	
Carried Out by:		Idris Shafqat		Atmospheric Pressure Variations During Visit										Ground Surface Conditions							
Date:		09.09.2020		1020mb										Dry							
Instrument Details	GA 5000 G501261			Atmospheric Pressure Trend Over Previous 48hrs										Weather Conditions							
				Rising										Sunny, warm, blue skies							
Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH ₄ (% v/v)		CH ₄ Steady LEL (%)	CO ₂ (% v/v)		O ₂ (% v/v)		Duration (secs) ^	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AoD)	Depth of Pipe (m bgl)	Comments		
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady							
WS1	38.180	50	0.0	0.0	0.0	12.3	9.0	13.2	16.2	60	0.2	0.54	-	-	1020	3.260	34.920	4.000			
CP2	40.530	50	0.0	0.0	0.0	1.9	1.2	19.2	20.0	60	0.4	0.31	-	-	1020	DRY	DRY	4.000			
WS2	42.120	50	0.0	0.0	0.0	6.8	5.3	11.9	14.5	60	0.1	0.02	-	-	1020	DRY	DRY	4.000			

Notes: NR = Not Recorded ^ For measurement of gas concentrations > = Above LEL WST = Water Sample Taken GL = Ground Level

GAS & GROUNDWATER MONITORING DATA													Remada								
SITE		Purbrook Way, Hampshire, PO9 3QJ																			
PROJECT No.		770.02		Atmospheric & Ground Conditions																	
				Atmospheric Pressure Variations During Visit									Ground Surface Conditions								
Carried Out by:		Idris Shafqat		1020mb									Dry								
Date:		16.09.2020		Atmospheric Pressure Trend Over Previous 48hrs									Weather Conditions								
Instrument Details		GA 5000 G501261		Falling									Sunny, warm, blue skies								
Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH ₄ (% v/v)		CH ₄ Steady LEL (%)	CO ₂ (% v/v)		O ₂ (% v/v)		Duration (secs) *	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m AoD)	Depth of Pipe (m bgl)	Comments		
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady							
WS1	38.180	50	0.0	0.0	0.0	13.2	10.1	13.6	14.8	60	-0.2	0.80	-	-	1020	3.650	34.530	4.000			
CP2	40.530	50	0.0	0.0	0.0	2.1	1.0	19.0	20.6	60	-0.1	0.78	-	-	1020	DRY	DRY	4.000			
WS2	42.120	50	0.0	0.0	0.0	6.3	5.0	13.5	14.7	60	-0.1	0.77	-	-	1020	DRY	DRY	4.000			

Notes: NR = Not Recorded ^ For measurement of gas concentrations > = Above LEL WST = Water Sample Taken GL = Ground Level

GAS & GROUNDWATER MONITORING DATA													Remada						
SITE		Purbrook Way, Hampshire, PO9 3QJ																	
PROJECT No.		770.02		Atmospheric & Ground Conditions															
Carried Out by:		Idris Shafqat		Atmospheric Pressure Variations During Visit									Ground Surface Conditions						
Date:		23.09.2020		996mb									Dry						
Instrument Details		GA 5000 G501261		Atmospheric Pressure Trend Over Previous 48hrs									Weather Conditions						
				Falling									Sunny, warm, blue skies						
Well No.	Cover Height (m AOD)	Well Diameter (mm)	CH ₄ (% v/v)		CH ₄ Steady LEL (%)	CO ₂ (% v/v)		O ₂ (% v/v)		Duration (secs) ^	Flow Rate (l/hr)	Relative Pressure (Pa)	PID (ppm)		Atmospheric Pressure (mb)	Water Level (m bgl)	Water Level (m Aod)	Depth of Pipe (m)	Comments
			Peak	Steady		Peak	Steady	Minimum	Steady				Peak	Steady					
WS1	38.180	50	0.0	0.0	0.0	14.4	14.0	13.2	13.4	60	0.4	0.12	-	-	996	3.750	34.430	4.000	
CP2	40.530	50	0.1	0.0	0.0	2.4	2.1	19.5	19.7	60	0.5	-0.05	-	-	996	DRY	DRY	4.000	
WS2	42.120	50	0.0	0.0	0.0	5.1	4.7	14.8	15.0	60	0.4	-0.02	-	-	996	DRY	DRY	4.000	

Notes: NR = Not Recorded ^ For measurement of gas concentrations > = Above LEL WST = Water Sample Taken GL = Ground Level

Table 2: Gas and Groundwater Monitoring Data

Table 3: Comparison of Soil Chemical Analyses with Generic Assessment Criteria

Chemtest Sample ID.:			GAC (Commercial) 2.5% SOM	1048003	1048004	1048005	1048006	1051524	1051525	1051526	1051527	1051528	1051529	1051530
Sample Location:				WS1	WS2	WS3	WS5	CP3B	CP3B	CP2	CP2	CP2	CP1	CP1
Sample Type:				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Top Depth (m):				0.00	1.50	0.50	0.50	0.50	1.50	0.50	1.50	3.00	0.50	2.00
Bottom Depth (m):				0.20	2.00	1.00	1.00	0.70	2.00	0.70	2.00	3.50	0.70	2.50
Date Sampled:				11-Aug-2020	11-Aug-2020	11-Aug-2020	11-Aug-2020	17-Aug-2020	17-Aug-2020	17-Aug-2020	17-Aug-2020	17-Aug-2020	17-Aug-2020	17-Aug-2020
Determinand	Units	LOD												
ACM Type		N/A		-	-	-	-	-	-	-	-	-	-	-
Asbestos Identification	%	0.001		No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected	No Asbestos Detected
ACM Detection Stage		N/A		-	-	-	-	-	-	-	-	-	-	-
pH		4.0		5.7	7.7	8.6	6.2	8.5	8.4	8.5	8.2	6.4	8.0	6.3
Boron (Hot Water Soluble)	mg/kg	0.40	240,000	0.61	< 0.40	< 0.40	< 0.40	0.56	0.50	0.68	< 0.40	0.51	0.55	< 0.40
Arsenic	mg/kg	1.0	640	8.7	8.5	11	7.6	13	9.2	13	10	12	10	6.3
Beryllium	mg/kg	1.0	12	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.3	< 1.0	< 1.0
Cadmium	mg/kg	0.10	190	< 0.10	< 0.10	< 0.10	< 0.10	0.36	0.10	0.17	< 0.10	< 0.10	0.14	< 0.10
Copper	mg/kg	0.50	68,000	11	6.3	14	8.5	13	12	14	9.9	22	12	6.9
Mercury	mg/kg	0.10	320	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nickel	mg/kg	0.50	980	17	6.3	19	18	20	21	23	13	41	19	6.2
Lead	mg/kg	0.50	2,300	12	4.6	17	8.5	27	18	24	16	31	20	6.6
Selenium	mg/kg	0.20	12,000	0.64	0.41	0.60	0.43	0.30	0.42	0.41	0.41	0.60	0.33	0.31
Vanadium	mg/kg	5.0	9,000	28	23	40	26	40	35	43	30	33	36	20
Zinc	mg/kg	0.50	730,000	58	28	57	46	57	49	66	42	89	54	29
Chromium (Trivalent)	mg/kg	1.0	8,600	23	15	31	21	28	25	29	24	30	25	13
Chromium (Hexavalent)	mg/kg	0.50	33	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Fraction of Organic Carbon		0.0010		0.0049	0.0025	0.0044	0.0034	0.015	0.0057	0.0073	0.0019	0.0027	0.010	0.0089
TOC				0.49	0.25	0.44	0.34	1.5	0.57	0.73	0.19	0.27	1	0.89
SOM				0.84	0.43	0.76	0.58	2.58	0.98	1.26	0.33	0.46	1.72	1.53
Aliphatic TPH >C5-C6	mg/kg	1.0	5900	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C6-C8	mg/kg	1.0	17000	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C8-C10	mg/kg	1.0	4800	< 1.0	32	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C10-C12	mg/kg	1.0	23000	< 1.0	8.5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C12-C16	mg/kg	1.0	82000	< 1.0	24	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C16-C21	mg/kg	1.0	1700000	< 1.0	21	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C21-C35	mg/kg	1.0		< 1.0	36	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aliphatic TPH >C35-C44	mg/kg	1.0	1700000	< 1.0	4.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Aliphatic Hydrocarbons	mg/kg	5.0		< 5.0	130	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Aromatic TPH >C5-C7	mg/kg	1.0	46000	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C7-C8	mg/kg	1.0	110000	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C8-C10	mg/kg	1.0	8100	< 1.0	3.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C10-C12	mg/kg	1.0	28000	< 1.0	5.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C12-C16	mg/kg	1.0	37000	< 1.0	20	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C16-C21	mg/kg	1.0	28000	< 1.0	26	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C21-C35	mg/kg	1.0	28000	< 1.0	120	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Aromatic TPH >C35-C44	mg/kg	1.0	28000	< 1.0	7.5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Aromatic Hydrocarbons	mg/kg	5.0		< 5.0	190	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Total Petroleum Hydrocarbons	mg/kg	10.0		< 10	310	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Naphthalene	mg/kg	0.10	460	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthylene	mg/kg	0.10	97000	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	mg/kg	0.10	97000	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	mg/kg	0.10	68000	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	mg/kg	0.10	22000	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Anthracene	mg/kg	0.10	540000	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	mg/kg	0.10	23000	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.55	< 0.10	< 0.10
Pyrene	mg/kg	0.10	54000	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.44	< 0.10	< 0.10
Benzo[a]anthracene	mg/kg	0.10	170	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Chrysene	mg/kg	0.10	350	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[b]fluoranthene	mg/kg	0.10	44	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[k]fluoranthene	mg/kg	0.10	1200	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[a]pyrene	mg/kg	0.10	35	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Indeno[1,2,3-c,d]Pyrene	mg/kg	0.10	510	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz[a,h]Anthracene	mg/kg	0.10	3.6	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo[g,h,i]perylene	mg/kg	0.10	4000	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Of 16 PAH's	mg/kg	2.0		< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Benzene	µg/kg	1.0	47	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1.0	110,000	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1.0	13,000	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
m & p-Xylene	µg/kg	1.0	14,000	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-Xylene	µg/kg	1.0	15,000	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Phenols	mg/kg	0.30	690	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30	< 0.30

350

Denotes an exceedence of GAC

NC: No published criteria

vap: Screening criteria presented exceed the vapour saturation limit, which is presented in brackets.

sol: Screening criteria presented exceed the solubility saturation limit, which is presented in brackets.

dc: Screening criteria based on threshold protective of direct skin contact (guideline in brackets based on health effects following long term exposure provided for illustration only).

(1): For assessment based on the use of the surrogate marker approach the GAC for Coal Tar must be used instead of benzo[a]pyrene.