



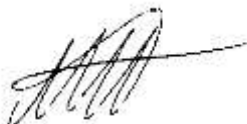
PHASE 2 GROUND INVESTIGATION REPORT

for the site at

LAND TO THE REAR OF 5 – 13 BRAMPTON ROAD, HILLINGDON, UXBRIDGE, MIDDLESEX UB10 0DR

on behalf of

BALWINDER GILL C/O GILL BUILDERS LIMITED

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EXECUTIVE SUMMARY	
Site Location and Description	The site comprised a 0.13ha irregular shaped plot of land orientated west to east and accessed via a narrow alleyway east of Brampton Road. The site comprised a total of thirty-five single storey flat roof domestic garages arranged over three separate blocks along the northern, southern, and western boundaries. The site was accessible directly from Brampton Road at its north western corner via a narrow access road leading into the existing rear garage plaza of a number of surrounding properties. The site was almost entirely hard landscaped with only a small area of soft landscaping bordering the western garage block.
Proposed Development	Under planning reference 74993/APP/2019/2504 dated 13th February 2020, the proposed development comprised demolition of the existing garages and the construction of three, four-bedroom residential properties with provision for private gardens, parking, and associated areas of hard and soft landscaping.
Geology	The ground conditions encountered within the trial holes constructed on the site did generally conform to that anticipated from examination of the geology map. A shallow capping of Made Ground was noted to overlie superficial deposits of the Black Park Gravel Member, the bedrock deposits of the London Clay Formation were not encountered due to refusal in the overlying dense sand and gravels. Live roots were noted only in WS4 and WS5 to proven depths of between 0.60 – 0.80m bgl. Groundwater ingress was noted in all borehole locations (WS1 – WS5) at the base at depths between 1.60 – 1.90m bgl. No groundwater was recorded in the hand dug trial pits (TP1 – TP2).
Site Works	Site works were undertaken on Thursday 19th November 2020 and comprised the drilling of 5No. Handheld Window Sampler Boreholes (WS1 – WS5) to a maximum depth of between 1.60 – 1.90m below ground level (bgl). The borehole drilling was terminated in all locations due to refusal in the underlying dense sand and gravel. A total of 2No. Heavy Dynamic Probing were undertaken in WS1 (DP1) and WS5 (DP5) extending from the borehole base to a maximum penetration of 2.50m bgl before also both terminating due to refusal in the underlying dense sand and gravel.
Soil Testing	In-situ strength testing of underlying superficial deposits of the Black Park Gravel Member recorded equivalent SPT blow counts of between 44 – 116, equating to very dense to extremely dense soils and soils of low to no volume change potential in accordance with NHBC Standards Chapter 4.2 and BRE240.
Foundation Design	The depth of Made Ground was proven in all trial hole locations and was underlain with superficial deposits of the Black Park Gravel Member comprising granular bands of clayey sand and gravel at depths between 0.40 – 1.90m bgl and cohesive bands comprising sandy gravelly clay at depths between 0.40 – 1.80m bgl. The base of the inferred superficial Black Park Gravel Member or underlying bedrock of the London Clay Formation was not proven at a depth of 2.50m bgl during heavy dynamic probing (DP1 and DP5). All trial hole locations refused due to dense sand and gravels. Based on the results of the site investigation, a minimum foundation depth of 0.75 – 1.10m bgl was considered, as long as foundations are constructed on competent, moisture stable soils. Foundations constructed within the granular soils of the Black Park Gravel Member can be designed on an assumed safe bearing capacity of 150 - 200kPa, based on the Heavy Dynamic Probes. It should be noted however that shallow SPT/strength testing was not carried out and some bands were noted to be cohesive. Therefore, a suitable bearing capacity at 0.75m bgl or/ and at cohesive bands should be taken as 125 KPa.
Contamination Considerations	A programme of chemical laboratory testing scheduled by Ground and Water Limited, and carried out by DETS Limited, was undertaken on No.5 samples of Made Ground soils at depths of between 0.30m – 0.50m bgl. With the inclusion of private gardens within the proposed development, the potential for home growing of any fruit or vegetable produce would likely be undertaken therefore the results of the chemical laboratory testing were compared to the LQM/CIEH Suitable 4 Use Levels (S4UL) for a 'Residential with Home-grown Produce (RwHP)' land-use scenario, as this was considered the most appropriate land-use scenario. Chemical laboratory testing of the Made Ground did not reveal any elevated levels of determinands above the guideline levels for a 'Residential with Homegrown Produce' land-use scenario. In addition, the intrusive investigation did not reveal any visual or olfactory evidence to suggest any hydrocarbon-type contamination in the trial holes excavated on the site.

Concrete Classification	The water-soluble sulphates for the samples of the Black Park Gravel Member tested were 14 – 42mg/l with a pH of 6.7 – 7.1. The total potential sulphates were noted to be 0.06%. According to BRE Special Digest 1, 2005, '<i>Concrete in Aggressive Ground</i>' a Sulphate Design Class of DS-1 is appropriate for sub-surface concrete in contact with the Black Park Gravel Member. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.
Recommendations	<u>Soils/Current Buildings</u> Based on the results of the intrusive works and chemical analyses undertaken to-date, no remediation was considered necessary in order to protect human health and end-users of the proposed development. However, an asbestos management strategy should be put in place in order to identify and appropriately remove any asbestos containing materials. If asbestos materials are encountered in soils and/ or suspected, then the consultant should be informed and a strategy to be implemented. An asbestos survey should be carried out in the existing buildings prior to demolition. <u>Groundwater</u> No remediation is considered necessary in order to protect groundwater/controlled waters, and therefore Made Ground can be left under hardstanding. <u>Ground-gas</u> Based on the risk assessment to date, the site fell into a Character Situation 1 (CS1) where precautions to prevent the ingress of ground-gas were not necessary.

The executive summary should be read in conjunction with the full report.

1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Balwinder Gill c/o Gill Builders Limited on 5th November 2020 to conduct a Phase 1 Desk Study and Phase 2 Ground Investigation at land to the rear of Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR. The scope of the investigation was detailed within the Ground and Water Limited fee proposal (reference: GWQ5986, dated 4th November 2020).

1.2 Aims of the Investigation

The aim of the Phase 2 Ground Investigation was understood to be to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

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

Included within the fee proposal was an allowance to undertake chemical laboratory testing on soil samples recovered from the site to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any potential contamination identified, as detailed in the Conceptual Site Model (CSM) within this report.

A Phase 1 Desk Study and preliminary risk assessment was undertaken, and an intrusive ground investigation was advised. The techniques adopted for the investigation were chosen considering the requirements of the client, anticipated ground conditions, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3 Conditions and Limitations

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

This report should be read in conjunction with the Phase 1 Desk Study Report undertaken by Ground and Water Ltd (report reference: GWPR3961/DS/January 2021 v1.01).

2.0 SITE SETTING

2.1 Site Location

The site comprised a 0.13ha irregular shaped plot of land orientated west to east and accessed via a narrow alleyway east of Brampton Road. The site was located in a residential setting in the central Hillingdon area at the approximate grid reference TQ 07628 83122. The A40 highway ran west to east ~1.5km north, Brunel University London ~1.4km west, Hillingdon Heath ~700m south and Swakeleys Girls High School ~300m east. A site location plan is provided as Figure 1 and the site development area as Figure 2.

2.2 Site Description

At the time of reporting in January 2021, the site comprised a total of thirty-five single storey flat roof domestic garages arranged over three separate blocks along the northern, southern, and western boundaries. The site was accessible directly from Brampton Road at its north western corner via a narrow access road leading into the existing rear garage plaza of a number of surrounding properties. The site was almost entirely hard landscaped with only a small area of soft landscaping bordering the western garage block. An aerial view of the site showing an approximate site boundary is presented as Figure 3.

2.3 Proposed Development

At the time of reporting in January 2021, under planning reference 74993/APP/2019/2504 dated 13th February 2020, the proposed development comprised demolition of the existing garages and the construction of three, four-bedroom residential properties with provision for private gardens, parking, and associated areas of hard and soft landscaping. The layout of the proposed development is presented in Figure 4.

2.4 Geology

The British Geological Survey (BGS) geological map of the Beaconsfield area (Beaconsfield Soil and Drift - Sheet 255) revealed that the site was located on superficial Black Park Gravel Member overlying bedrock deposits of the London Clay Formation. Areas of worked ground and infilled ground were recorded ~200m south of the site and approximately ~300m in areas to the north.

On-site Geology

Black Park Gravel Member - The Black Park Gravel Member is part of a complex series of River Terrace Deposits formed by the River Thames and its tributaries. Deposits generally consist of sand and gravel, with possible lenses of silt, clay and peat.

London Clay Formation - The London Clay Formation comprises stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of Gypsum (Selenite) are often found within the weathered part of the London Clay Formation, and precautions against sulphate attack to concrete are sometimes required. The lowest part of the formation is a sandy bed with black rounded gravel and occasional layers of sandstone and is known as the Basement Bed.

Off-site Geology

Worked Ground - Worked Ground is where natural materials are known to have been removed, for example in quarries and pits, excavations for roads and railways and in general landscaping. Areas of Worked Ground often have been either partially or wholly backfilled.

Infilled Ground - Infilled ground is an area where pre-existing land surface has been excavated

(worked) and subsequently partially or wholly backfilled (Made Ground) and is typically highly variable in composition, e.g. a backfilled quarry or landfill.

BGS Borehole Records

A BGS borehole record (ref: TQ08SE228) some ~500m south of the site located at Hillingdon Fire Station identified a Tarmacadam and reinforced concrete hardstanding to proved depths of 0.20m bgl, underlain with yellowish grey clayey gravelly sand to a proved depth of 0.40m bgl underlain with a stiff greyish yellowish sandy silty clay with flint gravels to a proved depth of 1.00m bgl and becoming a firm to stiff grey fissured silty clay to the base of the borehole to a proved depth of 15.00m bgl. The clay became very stiff and closely fissured from 10.00m bgl with no record of a groundwater strike. Records of an adjacent trial pit (ref: TQ08SE233) noted similar geology of tarmacadam and reinforced concrete hardstanding to 0.25m bgl onto underlying dark greyish brown sandy gravelly clay to proved depths of 0.30m bgl onto underlying silty sand and gravel to the pit base at a proved depth of 1.50m bgl, no groundwater strike was recorded in the trial pit.

2.5 Hydrogeology and Hydrology

A study of the aquifer maps on the DEFRA website revealed the site to be located on a Secondary (A) Aquifer relating to superficial deposits of the Black Park Gravel Member and an Unproductive Aquifer relating to underlying bedrock deposits of the London Clay Formation.

Secondary (A) Aquifers consist of deposits with permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

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

Examination of the DEFRA records indicate that the site **did not** fall within a Groundwater Source Protection Zone as classified in the Policy and Practice for the Protection of Groundwater.

The nearest surface water feature relates to a land drainage trench ~400m east along the field boundary of Oak Wood School. Other nearby features relate to drainage trenches in recreational land ~700m northwest in Hillingdon Court Park and ~1.1km southwest in Brunel University Sports Park. The River Pinn was noted ~1.13km west and flowing north to south.

From analysis of hydrogeological and topographical maps, groundwater was anticipated to be encountered at moderate depth (<7m) below ground level (bgl) and likely perched water within granular Black Park Gravel Member deposits overlying impermeable bedrock deposits of the London Clay Formation. It was considered that the groundwater was flowing in an overall south-westerly direction towards the River Pinn and Grand Union Canal in line with regional geology and topography.

Examination of the Environment Agency records showed that the site fell within a **Flood Zone 1**, an area with less than 1 in 1,000 annual probability of river or sea flooding. The site is at **very low** risk of surface water flooding and **low risk** from groundwater flooding. Groundwater flooding is caused by unusually high groundwater levels. It occurs when the water table rises above the ground surface or within underground structures, such as basements or cellars.

2.6 Radon

BRE 211 (2015) Map 5 of the London, Sussex and West Kent area indicates that the site is located within an area where mandatory protection measures against the ingress of radon are **not** likely to be required. The site is in a lower probability radon area (where less than 1% of the homes are estimated to be at or above the Action Level) and a risk assessment is **not** required.

Further investigation using www.ukradon.org showed that the site was located within an area where less than 1% of the homes are estimated to be at or above the Action Level.

2.7 Conceptual Site Model

The Phase 1 preliminary risk assessment identified potential sources of contamination, receptors of the proposed development and the pathways that link them. In order to identify if there are complete linkages, an initial level of risk assigned based on historical information. The level of risk is categorised as per the table below and preliminary conceptual site model (CSM) is presented below.

CSM Risk Categories	
Level	Explanation
Negligible	The site is considered suitable for the proposed end-use and no further actions are required.
Low	The site is considered suitable for the proposed end-use and there is not considered to be a risk to environmental receptors. Investigation is recommended to confirm this.
Moderate	The site is suitable for the proposed end-use, however, remediation and/or investigation is required to confirm this.
High	Site is not suitable for proposed end-use and there is likely to be a risk to environmental receptors. Remediation and detailed investigation are required.

Tabulated Conceptual Site Model – Pollutant Linkage Summary			
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
On-site			
Anticipated Made Ground deposits associated with the historical development of the site. - Heavy metals and semi-metals; - Poly-cyclic aromatic hydrocarbons (PAHs); - Total petroleum hydrocarbons (TPHs); - Volatile and semi-volatile organic Carbons (VOCs and SVOCs); BTEX compounds as markers; - BTEX compounds - Asbestos/asbestos containing materials (ACMs) within the Made Ground; - Cyanide; - Phenol; and, - Harmful pH.	Human Health - Direct ingestion of soil and soil derived dust; - Dermal contact of soil and soil derived dust; - Ingestion of soil with elevated concentration of determinands; - Dermal contact with impacted soils; - Ingestion of home-grown vegetables and soils attached; - Inhalation of contaminated dust (indoor and outdoor) with elevated concentration of determinands; and, - Inhalation of ground-gases or vapours (indoor and outdoor) with elevated concentration of determinands.	Human Health - Site operatives during demolition of the lock-up garages and construction of the proposed residential properties and future maintenance works; - End users of the site (residents, site users and visitors); and - Neighbours/public	Moderate Risk (Moderate risk until the extent and chemical composition of the Made Ground is determined)
	Groundwater and Surface Water - Via surface water runoff; - Via anthropogenic (man-made) pathways; and, - Via permeable Made Ground and superficial deposits (if present).	Controlled Waters - Surface water runoff; - Surface water drainage; and - Potential perched groundwater within Made Ground/ superficial deposits overlying impermeable bedrock of the London Clay Formation.	Low Risk (Given the unproductive aquifer of the underlying London Clay, flat topography and absence of any viable nearby surface or groundwater receptors) The Black park Gravel Member is expected to be a more sensitive aquifer, however limited risk is anticipated.
	Vegetation Direct uptake of impacted water.	Vegetation - Vegetation within the proposed private gardens and areas of communal soft landscaping; - Off-site vegetation in neighbouring properties; and - Limited existing soft landscaping to the west of the site.	Low Risk (Given very limited existing and proposed soft landscaping)

Tabulated Conceptual Site Model – Pollutant Linkage Summary			
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
On-site			
Aggressive ground conditions with Made Ground and natural ground; - Sulphates - Acidic pH - PAHs	Building Materials and Services - Direct contact with hydrocarbons within soil; and, - Direct contact with hydrocarbons within groundwater.	Building Materials and Services - Sub-surface concrete. - Sub-surface services (water supply pipes).	Moderate Risk (Moderate risk until the extent and chemical composition of the Made Ground is determined)
Potential Asbestos and Asbestos Containing Materials in the soils and existing buildings on-site. Risk of disturbance of ACMs during demolition, enabling and construction works.	Human Health - Direct ingestion of soil and soil derived dust; - Dermal contact of soil and soil derived dust; - Ingestion of soil with elevated concentration of determinands; - Dermal contact with impacted soils; - Ingestion of home-grown vegetables and soils attached; - Inhalation of contaminated dust (indoor and outdoor) with elevated concentration of determinands; and - Inhalation of ground-gases or vapours (indoor and outdoor) with elevated concentration of determinands.	Human Health - Site operatives during demolition of the lock-up garages and construction of the proposed residential properties and future maintenance works; - End users of the site (residents, site users and visitors); and - Neighbours/public	Moderate Risk (Can be reduced to Low Risk provided asbestos survey of existing structures implemented and H&S/ discovery procedures followed)
Potential Ground gas within limited Made Ground deposits. - Carbon dioxide; - Methane; - Hydrogen sulphide; and - Carbon monoxide.	Ground Gas - Migration through anthropogenic & natural pathways; - Inhalation of gases; - Explosive risk (methane only); and - Asphyxiating gases.	Ground gas - Site operatives during demolition of the lock-up garages and construction of the proposed residential properties and future maintenance works; - End users of the site (residents, site users and visitors); and - Neighbours/public	Low Risk (Low risk considered given the limited development on site and surrounding areas. Any potential gas accumulation within Made Ground has likely dissipated via passive ventilation)

Tabulated Conceptual Site Model – Pollutant Linkage Summary			
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Off-site			
Off Site Construction, Demolition/ Infilling Activities: Including the demolition and redevelopment of a school campus ~150m east of the site, infilling of a number of localised ponds 146 – 153m west and records of worked ground 171m south. - Heavy metals and semi-metals; - Poly-cyclic aromatic hydrocarbons (PAHs); - Total petroleum hydrocarbons (TPHs); - Volatile and semi-volatile organic Carbons (VOCs and SVOCs); - BTEX compounds; - Asbestos/asbestos containing materials (ACMs); - Cyanide; - Phenol; and. - Harmful pH.	Human Health - Direct ingestion of soil and soil derived dust; - Dermal contact of soil and soil derived dust; - Ingestion of soil with elevated concentration of determinands; - Dermal contact with impacted soils; - Inhalation of contaminated dust (indoor and outdoor) with elevated concentration of determinands; and - Inhalation of ground-gases or vapours (indoor and outdoor) with elevated concentration of determinands.	Human Health - Site operatives during demolition of the lock-up garages and construction of the proposed residential properties and future maintenance works; - End users of the site (residents, site users and visitors); and - Neighbours/public	Moderate Risk
	Groundwater and Surface Water - Via surface water runoff; - Via anthropogenic (man-made) pathways; and - Via permeable Made Ground/ superficial deposits (if present).	Controlled Waters - Surface water runoff; - Surface water drainage; and - Potential perched groundwater within Made Ground/ superficial deposits overlying impermeable bedrock of the London Clay Formation.	Low Risk (Given Unproductive Aquifer, impermeable bedrock, limited presence of the Black park Gravel Member and absence of any nearby surface water receptors)
	Vegetation Direct uptake of impacted water.	Vegetation - Vegetation within the proposed private gardens and areas of communal soft landscaping; - Off-site vegetation in neighbouring properties; and - Limited existing soft landscaping to the west of the site.	Low Risk (Given very limited existing on-site vegetation and limited proposed vegetation)

Ground Gas from Historical Ground Workings and presence of variable Made Ground related to redevelopment of a school campus ~150m east, worked ground 171m south and infilling of ponds 146 – 153m west. • Carbon dioxide; • Methane; • Hydrogen sulphide; and • Carbon monoxide.	Ground Gas • Migration through anthropogenic & natural pathways; • Inhalation of gases; • Explosive risk (methane only); and • Asphyxiating gases.	Ground gas • Site operatives during demolition of the commercial premises and construction of the proposed properties and future maintenance works; • End users of the site (residents, site users and visitors); and • Neighbours/public	Negligible Risk (Given limited historical records relating to worked or infilled ground, age of the records and distance from the site.
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3.0 SITE WORKS

3.1 Scope of Works

Site works were undertaken on Thursday 19th November 2020 and comprised the drilling of 5No. Handheld Window Sampler Boreholes (WS1 – WS5) to a maximum depth of between 1.60 – 1.90m below ground level (bgl). The borehole drilling was terminated in all locations due to refusal in the underlying dense sand and gravel. A total of 2No. Heavy Dynamic Probing were undertaken in WS1 (DP1) and WS5 (DP5) extending from the borehole base to a maximum penetration of 2.50m bgl before also both terminating due to refusal in the underlying dense sand and gravel.

Equivalent SPTs blow counts were recorded during the probing and a number of disturbed samples were recovered from the trial holes for geotechnical and chemical laboratory testing. Other works comprised the hand digging of 2No. Trial Pits in the location of the proposed private gardens to a maximum depth of 0.50m bgl to obtain disturbed samples for chemical testing.

A trial hole location plan can be viewed within Figure 5, with the full trial hole logs provided within Appendix B.

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

As a further precautionary measure, the positions were hand excavated to 1.20m bgl and scanned with a Cable Avoidance Tool (CAT scanner) to minimise the risk to services.

Upon completion of the site works, the trial holes were reverse backfilled with clean arisings, compacted and reinstated in relation to the surrounding environs.

3.2 Sampling Procedures

A number of disturbed samples were recovered from all trial holes at the depths shown on the trial hole records (D). Soil samples were generally retrieved from Made Ground deposits, the underlying natural strata and at each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.50m intervals during broad homogenous soil horizons.

A selection of samples was despatched for geotechnical testing purposes and chemical analysis for a broad range of contaminants and DEFRA/CLEA methodologies and in accordance with the conceptual site model, to provide identification of potential contaminants within the soils for remediation purposes and for initial waste classification purposes.

4.0 ENCOUNTERED GROUND CONDITIONS

4.1 Soil Conditions

All exploratory holes undertaken on-site during the site works were logged by Chris Gordon of Ground and Water Limited, generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial holes constructed on the site did generally conform to that anticipated from examination of the geology map. A shallow capping of Made Ground was noted to overlie superficial deposits of the Black Park Gravel Member, the bedrock deposits of the London Clay Formation were not encountered due to refusal in the overlying dense sand and gravels.

A tabulated summary of the geology encountered is provided below.

Summary of Strata Encountered (Full logs provided within Appendix B)			
Strata	Top Depth (m bgl)	Base Depth (m bgl)	Thickness (m)
CONCRETE HARDSTANDING: (In all trial holes with the exception of WS5 in an area of isolated soft landscaping).	GL	0.20	0.20
MADE GROUND: (In all trial holes) Multicoloured sandy very gravelly clay/ clayey very gravelly sand or clayey sandy gravel. Sand is fine to coarse. Gravel is angular to rounded fine to medium flint brick and tarmacadam. Or Dark greyish brown sandy slightly gravelly silt. Sand is fine to medium. Gravel is subangular to rounded fine to medium flint, brick and tarmacadam. (Encountered in WS5).	GL – 0.20	0.40 – 0.80	0.20 – 0.80
BLACK PARK GRAVEL MEMBER – Granular (WS1, WS2, WS4 and WS5) Dark orangish brown and grey mottled or dark reddish and orangish brown clayey sand and gravel. Sand is coarse. Gravel is angular to rounded fine to coarse flint.	0.40 – 0.80	>0.50 - >1.90	>0.10 - >1.30
BLACK PARK GRAVEL MEMBER - Cohesive (WS2, WS3) Dark orangish brown and grey mottled sandy gravelly clay with rare orange sand lenses.	0.40 – 1.00	>0.50 - >1.80	>0.10 – >1.20

For details of the composition of the Made Ground and Black Park Gravel Member at particular points, reference must be made to the trial hole logs provided within Appendix B. A trial hole location plan is presented in Figure 5.

4.2 Roots Encountered

Live roots were noted only in WS4 and WS5 to proven depths of between 0.60 – 0.80m bgl. It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs (i.e. closer to vegetation in proximity to the site boundaries from surrounding private gardens).

4.3 Groundwater Conditions

Groundwater ingress was noted in all borehole locations (WS1 – WS5) at the base at depths between 1.60 – 1.90m bgl. No groundwater was recorded in the hand dug trial pits (TP1 – TP2). The limited water ingress was considered to be pockets of perched groundwater within granular horizons of the

Black Park Gravel Member. It should be noted that groundwater strikes may have been obstructed by the drilling process.

The online DEFRA maps classified the superficial deposits of the Black Park Gravel Member as Secondary (A) Aquifer and underlying London Clay Formation as Unproductive Strata. Groundwater typically can perch within permeable horizons of Made Ground or superficial deposits over impermeable underlying London Clay Formation.

The site investigation was conducted in the winter season, when groundwater levels should be returning to their annual maximum (highest elevation). The long-term groundwater elevation might further increase or fall in the future due to seasonal fluctuation in weather conditions. Isolated pockets of groundwater may be perched within the Made Ground and granular superficial horizons due to the impermeability of the underlying London Clay, particularly following periods of heavy or prolonged rainfall.

4.4 Obstructions

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

5.0 IN-SITU STRENGTH TESTING AND LABORATORY GEOTECHNICAL TESTING

5.1 In-Situ Strength Testing

A total of 2 No. Heavy Dynamic Probes (DP1 and DP5) was undertaken through the base of Windowless Sampler Boreholes (WS1 and WS5) to provide an indication of in-situ ground strength with derived equivalent SPT N values. The test results are presented on the trial hole logs within Appendix B.

Dynamic Probing involves the driving of a metal cone into the ground via a series of steel rods. These rods are driven from the surface by a hammer system that lifts and drops a 50.0kg (HDP) hammer onto the top of the rods through a set height, thus ensuring a consistent energy input. The number of hammer blows that are required to drive the cone down by each 100mm increment are recorded. These blow counts then provide a comparative assessment from which correlations have been published, based on dynamic energy, which permits engineering parameters to be generated. (The 'Heavy' (HDP) Tests were conducted in accordance with BS 1377; 2016; Part 9, Clause 3.2).

The inferred granular soils of the Black Park Gravel Member were classified based on the table below.

Correlation between equivalent 'SPT's derived from SHDP results and granular classification	
Classification	Equivalent SPT Blow Counts (N1)
Extremely Dense	>58
Very Dense	42 – 58
Dense	25 – 42
Medium-dense	8 – 25
Loose	3 – 8
Very Loose	0 – 3

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

Interpretation of In-situ Geotechnical Testing Results				
Strata	Equivalent SPT "N" Blow Counts	Equivalent Undrained Shear Strength (kPa)	Granular Soil Type	Stratum
DP1/ 1.90 – 2.50m bgl	44 - 102	-	Very Dense to Extremely Dense	Inferred Black Park Gravel Member
DP5/ 1.60 - 2.50m bgl	58 - 116	-	Very Dense to Extremely Dense	Inferred Black Park Gravel Member

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

5.2 Laboratory Geotechnical Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by K4 Soils Laboratory and DETS Limited, was undertaken on samples recovered from the Black Park Gravel Member. The test procedures used were generally in accordance with the methods described in BS1377:2016 and 2018. Details of the specific tests used in each case are given below.

Standard Methodology for Laboratory Geotechnical Testing		
Test	Standard	Number of Tests
Atterberg Limit Tests	BS1377:2016:Part 2:Clauses 3.2, 4.3 & 5	2
Particle Size Distribution	BS1377:2016:Part 2:Clause 9	1
BRE Special Digest 1 (incl. pH, Total Sulphate, W/S Sulphate, Total Chlorine, W/S Chlorine, Total Sulphur, Ammonium as NH ₄ , W/S Nitrate, W/S Magnesium)	BRE Special Digest 1 "Concrete in Aggressive Ground (BRE, 2005).	2

5.2.1 Atterberg Limit Tests

A précis of Atterberg Limit Tests undertaken on two samples of the Black Park Gravel Member can be seen tabulated below and results of the Atterberg Testing can be viewed within Appendix C.

Atterberg Limit Tests Results Summary							
Geological Formation	Moisture Content (%)	Passing 425 µm sieve (%)	Modified PI (%)	Soil Class	Consistency Index (I _c)	Volume Change Potential	
						NHBC	BRE
Black Park Gravel Member: (WS3/ 1.00m bgl) <i>Lab description:</i> <i>Brown clayey sandy gravel. Gravel is fmc and subangular to subrounded</i>	15	21	7.77	MV	Very Stiff	None	Low (No NP classification)
Black Park Gravel Member: (WS2/ 1.80m bgl) <i>Lab description:</i> <i>Brown sandy gravelly silty clay. Gravel is fmc and subangular</i>	15	58	15.66	MI	Very Stiff	Low	Low
- NP – Non-plastic - BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results) - Soil Classification based on British Soil Classification System. - Consistency Index (I_c) based on BS EN ISO 14688-2:2018.							

5.2.2 Comparison of Soil's Moisture Content with Index Properties

The results of the Atterberg Limit tests undertaken on two samples of the Black Park Gravel Member were analysed to determine the Liquidity Index of the samples. This gives an indication as to whether the samples recovered showed a moisture deficit and degree of consolidation and shown below.

Liquidity Index Calculations Summary					
Sample	Moisture Content (%)	Plastic Limit (%)	Modified Plasticity Index (%)	Liquidity Index	Result
Black Park Gravel Member: (WS3/ 1.00m bgl) <i>Lab description:</i> <i>Brown clayey sandy gravel. Gravel is fmc and subangular to subrounded</i>	15	34	7.77	-2.45	Potential Moisture Deficit
Black Park Gravel Member: (WS2/ 1.80m bgl) <i>Lab description:</i> <i>Brown sandy gravelly silty clay. Gravel is fmc and subangular</i>	15	16	15.66	-0.06	Potential Moisture Deficit

Liquidity Index testing revealed evidence for moisture deficits within both samples of the Black Park Gravel Member. Sample WS3/ 1.00m bgl had a lab description of a clayey sandy gravel, whilst WS2/ 1.80m bgl had a lab description of a sandy gravelly silty clay. Engineers described the strata at these depths as either sandy very gravelly clay or sandy clay with the presence of localised sand lenses and absence of any deep penetrating roots. It is therefore likely; any potential moisture deficit was

related to the lithology of the soils (high granular content) rather the water demand of roots from nearby trees.

5.2.3 Liquid Limit

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

Moisture Content vs. Liquid Limit				
Sample	Moisture Content (MC) (%)	Liquid Limit (LL) (%)	40% Liquid Limit (LL)	Result
Black Park Gravel Member: (WS3/ 1.00m bgl) <i>Lab description:</i> <i>Brown clayey sandy gravel. Gravel is fmc and subangular to subrounded</i>	15	71	28.4	$MC < 0.4 \times LL$ (Potentially significant moisture deficit)
Black Park Gravel Member: (WS2/ 1.80m bgl) <i>Lab description:</i> <i>Brown sandy gravelly silty clay. Gravel is fmc and subangular</i>	15	43	17.2	$MC < 0.4 \times LL$ (Potentially significant moisture deficit)

The results in the table above were indicative of a potential significant moisture deficit in both tested samples of the Black Park Gravel Member (WS3/ 1.00m bgl and WS2/ 1.80m bgl). Given the absence of any roots, the potential significant moisture deficits were likely lithology derived due to the high granular content.

5.2.4 Particle Size Distribution (PSD) Testing

The results of PSD testing undertaken on one granular sample of the Head Deposits encountered are tabulated below.

PSD Test Results Summary			
Trial Hole/Depth/Soil Description	Volume Change Potential Range		Passing 63µm sieve Range (%)
	BRE	NHBC	
Black Park Gravel Member (WS2/ 0.80m bgl) <i>Lab description:</i> <i>Brown slightly clayey very sandy GRAVEL. Gravel is fmc subangular to subrounded</i>	No	No	4.4

NB Volume Change Potential refers to BRE Digest 240 (based on Grading test results).
 Shrinkability refers to NHBC Standards Chapter 4.2 (based on Grading test results).
 Volume Change Potential – BRE 240 states that a soil has a volume change potential when the clay fraction exceeds 15%. Only the silt and clay combined fraction are determined by sieving therefore the volume change potential is estimated from the percentage passing the 63µm sieve.
 NHBC Standards Chapter 4.2 states that a soil is shrinkable if the percentage of silt and clay passing the 63µm sieve is greater than 35% and the Plasticity Index is greater than 10%.

5.2.5 Water-Soluble Sulphate and pH Testing

Chemical laboratory testing of water-soluble sulphate and pH was undertaken in five shallow Made Ground samples (WS1, WS3, TP2 and WS5/ 0.30m bgl and WS5/ 0.50m bgl). The water-soluble sulphate concentration ranged between <10 - 169mg/l (0.169g/l) with a pH between 7.6 – 9.5. The results have been provided in Appendix C.

5.2.6 BRE Special Digest 1 Testing

In accordance with BRE Special Digest 1 'Concrete in Aggressive Ground' (BRE, 2005) two samples of the Black Park Gravel Member (TP2/ 0.50m bgl and WS4/ 1.50m bgl) were scheduled for laboratory analysis to determine parameters for concrete specification. The results are given within Appendix D and a summary is tabulated below.

Summary of Results of BRE Special Digest Testing			
Determinand	Unit	Minimum	Maximum
pH	-	6.7	7.1
Ammonium as NH ₄	mg/kg	2.1	4.3
Sulphur	%	<0.02	<0.02
Chloride (water soluble)	mg/kg	6	6
Magnesium (water soluble)	mg/l	1.7	2.2
Nitrate (water soluble)	mg/kg	3	4
Sulphate (water soluble)	g/l	0.01	0.04
Sulphate (total)	mg/kg	<200	<221

6.0 ENGINEERING CONSIDERATIONS

6.1 Soil Characteristics, Geotechnical Parameters and Foundation Considerations

At the time of reporting in January 2021, under planning reference 74993/APP/2019/2504 dated 13th February 2020, the proposed development comprised demolition of the existing garages and the construction of three, four-bedroom residential properties with provision for private gardens, parking, and associated areas of hard and soft landscaping.

The proposed development is likely to fall within Geotechnical Design Category 2 in accordance with Eurocode 7. The total foundation loads were not known to Ground and Water Limited at the time of reporting but are likely to range from 75 – 150kN/m².

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

- Concrete hardstanding capped the site with the exception of an isolated area of soft landscaping to the west at WS5. The concrete had a consistent thickness of 200mm and underlaid with shallow Made Ground from 0.20m bgl to proved depths of between 0.40 – 0.80m bgl in all trial holes. Made Ground may be found to deeper depths at other locations on the site, especially within the footprint of the existing structure upon demolition and any associated subsurface structures, foundations and service runs. **Given the variable composition and presence of putrescible materials, Made Ground is typically unpredictable in terms of bearing capacity and settlement characteristics. Foundations should be taken through these deposits and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.**
- The depth of Made Ground was proven in all trial hole locations and was underlain with superficial deposits of the Black Park Gravel Member comprising granular bands of clayey sand and gravel at depths between 0.40 – 1.90m bgl and cohesive bands comprising sandy gravelly clay at depths between 0.40 – 1.80m bgl. The base of the inferred superficial Black Park Gravel Member or underlying bedrock of the London Clay Formation was not proved at a depth of 2.50m bgl during dynamic probing (DP1 and DP5). All trial hole locations refused due to dense sand and gravels. Soils of the Black Park Gravel Member were described as soils of low to no volume change potential in accordance with NHBC Standards Chapter 4.2 and BRE240. **Any foundations should assume the worst-case scenario and be designed in accordance with soils of low volume change potential and should not be placed at depths shallower than 0.75m bgl, which is the minimum foundation depth for soils of low VCP.**
- In-situ strength testing of underlying superficial deposits of the Black Park Gravel Member recorded equivalent SPT blow counts of between 44 – 116, equating to very dense to extremely dense soils. **The loads of proposed foundations should not exceed the allowable bearing capacity of the soils they are founding upon, nor should >25mm of load-induced settlement occur. Any known or newly encountered soft spots should be bypassed and foundations in areas of soft ground should extend to deeper depths into soils of higher strength unless light foundations can be proved to be suitable.**

The final design of foundations will need to consider the volume change potential of the soil, the depth of any desiccation, soft spots and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are discussed in the next section of this report.

- Groundwater ingress was noted at the base of all boreholes (WS1 – WS5) at depths of between 1.60 – 1.90m bgl. Though no groundwater strike was recorded the presence of groundwater perched within granular horizons of the Black Park Gravel Member may be present and some localised water management/dewatering may be required. It should be noted that groundwater strikes may be obscured by the drilling process. **Any groundwater or surface water ingress must be prevented from entering foundation trenches. Excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation for even a short time, not only would an increase in heave occur resulting from the soil increasing in volume by taking up water, but also the shear strength and hence the bearing capacity would also be reduced, and this could result in increased settlements. Perched water may be recorded within the excavation of foundation trenches, especially after a period of prolonged rainfall. Instability issues may arise within the foundation trenches, in case of perched water being present.**
- Large or deep roots were generally not expected to be encountered given the limited development of the site and current use, though some roots were recorded in WS4 and WS5 to proved depths of between 0.60 – 0.80m bgl. It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low and roots may be found to greater depths at other locations on the site, particularly close to the site boundaries as these are shared with private gardens from neighbouring properties where mature trees and/or trees that have been removed may be present. **Foundations must not be placed within root penetrated and/or desiccated soils with volume change potential. It is recommended that foundations are taken at least 300mm into non-root penetrated strata if the soils have volume change potential, or into soils of no volume change potential. The influence of trees on or surrounding the site will need to be considered in the final design (NHBC Standards Chapter 4. 2) (tree rings).**

6.2 Spread Foundations

Based on the information obtained from the site investigation, strip foundations should bypass Made Ground and root penetrated soils and be founded on competent underlying Black Park Gravel Member. Any shallow soft ground or deeper Made Ground should also be bypassed if encountered.

The minimum foundation depths for each trial hole based can be seen tabulated below.

Minimum Foundation Depth Based on Individual Boreholes			
Trial Hole	Minimum Foundation Depth (m bgl)	Founding Strata	Limiting Factor
WS1	0.80	Black Park Gravel Member	Bypass Made Ground and into competent underlying soils.
WS2	0.75	Black Park Gravel Member	Bypass Made Ground and into competent underlying soils and the minimum depth required in soils of low Volume Change Potential is 0.75m bgl according to NHBC 4.2 Standards
WS3	0.75	Black Park Gravel Member	Bypass Made Ground and into competent underlying soils and the minimum depth required in soils of low Volume Change Potential is 0.75m bgl according to NHBC 4.2 Standards
WS4	0.90	Black Park Gravel Member	Bypass Made Ground, 300mm into non root penetrated underlying soils and the minimum depth required in soils of low Volume Change Potential is 0.75m bgl according to NHBC 4.2 Standards
WS5	1.10	Black Park Gravel Member	Bypass Made Ground, 300mm into non root penetrated underlying soils and the minimum depth required in soils of low Volume Change Potential is 0.75m bgl according to NHBC 4.2 Standards

Therefore, based on the above and the results of the site investigation, a minimum foundation depth of 0.75 – 1.10m bgl was considered, as long as foundations are constructed on competent, moisture stable soils.

Foundations constructed within the granular soils of the Black Park Gravel Member can be designed on an assumed safe bearing capacity of 150 - 200kPa, based on the Heavy Dynamic Probes. It should be noted however that shallow SPT/strength testing was not carried out and some bands were noted to be cohesive. Therefore, a suitable bearing capacity at 0.75m bgl or/ and at cohesive bands should be taken as 125 KPa.

Settlements on loading at these depths are likely to be low to moderate. This was based on trial hole records, the results of the in-situ testing, inspection of samples recovered, and based on a 5m long by 0.75m wide foundation, a 5m long by 1.00m wide foundation, a 1.50m long by 1.50m wide foundation and a maximum settlement of 25mm.

Given the founding into competent granular and cohesive soils with volume change potential at shallow depths, precautions are required to prevent possible future shrinkage/swelling within the Black Park Gravel Member strata affecting the integrity of the faces of foundations. A compressible layer must be provided to accommodate potential seasonal movement, based on NHBC guidance.

General Recommendations for Spread Foundations:

- It is prudent to avoid having a foundation spanning across materials of different consistency, like clay and gravel, in order to avoid potential differential settlements. If unavoidable, foundations must be reinforced to allow for such potential differential movement. It should be noted that differential settlement may also occur between strip and isolated pad foundations.
- Foundation excavations must be carefully bottomed out and any loose soil or soft spots removed prior to the foundation concrete or blinding being placed. Failure to ensure that foundation excavations are suitably bottomed out could result in additional settlements.
- Inspection of foundation excavations, prior to concreting, must be made by a competent and suitably qualified person to check for soft spots and to check for the presence of roots.
- Any groundwater or surface water ingress must be prevented from entering foundation trenches. Excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation for even a short time the shear strength and hence the bearing capacity would be reduced, and this could result in increased settlements.
- Foundations must not be cast over foundations of former structures and/or other hard spots.
- Given the general thickness of Made Ground across the site and soils of volume change potential, a suspended slab is recommended. The volume change potential of the shallow surface soils must be considered in the final design (underfloor void diameter/compressible material/void formers etc).
- Isolated Pad Foundations must be at least 1.5 times the width of the widest pad apart to keep to the anticipated settlements.
- Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the structure and the developments proximity to former, present, and proposed trees.

6.3 Piled Foundations

Given the results of the ground investigation, it was considered unlikely that a piled foundation system will be required.

6.4 Excavations and Stability

Shallow excavations in the Made Ground are likely to be marginally stable at best. Long, deep excavations through the underlying Black Park Gravel Member are also likely to become unstable, especially if groundwater ingress is encountered or excavation works are undertaken during seasonally wet conditions.

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

6.5 Sub-Surface Concrete

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

For the classification given below, the "mobile" and "natural" case was adopted given the geology encountered and the use of the site.

Black Park Gravel Member

The water-soluble sulphates for the samples of the Black Park Gravel Member tested were 14 – 42mg/l with a pH of 6.7 – 7.1. The total potential sulphates were noted to be 0.06%.

Based on BRE Special Digest 1, 2005, '*Concrete in Aggressive Ground*' a Sulphate Design Class of **DS-1** is appropriate for sub-surface concrete in contact with the Black Park Gravel Member. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of **AC-1**.

6.6 Road and Hardstanding

This section summarises the recommendations for each geological stratum with regards to roads and hardstanding.

Made Ground

Roads and hardstanding should not be constructed on Made Ground given its variability in composition and likely low strength/density. Where these cannot be bypassed a CBR value of 1% should be adopted for Made Ground. Given that Made Ground encountered beneath the site comprised a mixture of poorly drained clayey sandy gravel-based soils, these deposits are likely to be **frost susceptible**.

Black Park Gravel Member

Roads and hardstanding constructed on underlying cohesive and granular soils of the Black Park Gravel Member should be designed based on a CBR value of 4.0%. This is based on reference to Table C1 of TRL1132 and average construction conditions. Based on wet conditions a CBR of 2.5% should be adopted, with dry conditions a CBR of 4.5% being applicable. Given these deposits were poorly draining primarily granular soils, they were considered to be **frost susceptible**.

All formation levels for roads and hardstanding should be proof rolled to highlight any soft areas which should then be dug out and replaced with selected granular material compacted in thin layers to a suitable specification.

6.7 Surface Water Disposal

Soakage testing was not part of remit of this Ground investigation. Soakaways are not considered a viable option for surface water drainage due to the presence of cohesive ground and low permeability of the London Clay formation at depth.

The principles of sustainable urban drainage system (SUDS) and the requirements of the London Plan Policy 5.13 Sustainable Drainage should be applied.

In accordance with the London Plan Policy 5.13 Sustainable Drainage the surface water run-off should be managed as close to its source as possible in line with the following drainage hierarchy:

- store rainwater for later use;
- use infiltration techniques, such as porous surfaces in non-clay areas;
- attenuate rainwater in ponds or open water features for gradual release;
- attenuate rainwater by storing in tanks or sealed water features for gradual release;
- discharge rainwater direct to a watercourse;
- discharge rainwater to a surface water sewer/drain;
- discharge rainwater to the combined sewer.

Drainage should be designed and implemented in ways that deliver other policy objectives of this plan, including water use efficiency and quality, biodiversity, amenity and recreation.

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

7.0 PHASE 2 CONTAMINATION RISK ASSESSMENT

7.1 Results of the Phase 1 Risk Assessment (Conceptual Site Model)

The tabulated Conceptual Site Model can be viewed within Section 2.7 of this report.

Concrete hardstanding was noted from ground level at a thickness of 200mm. An isolated uncapped area of soft landscaping was encountered in WS5 to the west of the site.

Underlying the concrete were soils described as Made Ground (noted in all trial holes) to proved depths of between 0.40 – 0.80m bgl. These soils comprised multicoloured sandy very gravelly clay, clayey very gravelly sand or clayey sandy gravel. Sand was fine to coarse-grained and gravel was angular to rounded fine to medium flint, brick and tarmacadam. In the isolated area of soft landscaping (WS5) to the west of the site, Made Ground comprised sandy slightly gravelly silt. Sand was fine to medium-grained and gravel was subangular to rounded fine to medium flint, brick and tarmacadam and resembled a shallow reworked topsoil.

No visual or olfactory evidence for hydrocarbon contamination was identified during the investigation.

Given that Made Ground was anticipated on site, the Conceptual Site Model did not have to be adapted and could be used for the Phase 2 Contamination Risk Assessment.

7.2 Sampling Locations

The methodology for sampling locations can be seen tabulated below. A trial hole location plan has been provided within Figure 5. A random sampling strategy was adopted.

Methodology for Sampling Locations and Chemical Laboratory Testing			
Trial Hole	Final Depth (m bgl)	Sampling Strategy	Proposed End Use
WS1	1.60	Random Sampling	Area within footprint of proposed private gardens
WS2	1.80	Random Sampling	Area within footprint of proposed buildings
WS3	1.80	Random Sampling	Area within proposed communal hard and soft landscaping
WS4	1.90	Random Sampling	Area within proposed communal hard and soft landscaping
WS5	1.90	Random Sampling	Area within only existing area of soft landscaping
TP1	0.50	Random Sampling	Area within footprint of proposed private gardens
TP2	0.50	Random Sampling	Area within footprint of proposed private gardens

The area investigated totals ~1,300m² and with seven sampling locations, given an unknown hotspot shape, the sampling density means that a hotspot with an area of approximately 278.5m² and a radius of approximately 9.4m would be encountered (CLR 4).

Soil sampling depths were chosen to reflect the receptors of concern, human health, and typically comprised a surface or near surface sample within the Made Ground deposits and deeper increments extending into the underlying natural soils. The receptors relevant to the sampling depths can be seen overleaf.

Summary of Receptors	
Depth	Receptors
Made Ground or near surface samples	- Human Health (future site users and visitors); - Human Health (construction workers); - Vegetation;
Natural underlying soils or >0.50m below ground level	- Human Health (construction workers); - Vegetation; - Controlled Waters;

7.3 Chemical Laboratory Testing – Human Health Risk Assessment

A programme of chemical laboratory testing scheduled by Ground and Water Limited, and carried out by DETS Limited, was undertaken on No.5 samples of Made Ground soils at depths of between 0.30m – 0.50m bgl. The samples tested and sampling strategy can be seen tabulated below and the laboratory results of the chemical testing are presented within Appendix D.

Methodology for Sampling Locations and Chemical Laboratory Testing			
Trial Hole	Depth (m bgl)	Sampling Strategy	Proposed End Use
WS1	0.30	Representative sample of the Made Ground on site	Area within footprint of proposed private gardens
WS3	0.30	Representative sample of the Made Ground on site	Area within proposed communal hard and soft landscaping
TP2	0.30	Representative sample of the Made Ground on site	Area within footprint of proposed private gardens
WS5	0.30	Representative sample of the Made Ground on site	Area within proposed communal hard and soft landscaping
WS5	0.50	Representative sample of the Made Ground on site	Area within proposed communal hard and soft landscaping

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

The analysis suite was based on recommendations noted in the Phase 1 Desk Study and Conceptual Site Model (CSM) and comprised:

- Semi-metals and heavy metals;
- Inorganics (asbestos, phenol and cyanide);
- Polycyclic Aromatic Hydrocarbons (PAH's);
- Fuel Oils – Speciated TPH including full aliphatic/aromatic split;
- BTEX compounds (benzene, toluene, ethylbenzene, xylene) and MTBE (methyl tert-butyl ether) – used as marker compounds for Volatile Organic Compounds (VOCs).
- Waste Acceptance Criteria testing.

The chemical laboratory results for all phases of site investigation are presented in Appendix D.

7.3.1 Soil Assessment Criteria

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

7.3.2 Determination of Representative Contamination Concentration

At the time of reporting in January 2021, the proposed development comprised demolition of the existing garage blocks and construction of three, four-bedroom residential properties with provision for private gardens, parking, and associated areas of hard and soft landscaping.

With the inclusion of private gardens within the proposed development, the potential for home growing of any fruit or vegetable produce would likely be undertaken therefore the results of the

chemical laboratory testing were compared to the LQM/CIEH Sutable 4 Use Levels (S4UL) for a '**Residential with Home-grown Produce (RwHP)**' land-use scenario, as this was considered the most appropriate land-use scenario. The C4SL LLTC for Lead was compared to a '**Residential with Home-grown Produce (RwHP)**' land-use scenario.

Where no LQM/CIEH S4UL/C4SL LLTC was available for a particular determinand then preliminary reference was made to the laboratory detection limit of the determinand. If a positive concentration was noted, then further risk assessment was undertaken.

For Cyanide, where no S4UL/C4SL was available for chronic exposure, the Society of Brownfield Risk Assessment's (SoBRA) free cyanide acute Generic Assessment Criteria for a child receptor of 24mg/kg was adopted. As acute GACs are typically of higher concentration when compared to chronic GACs, the adopted GAC of 24mg/kg is considered conservative.

Where a contaminant of concern's LQM/CIEH/S4UL/C4SL LLTC varies according to the Soil's Organic Matter (SOM), the SOM recorded for each soil sample was used to derive the appropriate SGV/GAC based on the average for that soil type. 5No samples of Made Ground were tested and the average SOM was 1.14%, therefore, the 1% SOM guideline value was adopted.

The results of the comparison of the representative contaminants concentrations are presented in the table below/overleaf.

Soil Contamination Test Results and Guideline Value					
Determinand	No. of Samples	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Adopted Screening Value (mg/kg)	Was the adopted screening value exceeded for relevant land-use scenario?
INORGANICS					
Asbestos	5	Not Detected	Not Detected	Not Detected	No
Cyanide (total)	5	<2	3	24	No
Phenols	5	<2	<2	280	No
METALS					
Arsenic	5	5	18	37	No
Boron	5	<1	<1	290	No
Cadmium	5	<0.2	0.8	11	No
Chromium (III)	5	10	23	910	No
Chromium (Hexavalent)	5	<2	<2	6	No
Copper	5	9	69	2400	No
Lead	5	9	50	200	No
Mercury	5	<1	<1	1.2	No
Nickel	5	5	32	130	No
Selenium	5	<3	<3	250	No
Vanadium	5	16	55	410	No
Zinc	5	43	271	3,700	No
TOTAL PETROLEUM HYDROCARBONS (TPHs)					
Aliphatic >C5 - C6	2	<0.01	<0.01	42	No
Aliphatic >C6 - C8	2	<0.05	<0.05	100	No
Aliphatic >C8 - C10	2	<2	<2	27	No
Aliphatic >C10 - C12	2	<2	<2	130	No
Aliphatic >C12 - C16	2	<3	<3	1,100	No
Aliphatic >C16 – C21	2	<3	<3	65,000	No
Aliphatic >C5 – C34	2	<21	<21	65,000	No

Aromatic >C5 - C7	2	<0.01	<0.01	70	No
Aromatic >C7 - C8	2	<0.05	<0.05	130	No
Aromatic >C8 - C10	2	<2	<2	34	No
Aromatic >C10 - C12	2	<2	<2	74	No
Aromatic >C12 - C16	2	<2	<2	140	No
Aromatic >C16 - C21	2	<3	<3	260	No
Aromatic >C21 - C35	2	<10	<10	1,100	No
Benzene	2	<0.002	<0.002	0.087	No
Toluene	2	<0.006	<0.016	130	No
Ethylbenzene	2	<0.002	<0.002	47	No
m,p-Xylene	2	<0.007	<0.012	59	No
o-Xylene	2	<0.004	<0.006	60	No
POLYCYCLIC-AROMATIC HYDROCARBONS					
Acenaphthene	5	<0.1	<0.1	210	No
Acenaphthylene	5	<0.1	<0.1	170	No
Anthracene	5	<0.1	0.22	2,400	No
Benzo(a)anthracene	5	<0.1	1.46	7.20	No
Benzo(a)pyrene	5	<0.1	1.33	2.20	No
Benzo(b)fluoranthene	5	<0.1	1.88	2.60	No
Benzo(ghi)perylene	5	<0.1	0.56	320	No
Benzo(k)fluoranthene-	5	<0.1	0.61	77	No
Chrysene	5	<0.1	1.49	15	No
Dibenzo(a,h)anthracene	5	<0.1	0.16	0.24	No
Fluoranthene	5	<0.1	2.76	280	No
Fluorene	5	<0.1	<0.1	170	No
Indeno(1,2,3-cd)pyrene	5	<0.1	0.89	27	No
Naphthalene	5	<0.1	<0.1	2.30	No
Phenanthrene	5	<0.1	0.98	95	No
Pyrene	5	<0.1	2.14	620	No
VOC MARKER COMPOUND					
Methyl tert-butyl ether (MTBE)	2	<0.005	<0.005	49	No
The derivation of the Soil Assessment Criteria used within this report can be seen within Appendix E. The soil concentrations were typically compared to the LQM/CIEH Suitable for Use Levels (S4UL) (2014), based upon the assumption of 1% soil organic matter. A screening value for Lead is based on the Category 4 Screening Levels (C4SLs). Where no S4UL or C4SL is available for Cyanide, a SoBRA acute GAC is assigned. Where no S4UL or C4SL is available for MTBE, a CL:AIRE 2010 GAC is assigned.					

Chemical laboratory testing of the Made Ground **did not** reveal any elevated levels of determinands above the guideline levels for a '*Residential with Homegrown Produce*' land-use scenario.

In addition, the intrusive investigation **did not** reveal any visual or olfactory evidence to suggest any hydrocarbon-type contamination in the trial holes excavated on the site. The chemical laboratory results have verified that no elevated concentrations of aliphatic/aromatic hydrocarbons (C5-C35) or BTEX compounds are present in the soils underlying the site.

The chemical analysis therefore indicates that the soils at the site are unlikely to represent an unacceptable level of risk to future receptors.

7.4 Groundwater and Controlled Waters Risk Assessment

A study of the DEFRA online map resource noted the site was underlain by a Secondary (A) Aquifer comprising superficial deposits of the Black Park Gravel Member and underlying Unproductive Strata comprising the bedrock deposits of the London Clay Formation.

No significant surface water features or watercourses were noted within a 250m radius of the site.

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

From analysis of hydrogeological and topographical maps, groundwater was anticipated to be encountered at moderate depth (<7m) below ground level (bgl) and likely perched water within granular Black Park Gravel Member deposits overlying impermeable bedrock deposits of the London Clay Formation. It was considered that the groundwater was flowing in an overall south-westerly direction towards the River Pinn and Grand Union Canal in line with regional geology and topography.

Given the low levels of determinands noted during the chemical laboratory testing of the soils and their likely low mobility, the Made Ground encountered was not considered likely to pose an unacceptable risk to groundwater or controlled waters.

7.5 Ground Gas Risk Assessment

The conceptual site model presented within the desk study identified a low potential risk from ground gases.

The CL:AIRE research bulletin RB17 titled *A pragmatic approach to ground gas risk assessment* can be utilised in situations where there is limited to no source of ground gas, which is based on principles of CIRIA C665 and is included as Annex D of BS8485:2015+A1:2019. This approach looks at the gas generation potential of the soils from data that is not subject to external influences, for example atmospheric pressure can change the recorded flow and concentrations of ground gas during spot monitoring. Determination of the characteristic situation where Made Ground <5m is present is based on the total organic carbon (TOC) of the soils, coupled with any organic-rich material identified within the borehole logs.

Ground gas monitoring is generally required for.

- High risk sites where gas can be emitted from the ground in large volumes (domestic or industrial landfill sites with a high degradable content, Made Ground with a higher degradable content, mine workings where there is still a large gas reservoir and a vent to the ground surface such as a shaft or fractured rock).
- Sites with Made Ground where maximum depth is greater than 5.00m or average depth greater than 3.00m.
- Sites where migration from an off-site source with a credible migration pathway needs to be assessed.

The capping of Made Ground was relatively shallow across the extent of the site with a maximum thickness of between 0.40 – 0.80m bgl, with an average depth of 0.60m bgl. The composition and limited depth reflected anticipated conditions based on the historical development and landuse of the site. The shallow Made Ground soils comprised multicoloured sandy very gravely clay, clayey very gravely sand or clayey sandy gravel. Sand was fine to coarse-grained and gravel was angular to rounded fine to medium flint, brick and tarmacadam. In the isolated area of soft landscaping (WS5)

to the west of the site, Made Ground comprised sandy slightly gravelly silt. Sand was fine to medium-grained and gravel was subangular to rounded fine to medium flint, brick and tarmac and resembled a shallow reworked topsoil.

The total organic carbon (TOC) ranged between 0.40 – 1.30%, with an average TOC of 0.66%.

Groundwater ingress was noted at the base of all boreholes (WS1 – WS5) at depths of between 1.60 – 1.90m bgl. Though no groundwater strike was recorded the presence of groundwater perched within granular horizons of the Black Park Gravel Member may be present. The ground investigation was undertaken in the winter months where groundwater levels are reaching their seasonal high and groundwater may be encountered during periods of intense or prolonged rainfall.

The Phase 1 investigation did not identify any credible sources of ground gases that pose a risk to the development. The site investigation identified Made Ground with an average thickness of less than 3.00m, and not exceeding 5.00m at the site. Chemical analysis identified TOC to be at concentrations lower than 6% and therefore the site was deemed suitable for assessment under the pragmatic approach. In line with the soil-based assessment, the site falls into a **Characteristic Situation CS1**, based on a TOC value between <1%, subject to the Made Ground being in place for more than 20 years.

7.6 Re-Evaluated Phase 2 Conceptual Site Model

Following completion of the Phase 2 Site Investigation, the CSM within Section 2.7 of this report was re-evaluated and can be seen overleaf.

For ease of reference and understanding, the risks have been assigned within this risk assessment against three possible risk categories:

- **Low risk** – Regarding this potential SPR linkage, the site is considered suitable for the proposed end-use and there is not considered to be a risk to environmental receptors
- **Moderate risk** – Regarding this potential SPR linkage, the site is suitable for the proposed end-use, however, remediation and/or further investigation is required to confirm this; and
- **High risk** – Regarding this potential SPR linkage, site is not suitable for proposed end-use and there is likely to be a risk to environmental receptors. Urgent action required in the short term.

Tabulated Conceptual Site Model – Pollutant Linkage Summary			
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
On-site			
Anticipated Made Ground deposits associated with the historical development of the site. - Heavy metals and semi-metals; - Poly cyclic aromatic hydrocarbons (PAHs); - Total petroleum hydrocarbons (TPHs); - Volatile and semi-volatile organic Carbons (VOCs and SVOCs); BTEX compounds as markers; - BTEX compounds - Asbestos/asbestos containing materials (ACMs) within the Made Ground; - Cyanide; - Phenol; and, - Harmful pH.	Human Health - Direct ingestion of soil and soil derived dust; - Dermal contact of soil and soil derived dust; - Ingestion of soil with elevated concentration of determinands; - Dermal contact with impacted soils; - Ingestion of home-grown vegetables and soils attached; - Inhalation of contaminated dust (indoor and outdoor) with elevated concentration of determinands; and, - Inhalation of ground-gases or vapours (indoor and outdoor) with elevated concentration of determinands.	Human Health - Site operatives during demolition of the lock-up garages and construction of the proposed residential properties and future maintenance works; - End users of the site (residents, site users and visitors); and - Neighbours/public	Low Risk Low risk considered as Made Ground was relatively shallow, representative of the current development and no residual chemical contamination was encountered.
	Groundwater and Surface Water - Via surface water runoff; - Via anthropogenic (man-made) pathways; and, - Via permeable Made Ground and superficial deposits (if present).	Controlled Waters - Surface water runoff; - Surface water drainage; and - Potential perched groundwater within Made Ground/ superficial deposits overlying impermeable bedrock of the London Clay Formation.	Low Risk Low risk considered given the unproductive aquifer of the underlying London Clay, flat topography, absence of any controlled water receptors within 250m of the site and absence of any chemical contamination.
	Vegetation Direct uptake of impacted water.	Vegetation - Vegetation within the proposed private gardens and areas of communal soft landscaping; - Off-site vegetation in neighbouring properties; and - Limited existing soft landscaping to the west of the site.	Low Risk Low risk considered given very limited existing and proposed soft landscaping. Vegetation uptake is also considered to be a low risk in the absence of any chemical contamination.

Tabulated Conceptual Site Model – Pollutant Linkage Summary			
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
On-site			
Aggressive ground conditions with Made Ground and natural ground; • Sulphates • Acidic pH • PAHs	Building Materials and Services • Direct contact with hydrocarbons within soil; and, • Direct contact with hydrocarbons within groundwater.	Building Materials and Services • Sub-surface concrete. • Sub-surface services (water supply pipes).	Low Risk Hydrocarbon contamination was not identified in any soil samples and sulphate concentrations confirm to a Sulphate Design Class of DS-1 for subsurface concrete in contact with the underlying soils of the Black Park Gravel Member and a classification of AC1 for Aggressive Chemical Environment for Concrete should be adopted.
Potential Asbestos and Asbestos Containing Materials in the soils and existing buildings on-site. Risk of disturbance of ACMs during demolition, enabling and construction works.	Human Health • Direct ingestion of soil and soil derived dust; • Dermal contact of soil and soil derived dust; • Ingestion of soil with elevated concentration of determinands; • Dermal contact with impacted soils; • Ingestion of home-grown vegetables and soils attached; • Inhalation of contaminated dust (indoor and outdoor) with elevated concentration of determinands; and • Inhalation of ground-gases or vapours (indoor and outdoor) with elevated concentration of determinands.	Human Health • Site operatives during demolition of the lock-up garages and construction of the proposed residential properties and future maintenance works; • End users of the site (residents, site users and visitors); and • Neighbours/public	Low Risk A low risk is considered as no asbestos was identified in soils. ACM may be present within the building fabric and released during demolition works. A low risk is considered providing a suitable asbestos survey of the existing structures is implemented and H&S/ discovery procedures are followed
Potential Ground gas within limited Made Ground deposits. • Carbon dioxide; • Methane; • Hydrogen sulphide; and • Carbon monoxide.	Ground Gas • Migration through anthropogenic & natural pathways; • Inhalation of gases; • Explosive risk (methane only); and • Asphyxiating gases.	Ground gas • Site operatives during demolition of the lock-up garages and construction of the proposed residential properties and future maintenance works; • End users of the site (residents, site users and visitors); and • Neighbours/public	Low Risk The Phase 1 investigation did not identify any credible sources of ground gases that pose a risk to the development. The site investigation identified Made Ground with an average thickness of less than 3.00m, and not exceeding 5.00m at the site. Chemical analysis identified TOC to be at concentrations lower than 6% and therefore the site was deemed suitable

			for assessment under the pragmatic approach. In line with the soil-based assessment, the site falls into a Characteristic Situation CS1 , based on a TOC value between <1% and subject to the Made Ground being in place for more than 20 years.
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Tabulated Conceptual Site Model – Pollutant Linkage Summary			
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Off-site			
Off Site Construction, Demolition/ Infilling Activities: Including the demolition and redevelopment of a school campus ~150m east of the site, infilling of a number of localised ponds 146 – 153m west and records of worked ground 171m south. - Heavy metals and semi-metals; - Poly-cyclic aromatic hydrocarbons (PAHs); - Total petroleum hydrocarbons (TPHs); - Volatile and semi-volatile organic Carbons (VOCs and SVOCs); - BTEX compounds; - Asbestos/asbestos containing materials (ACMs); - Cyanide; - Phenol; and - Harmful pH.	Human Health - Direct ingestion of soil and soil derived dust; - Dermal contact of soil and soil derived dust; - Ingestion of soil with elevated concentration of determinands; - Dermal contact with impacted soils; - Inhalation of contaminated dust (indoor and outdoor) with elevated concentration of determinands; and - Inhalation of ground-gases or vapours (indoor and outdoor) with elevated concentration of determinands.	Human Health - Site operatives during demolition of the lock-up garages and construction of the proposed residential properties and future maintenance works; - End users of the site (residents, site users and visitors); and - Neighbours/public	Low Risk Offsite historical developments and infilling activities are highly localised and not considered to be in proximity to the site to provide a viable pathway linkage to on-site receptors. No residual contamination was encountered in any tested Made Ground soil samples including asbestos. No viable pollution linkage from offsite sources were considered.
	Groundwater and Surface Water - Via surface water runoff; - Via anthropogenic (man-made) pathways; and - Via permeable Made Ground/ superficial deposits (if present).	Controlled Waters - Surface water runoff; - Surface water drainage; and - Potential perched groundwater within Made Ground/ superficial deposits overlying impermeable bedrock of the London Clay Formation.	Low Risk Given the underlying Unproductive Aquifer, impermeable bedrock and absence of any substantial groundwater body/ nearby surface water receptors, no realistic pathway was identified that would pose a significant risk to on-site receptors
	Vegetation Direct uptake of impacted water.	Vegetation - Vegetation within the proposed private gardens and areas of communal soft landscaping; - Off-site vegetation in neighbouring properties; and - Limited existing soft landscaping to the west of the site.	Low Risk Given very limited existing on-site vegetation and limited proposed vegetation and exclusion of any viable pathway linkage

8.0 RECOMMENDATIONS AND DEVELOPMENT OF A REMEDIATION STRATEGY

8.1 Option Appraisal

Soils/Current Buildings

Based on the results of the intrusive works and chemical analyses undertaken to-date, no remediation was considered necessary in order to protect human health and end-users of the proposed development.

However, an asbestos management strategy should be put in place in order to identify and appropriately remove any asbestos containing materials. If asbestos materials are encountered in soils and/ or suspected, then the consultant should be informed and a strategy to be implemented. An asbestos survey should be carried out in the existing buildings prior to demolition.

Groundwater

No remediation is considered necessary in order to protect groundwater/controlled waters, and therefore Made Ground can be left under hardstanding.

Ground-gas

Based on the risk assessment to date, the site fell into a Character Situation 1 (CS1) where precautions to prevent the ingress of ground-gas were not necessary.

8.2 Discovery Strategy

There may be areas of contamination that have not been identified during the intrusive investigation. Such occurrences may be discovered during the demolition and construction phases for the redevelopment of the site.

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

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

8.3 Waste Disposal

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

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

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

The Environment Agency's Hazardous Waste Technical Guidance (WM3) document outlines the methodology for classifying wastes. Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

A risk phase analysis of the chemical laboratory test results, in accordance with EC Hazardous Waste Directive was undertaken by Ground and Water Limited, 5No. Made Ground samples were tested and classified as **non-hazardous**. The results can be seen in Appendix F.

Following this initial waste hazard assessment, a Full WAC Solid Suite Test with single batch leachate was undertaken on one sample of the Made Ground (TP1/ 0.30m bgl) to determine which landfill category the waste conformed to. The representative Made Ground sample complied to the **inert** waste category. The results of the WAC test can be seen in Appendix D.

It is important to note that whilst we consider our in-house assessment tool to be an accurate interpretation of the requirements of WM3, therefore producing an initial classification in accordance with the guidance, landfill operators have their own assessment tools and can often come to different conclusions. As a result, some landfill operators could refuse to take apparently suitable waste. It is recommended that the receiving landfill views the results of this assessment and the chemical laboratory results to determine their own classification.

8.4 Imported Material

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

Any imported topsoil/ subsoil imported for the proposed private gardens or areas of communal soft landscaping must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, either prior to placing (ideally) or after placing, to ensure that the human receptor cannot come into contact with compounds that could be detrimental to human health.

8.5 Duty of Care

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

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

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

APPENDIX A

Conditions and Limitations

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

The report has been prepared based on information, data and materials which were available at the time of writing. Any conclusions, opinions or judgements made in the report should not be regarded as definitive or relied upon to the exclusion of other information, opinions, and judgements.

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

Any decisions made by you, or by any organisation, agency or person who has read, received, or been provided with information contained in the report (“you” or “the Recipient”) are decisions of the Recipient and we will not make, or be deemed to make, any decisions on behalf of any Recipient. We will not be liable for the consequences of any such decisions.

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

Any Recipient must consider any other factors apart from the Report of which they and their experts and advisers are or should be aware of. The information, data, conclusions, opinions, and judgements set out in the report may relate to specific contexts and may not be suitable in other contexts. It is your responsibility to ensure that you do not use the information we provide in the wrong context.

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

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

The conclusions and recommendations of this report relate to **land to the rear of 5 – 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR.**

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

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

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets, remain with Ground and Water Limited. Licence is for the sole use of the client and may not be assigned, transferred, or given to a third party.

Only our client may rely on this report and should this report, or any information contained in it be provided to any third party we accept no responsibility to the third party for the contents of this report save to the extent expressly outlined by us in writing in a reliance letter addressed from us to the third party.

Recipients are not permitted to publish this report outside of their organisation without our express written consent.

APPENDIX B
Trial Hole Logs



Probe Log

Probe No
DP5
Sheet 1 of 1

Project Name: Land to rear 5 - 13 Brampton Road

Project No.
GWPR3961

Co-ords:

Hole Type
DP

Location: Land to rear 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR

Level:

Scale
1:25

Client: Blawinder Gill

Dates: 19/11/2020

Logged By

Depth (m)	Blows/100mm																								Torque (Nm)
	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	
1																									
2	21																								
	23																								
	23																								
	39																								
	51																								
	51																								
	60																								
3																									
4																									

Remarks:
Probing terminated at 2.50m bgl due to refusal on dense sand and gravel.

Fall Height 500

Cone Base Diameter

Hammer Wt 50

Final Depth 1.90

Probe Type



Trial Pit Log

Project Name: Land to rear 5 - 13 Brampton Road		Client: Blawinder Gill		Date: 19/11/2020	
Location: Land to rear 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR		Contractor:			
Project No. : GWPR3961		Crew Name: KDS Drilling Service		Equipment: Hand Dug Pit	
Location Number TP1	Location Type TP	Level	Logged By CG	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20			MADE GROUND: CONCRETE HARDSTANDING.	1
		0.30	ES		0.40			MADE GROUND: Dark grey to black medium to coarse grained sandy gravel. Gravel is subangular to subrounded fine tarmacadam (90%), brick (5%) and flint (5%).	
		0.50	D		0.50			Light greyish brown clayey very sandy GRAVEL. Sand is coarse. Gravel is frequent subrounded to rounded fine to medium flint (100%). BLACK PARK GRAVEL MEMBER.	
								End of Borehole at 0.500m	2
									3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
0.50	0.50	STABLE	Not Required				

Remarks No groundwater encountered. No roots encountered. Hand dug pit terminated at a depth of 0.50m bgl as the base of the Made Ground was proven. Pit was reverse backfilled with arisings and compacted on completion. ES - Environmental Sample, D - Disturbed Sample, SPT - Standard Penetration Test.							
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Trial Pit Log

Project Name: Land to rear 5 - 13 Brampton Road		Client: Blawinder Gill		Date: 19/11/2020	
Location: Land to rear 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR		Contractor:			
Project No. : GWPR3961		Crew Name: KDS Drilling Service		Equipment: Hand Dug Pit	
Location Number TP2	Location Type TP	Level	Logged By CG	Scale 1:25	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.20			MADE GROUND: CONCRETE HARDSTANDING.	
		0.30	ES		0.40			MADE GROUND: Dark grey to black medium to coarse grained sandy gravel. Gravel is subangular to subrounded fine tarmacadam (90%), brick (5%) and flint (5%).	
		0.50	ES		0.50			Dark yellowish brown sandy very gravelly CLAY. Sand is medium to coarse. Gravel is angular to rounded fine to medium flint (100%). BLACK PARK GRAVEL MEMBER. End of Borehole at 0.500m	
									1
									2
									3
									4
									5

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
0.50	0.50	STABLE	Not required				

Remarks	
No groundwater encountered. No roots encountered. Hand dug pit terminated at a depth of 0.50m bgl as the base of the Made Ground was proven. Pit was reverse backfilled with arisings and compacted on completion. ES - Environmental Sample, D - Disturbed Sample, SPT - Standard Penetration Test.	



Percussion Drilling Log

Project Name: Land to rear 5 - 13 Brampton Road		Client: Blawinder Gill		Date: 19/11/2020	
Location: Land to rear 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR		Contractor:			
Project No. : GWPR3961		Crew Name: KDS Drilling Service		Drilling Equipment: DANDO 2000	
Borehole Number WS1	Hole Type CP	Level	Logged By CG	Scale 1:50	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	ES		0.20			MADE GROUND: CONCRETE HARDSTANDING.	
		0.50	D					MADE GROUND: Dark brown sandy very gravelly clay. Sand is fine to medium. Gravel is subangular to rounded fine to medium flint (95%) with rare brick (5%).	
		1.00	D		0.80			Dark brown very clayey GRAVEL with occasional pockets of clay. Gravel is subangular to subrounded fine to medium flint (100%).	1
	▼	1.60	D		1.10			Dark orangish brown clayey SAND and GRAVEL. Sand is coarse. Gravel is frequent subangular to rounded fine to medium flint (100%). BLACK PARK GRAVEL MEMBER.	
					1.60			End of Borehole at 1.600m	2
									3
									4
									5
									6
									7
									8
									9
									10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks
Groundwater encountered at the base of the borehole at a depth of 1.60m bgl. No roots encountered. Borehole terminated at a depth of 1.60m bgl due to refusal in dense gravels and reverse backfilled with arisings. ES - Environmental Sample, D - Disturbed Sample, SPT - Standard Penetration Test.





Percussion Drilling Log

Project Name: Land to rear 5 - 13 Brampton Road		Client: Blawinder Gill		Date: 19/11/2020	
Location: Land to rear 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR		Contractor:			
Project No. : GWPR3961		Crew Name: KDS Drilling Service		Drilling Equipment: DANDO 2000	
Borehole Number WS2	Hole Type CP	Level	Logged By CG	Scale 1:50	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	ES		0.20			MADE GROUND: CONCRETE HARDSTANDING.	
		0.50	D		0.60			MADE GROUND: Dark brownish grey clayey very gravelly coarse grained sand. Gravel is frequent angular to subrounded, rarely rounded, fine to medium flint (95%) and brick (5%).	
		0.80	D		1.00			Dark orangish brown and grey mottled clayey very sandy GRAVEL. Sand is coarse. Gravel is frequent subangular to rounded fine to medium flint (100%) with rare grey clay lenses. BLACK PARK GRAVEL MEMBER.	1
		1.00	D		1.80			Dark orangish brown and grey mottled sandy CLAY with rare orange sand lenses. BLACK PARK GRAVEL MEMBER.	2
		1.80	D					End of Borehole at 1.800m	
									3
									4
									5
									6
									7
									8
									9
									10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks
Groundwater encountered at the base of the borehole at a depth of 1.80m bgl. No roots encountered. Borehole terminated at a depth of 1.80m bgl due to refusal in dense gravels and reverse backfilled with arisings. ES - Environmental Sample, D - Disturbed Sample, SPT - Standard Penetration Test.





Percussion Drilling Log

Project Name: Land to rear 5 - 13 Brampton Road		Client: Blawinder Gill		Date: 19/11/2020	
Location: Land to rear 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR		Contractor:			
Project No. : GWPR3961		Crew Name: KDS Drilling Service		Drilling Equipment: DANDO 2000	
Borehole Number WS3	Hole Type CP	Level	Logged By CG	Scale 1:50	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	ES		0.20			MADE GROUND: CONCRETE HARDSTANDING.	
		0.50	D		0.60			MADE GROUND: Light greyish brown clayey sandy gravel. Sand is fine to coarse. Gravel is angular to subrounded fine to medium flint (95%) and rare brick (5%).	
		0.80	D					Dark orangish brown mottled grey sandy very gravelly CLAY. Sand is fine to coarse. Gravel is frequent subangular to rounded fine to medium flint (100%). BLACK PARK GRAVEL MEMBER.	1
	▼	1.00	D						
		1.70	D		1.80			End of Borehole at 1.800m	2
									3
									4
									5
									6
									7
									8
									9
									10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

Groundwater encountered at the base of the borehole at a depth of 1.80m bgl. No roots encountered. Borehole terminated at a depth of 1.80m bgl due to refusal in dense gravels and reverse backfilled with arisings. ES - Environmental Sample, D - Disturbed Sample, SPT - Standard Penetration Test.





Date: 19/11/2020

Contractor:

Drilling Equipment: DANDO 2000

Page Number
Sheet 1 of 1[illegible]

Groundwater encountered at the base of the borehole at a depth of 1.90m bgl. Roots were encountered to a maximum penetration of 0.60m bgl. Borehole terminated at a depth of 1.90m bgl due to refusal in dense gravels and reverse backfilled with arisings. ES - Environmental Sample, D - Disturbed Sample, SPT - Standard Penetration Test.



Percussion Drilling Log

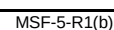
Project Name: Land to rear 5 - 13 Brampton Road		Client: Blawinder Gill		Date: 19/11/2020	
Location: Land to rear 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR		Contractor:			
Project No. : GWPR3961		Crew Name: KDS Drilling Service		Drilling Equipment: DANDO 2000	
Borehole Number WS5	Hole Type CP	Level	Logged By CG	Scale 1:50	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.30	ES		0.30			MADE GROUND: Dark greyish brown sandy slightly gravelly silt with frequent roots (<1 - 5mm). Sand is fine to medium. Gravel is subangular to rounded fine to medium flint (90%), brick (5%) and tarmacadam (5%).	
		0.50	ES						
		0.80	D		0.80			MADE GROUND: Dark greyish brown silty sandy gravelly clay with frequent fine selenite crystals and occasional roots (<1 - 5mm). Sand is medium to coarse. Gravel is angular to rounded fine to medium flint (95%), brick (5%) and tarmacadam (5%).	1
		1.00	D						
		1.60	D					Dark orangish brown clayey slightly sandy GRAVEL. Sand is coarse. Gravel is angular to subrounded fine to coarse flint (100%).	
					1.90			End of Borehole at 1.900m	2
									3
									4
									5
									6
									7
									8
									9
									10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base (m)	Diameter (mm)	Depth Base (m)	Diameter (mm)	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks Groundwater encountered at the base of the borehole at a depth of 1.90m bgl. Roots were encountered to a maximum concentration of 0.8m bgl. Borehole terminated at a depth of 1.90m bgl due to refusal in dense gravels and reverse backfilled with arisings. ES - Environmental Sample, D - Disturbed Sample, SPT - Standard Penetration Test.										
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APPENDIX C
Geotechnical Laboratory Testing Results

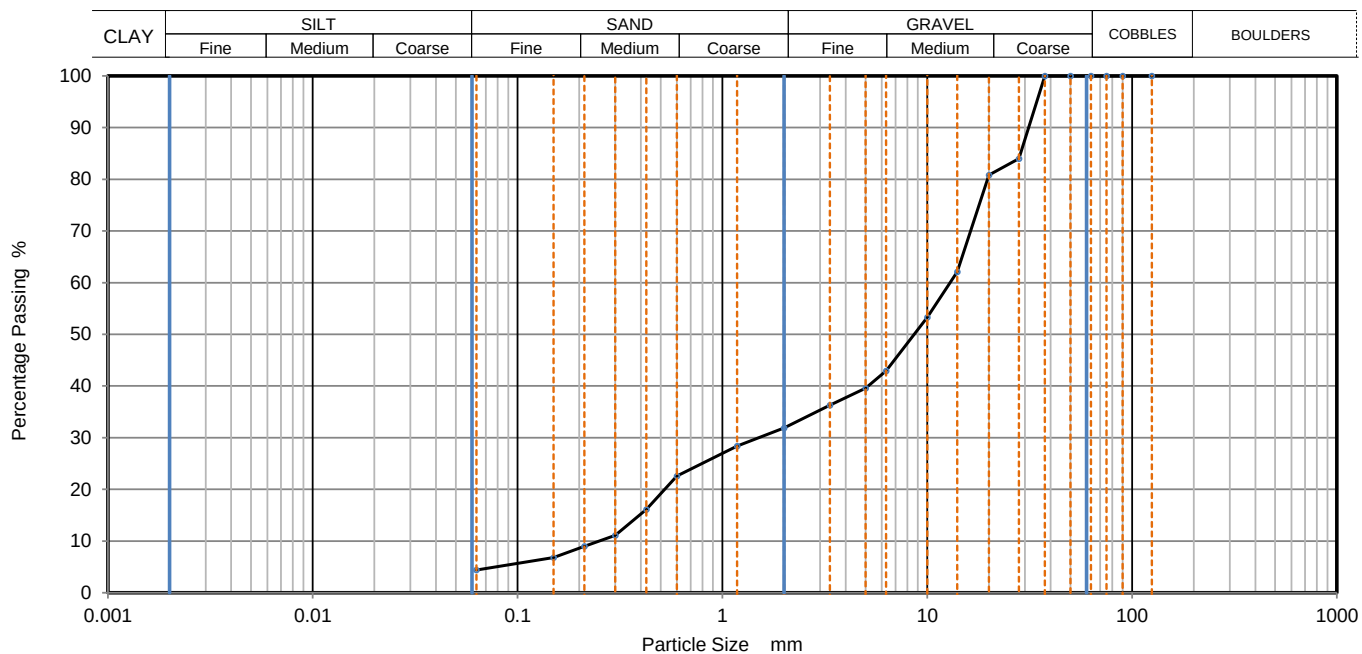
[illegible]



PARTICLE SIZE DISTRIBUTION

Job Ref	29153
Borehole/Pit No.	WS2
Sample No.	-
Depth Top	0.80 m
Depth Base	- m
Sample Type	D
Samples received	01/12/2020
Schedules received	01/12/2020
Project started	02/12/2020
Date tested	10/12/2020

Site Name	Brampton Road		
Project No.	GWPR3961	Client	Ground & Water Ltd
Soil Description	Brown slightly clayey very sandy GRAVEL (gravel is fmc and sub-angular to sub-rounded)		
Test Method	BS1377:Part 2: 1990, clause 9.0		



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
125	100		
90	100		
75	100		
63	100		
50	100		
37.5	100		
28	84		
20	81		
14	62		
10	53		
6.3	43		
5	40		
3.35	36		
2	32		
1.18	28		
0.6	23		
0.425	16		
0.3	11		
0.212	9		
0.15	7		
0.063	4		

Sample Proportions	% dry mass
Very coarse	0.0
Gravel	68.1
Sand	27.5
Fines <0.063mm	4.4

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	52
Curvature Coefficient	0.69

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: 15/12/2020

2519

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

MSF-5-R3

APPENDIX D
Chemical Laboratory Testing Results



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GU34 3NB

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Rose Lane
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t: 01622 850410

DETS Report No: 20-14283

Site Reference: Brampton Road

Project / Job Ref: GWPR3961

Order No: None Supplied

Sample Receipt Date: 02/12/2020

Sample Scheduled Date: 02/12/2020

Report Issue Number: 1

Reporting Date: 08/12/2020

Authorised by:

Dave Ashworth
Technical Manager

Dates of laboratory activities for each tested analyte are available upon request.

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Soil Analysis Certificate						
DETS Report No: 20-14283	Date Sampled	01/12/20	01/12/20			
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Brampton Road	TP / BH No	TP2	WS4			
Project / Job Ref: GWPR3961	Additional Refs	None Supplied	None Supplied			
Order No: None Supplied	Depth (m)	0.50	1.50			
Reporting Date: 08/12/2020	DETS Sample No	514432	514433			

Determinand	Unit	RL	Accreditation				
pH	pH Units	N/a	MCERTS	7.1	6.7		
Total Sulphate as SO ₄	mg/kg	< 200	MCERTS	< 200	221		
Total Sulphate as SO ₄	%	< 0.02	MCERTS	< 0.02	0.02		
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	14	42		
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.01	0.04		
Total Sulphur	%	< 0.02	NONE	< 0.02	< 0.02		
Ammonium as NH ₄	mg/kg	< 0.5	NONE	2.1	4.3		
Ammonium as NH ₄	mg/l	< 0.05	NONE	0.21	0.43		
W/S Chloride (2:1)	mg/kg	< 1	MCERTS	6	6		
W/S Chloride (2:1)	mg/l	< 0.5	MCERTS	2.9	3.2		
Water Soluble Nitrate (2:1) as NO ₃	mg/kg	< 3	MCERTS	4	< 3		
Water Soluble Nitrate (2:1) as NO ₃	mg/l	< 1.5	MCERTS	1.8	< 1.5		
W/S Magnesium	mg/l	< 0.1	NONE	1.7	2.2		

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
Subcontracted analysis (S)



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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 20-14283	
Ground & Water Ltd	
Site Reference: Brampton Road	
Project / Job Ref: GWPR3961	
Order No: None Supplied	
Reporting Date: 08/12/2020	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
514432	TP2	None Supplied	0.50	7	Light brown sandy gravel with stones
514433	WS4	None Supplied	1.50	8.3	Light brown sandy clay with stones

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

Insufficient Sample ^{1/s}

Unsuitable Sample ^{u/s}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-14283

Ground & Water Ltd

Site Reference: Brampton Road

Project / Job Ref: GWPR3961

Order No: None Supplied

Reporting Date: 08/12/2020

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	Fraction Organic Carbon (FOC)	Determination of TOC by combustion analyser.	E027
Soil	D	Organic Matter (SOM)	Determination of TOC by combustion analyser.	E027
Soil	D	TOC (Total Organic Carbon)	Determination of TOC by combustion analyser.	E027
Soil	AR	Exchangeable Ammonium	Determination of ammonium by discrete analyser.	E029
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received



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DETS Report No: 20-13977

Site Reference: Rosebery School

Project / Job Ref: GWPR3961

Order No: GWPR3961

Sample Receipt Date: 26/11/2020

Sample Scheduled Date: 26/11/2020

Report Issue Number: 1

Reporting Date: 02/12/2020

Authorised by:

A handwritten signature in black ink, appearing to read "Kevin Old".

Kevin Old
General Manager

Dates of laboratory activities for each tested analyte are available upon request.

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Soil Analysis Certificate						
DETS Report No: 20-13977	Date Sampled	25/11/20	25/11/20	25/11/20	25/11/20	25/11/20
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Rosebery School	TP / BH No	WS1	WS3	TP2	WS5	WS5
Project / Job Ref: GWPR3961	Additional Refs	NAT	MG	MG	MG	MG
Order No: GWPR3961	Depth (m)	0.30	0.30	0.30	0.30	0.50
Reporting Date: 02/12/2020	DETS Sample No	513059	513060	513062	513063	513064

Determinand	Unit	RL	Accreditation					
Asbestos Screen ^(S)	N/a	N/a	ISO17025	Not Detected	Not Detected	Not Detected	Not Detected	Not Detected
pH	pH Units	N/a	MCERTS	7.8	7.6	9.5	7.9	7.6
Total Cyanide	mg/kg	< 2	NONE	< 2	< 2	< 2	3	< 2
W/S Sulphate as SO ₄ (2:1)	mg/l	< 10	MCERTS	30	22	169	15	< 10
W/S Sulphate as SO ₄ (2:1)	g/l	< 0.01	MCERTS	0.03	0.02	0.17	0.01	< 0.01
Organic Matter	%	< 0.1	MCERTS	0.9	0.6	2.2	1.1	0.9
Total Organic Carbon (TOC)	%	< 0.1	MCERTS	0.5	0.4	1.3	0.6	0.5
Arsenic (As)	mg/kg	< 2	MCERTS	7	9	18	5	6
W/S Boron	mg/kg	< 1	NONE	< 1	< 1	< 1	< 1	< 1
Cadmium (Cd)	mg/kg	< 0.2	MCERTS	0.8	0.2	0.3	< 0.2	< 0.2
Chromium (Cr)	mg/kg	< 2	MCERTS	19	23	19	10	10
Chromium (hexavalent)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2
Copper (Cu)	mg/kg	< 4	MCERTS	11	10	69	13	9
Lead (Pb)	mg/kg	< 3	MCERTS	15	9	50	34	29
Mercury (Hg)	mg/kg	< 1	MCERTS	< 1	< 1	< 1	< 1	< 1
Nickel (Ni)	mg/kg	< 3	MCERTS	8	9	32	5	5
Selenium (Se)	mg/kg	< 2	MCERTS	< 3	< 3	< 3	< 3	< 3
Vanadium (V)	mg/kg	< 1	MCERTS	25	27	55	16	17
Zinc (Zn)	mg/kg	< 3	MCERTS	271	81	88	83	43
Total Phenols (monohydric)	mg/kg	< 2	NONE	< 2	< 2	< 2	< 2	< 2

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
 Subcontracted analysis (S)



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Soil Analysis Certificate - Speciated PAHs						
DETS Report No: 20-13977	Date Sampled	25/11/20	25/11/20	25/11/20	25/11/20	25/11/20
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Site Reference: Rosebery School	TP / BH No	WS1	WS3	TP2	WS5	WS5
Project / Job Ref: GWPR3961	Additional Refs	NAT	MG	MG	MG	MG
Order No: GWPR3961	Depth (m)	0.30	0.30	0.30	0.30	0.50
Reporting Date: 02/12/2020	DETS Sample No	513059	513060	513062	513063	513064

Determinand	Unit	RL	Accreditation					
Naphthalene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Acenaphthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fluorene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Phenanthrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.98	< 0.1
Anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.22	< 0.1
Fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.18	2.76	0.34
Pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.18	2.14	0.31
Benzo(a)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	0.37	1.46	0.41
Chrysene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	1.49	< 0.1
Benzo(b)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	1.88	0.17
Benzo(k)fluoranthene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.61	< 0.1
Benzo(a)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	1.33	< 0.1
Indeno(1,2,3-cd)pyrene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.89	0.11
Dibenz(a,h)anthracene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.16	< 0.1
Benzo(ghi)perylene	mg/kg	< 0.1	MCERTS	< 0.1	< 0.1	< 0.1	0.56	< 0.1
Total EPA-16 PAHs	mg/kg	< 1.6	MCERTS	< 1.6	< 1.6	< 1.6	14.5	< 1.6



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Tel : 01622 850410



Soil Analysis Certificate - TPH CWG Banded

DETS Report No: 20-13977	Date Sampled	25/11/20	25/11/20			
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Rosebery School	TP / BH No	WS1	WS5			
Project / Job Ref: GWPR3961	Additional Refs	NAT	MG			
Order No: GWPR3961	Depth (m)	0.30	0.50			
Reporting Date: 02/12/2020	DETS Sample No	513059	513064			

Determinand	Unit	RL	Accreditation			
Aliphatic >C5 - C6	mg/kg	< 0.01	NONE	< 0.01	< 0.01	
Aliphatic >C6 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	
Aliphatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	
Aliphatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	
Aliphatic >C12 - C16	mg/kg	< 3	MCERTS	< 3	< 3	
Aliphatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	
Aliphatic >C21 - C34	mg/kg	< 10	MCERTS	< 10	< 10	
Aliphatic (C5 - C34)	mg/kg	< 21	NONE	< 21	< 21	
Aromatic >C5 - C7	mg/kg	< 0.01	NONE	< 0.01	< 0.01	
Aromatic >C7 - C8	mg/kg	< 0.05	NONE	< 0.05	< 0.05	
Aromatic >C8 - C10	mg/kg	< 2	MCERTS	< 2	< 2	
Aromatic >C10 - C12	mg/kg	< 2	MCERTS	< 2	< 2	
Aromatic >C12 - C16	mg/kg	< 2	MCERTS	< 2	< 2	
Aromatic >C16 - C21	mg/kg	< 3	MCERTS	< 3	< 3	
Aromatic >C21 - C35	mg/kg	< 10	MCERTS	< 10	< 10	
Aromatic (C5 - C35)	mg/kg	< 21	NONE	< 21	< 21	
Total >C5 - C35	mg/kg	< 42	NONE	< 42	< 42	



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Soil Analysis Certificate - BTEX / MTBE						
DETS Report No: 20-13977	Date Sampled	25/11/20	25/11/20			
Ground & Water Ltd	Time Sampled	None Supplied	None Supplied			
Site Reference: Rosebery School	TP / BH No	WS1	WS5			
Project / Job Ref: GWPR3961	Additional Refs	NAT	MG			
Order No: GWPR3961	Depth (m)	0.30	0.50			
Reporting Date: 02/12/2020	DETS Sample No	513059	513064			

Determinand	Unit	RL	Accreditation					
Benzene	ug/kg	< 2	MCERTS	< 2	< 2			
Toluene	ug/kg	< 5	MCERTS	6	16			
Ethylbenzene	ug/kg	< 2	MCERTS	< 2	< 2			
p & m-xylene	ug/kg	< 2	MCERTS	7	12			
o-xylene	ug/kg	< 2	MCERTS	4	6			
MTBE	ug/kg	< 5	MCERTS	< 5	< 5			

Waste Acceptance Criteria Analytical Certificate - BS EN 12457/2

DETS Report No: 20-13977		Date Sampled	25/11/20		Landfill Waste Acceptance Criteria Limits		
Ground & Water Ltd		Time Sampled	None Supplied				
Site Reference: Rosebery School		TP / BH No	TP1				
Project / Job Ref: GWPR3961		Additional Refs	MG				
Order No: GWPR3961		Depth (m)	0.30				
Reporting Date: 02/12/2020		DETS Sample No	513061				
Determinand	Unit	MDL			Inert Waste Landfill	Stable Non-reactive HAZARDOUS waste in non-hazardous Landfill	Hazardous Waste Landfill
TOC ^{MU}	%	< 0.1	1		3%	5%	6%
Loss on Ignition	%	< 0.01	5		--	--	10%
BTEX ^{MU}	mg/kg	< 0.05	0.18		6	--	--
Sum of PCBs	mg/kg	< 0.1	< 0.1		1	--	--
Mineral Oil ^{MU}	mg/kg	< 10	< 10		500	--	--
Total PAH ^{MU}	mg/kg	< 1.7	< 1.7		100	--	--
pH ^{MU}	pH Units	N/a	9.6		--	>6	--
Acid Neutralisation Capacity	mol/kg (+/-)	< 1	1.1		--	To be evaluated	To be evaluated
Eluate Analysis			10:1 mg/l		Cumulative 10:1 mg/kg	Limit values for compliance leaching test using BS EN 12457-3 at L/S 10 l/kg (mg/kg)	
Arsenic ^U		0.02			0.2	0.5	2
Barium ^U		< 0.02			< 0.2	20	100
Cadmium ^U		< 0.0005			< 0.005	0.04	1
Chromium ^U		0.013			0.13	0.5	10
Copper ^U		0.01			0.1	2	50
Mercury ^U		< 0.0005			< 0.005	0.01	0.2
Molybdenum ^U		0.014			0.14	0.5	10
Nickel ^U		< 0.007			< 0.07	0.4	10
Lead ^U		< 0.005			< 0.05	0.5	10
Antimony ^U		< 0.005			< 0.05	0.06	0.7
Selenium ^U		< 0.005			< 0.05	0.1	0.5
Zinc ^U		< 0.005			< 0.05	4	50
Chloride ^U		2.1			21	800	15000
Fluoride ^U		< 0.5			< 5	10	150
Sulphate ^U		13.9			139	1000	20000
TDS		118			1180	4000	60000
Phenol Index		< 0.01			< 0.1	1	-
DOC		7.1			71	500	800
Leach Test Information							
Sample Mass (kg)			0.10				
Dry Matter (%)			86.8				
Moisture (%)			15.2				
Stage 1							
Volume Eluate L10 (litres)			0.89				

Analytical results are expressed on a dry weight basis where samples are assisted-dried at less than 30°C. The Samples Descriptions page describes if the test is performed on the dried or as-received portion
 Stated limits are for guidance only and DETS Ltd cannot be held responsible for any discrepancies with current legislation
 M Denotes MCERTS accredited test
 U Denotes ISO17025 accredited test



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Soil Analysis Certificate - Sample Descriptions

DETS Report No: 20-13977	
Ground & Water Ltd	
Site Reference: Rosebery School	
Project / Job Ref: GWPR3961	
Order No: GWPR3961	
Reporting Date: 02/12/2020	

DETS Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
513059	WS1	NAT	0.30	7.9	Brown sandy clay with stones
513060	WS3	MG	0.30	5.4	Brown sandy gravel with stones
513061	TP1	MG	0.30	13.3	Black loamy sand with stones and concrete
513062	TP2	MG	0.30	12.6	Black loamy sand with stones and concrete
513063	WS5	MG	0.30	8.9	Brown loamy sand with stones and vegetation
513064	WS5	MG	0.50	9.8	Brown loamy sand with stones

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

Insufficient Sample ^{1/5}

Unsuitable Sample ^{u/s}



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Soil Analysis Certificate - Methodology & Miscellaneous Information

DETS Report No: 20-13977

Ground & Water Ltd

Site Reference: Rosebery School

Project / Job Ref: GWPR3961

Order No: GWPR3961

Reporting Date: 02/12/2020

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazine followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 - C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received

Parameter	Matrix Type	Suite Reference	Expanded Uncertainty Measurement	Unit
TOC	Soil	BS EN 12457	13.49	%
Loss on Ignition	Soil	BS EN 12457	17	%
BTEX	Soil	BS EN 12457	14	%
Sum of PCBs	Soil	BS EN 12457	23	%
Mineral Oil	Soil	BS EN 12457	9	%
Total PAH	Soil	BS EN 12457	20	%
pH	Soil	BS EN 12457	0.399	Units
Acid Neutralisation Capacity	Soil	BS EN 12457	18	%
Arsenic	Leachate	BS EN 12457	16.63	%
Barium	Leachate	BS EN 12457	14.29	%
Cadmium	Leachate	BS EN 12457	14.44	%
Chromium	Leachate	BS EN 12457	18.06	%
Copper	Leachate	BS EN 12457	21.27	%
Mercury	Leachate	BS EN 12457	24.13	%
Molybdenum	Leachate	BS EN 12457	12.55	%
Nickel	Leachate	BS EN 12457	20.08	%
Lead	Leachate	BS EN 12457	13.43	%
Antimony	Leachate	BS EN 12457	18.85	%
Selenium	Leachate	BS EN 12457	18.91	%
Zinc	Leachate	BS EN 12457	13.71	%
Chloride	Leachate	BS EN 12457	16	%
Fluoride	Leachate	BS EN 12457	19.4	%
Sulphate	Leachate	BS EN 12457	19.63	%
TDS	Leachate	BS EN 12457	12	%
Phenol Index	Leachate	BS EN 12457	14	%
DOC	Leachate	BS EN 12457	10	%
Clay Content	Soil	BS 3882: 2015	15	%
Silt Content	Soil	BS 3882: 2015	14	%
Sand Content	Soil	BS 3882: 2015	13	%
Loss on Ignition	Soil	BS 3882: 2015	17	%
pH	Soil	BS 3882: 2015	0.399	Units
Carbonate	Soil	BS 3882: 2015	16	%
Total Nitrogen	Soil	BS 3882: 2015	12	%
Phosphorus (Extractable)	Soil	BS 3882: 2015	24	%
Potassium (Extractable)	Soil	BS 3882: 2015	20	%
Magnesium (Extractable)	Soil	BS 3882: 2015	26	%
Zinc	Soil	BS 3882: 2015	14.9	%
Copper	Soil	BS 3882: 2015	16	%
Nickel	Soil	BS 3882: 2015	17.7	%
Available Sodium	Soil	BS 3882: 2015	23	%
Available Calcium	Soil	BS 3882: 2015	23	%
Electrical Conductivity	Soil	BS 3882: 2015	10	%

APPENDIX E
Soil Assessment Criteria

Ground and Water Limited

Soil Guideline Values and Generic Assessment Criteria

The Contaminated Land Regime reflects the UK Government's stated objectives of achieving sustainable development through the 'suitable for use approach'. At preliminary risk assessment stage, risks are evaluated qualitatively. As the site investigation progresses to a generic or detailed quantitative risk assessment, data is collected and assessment criteria are utilised to evaluate whether the contaminants represent an unacceptable risk to the identified receptors.

1.1 Contaminated Land Exposure Assessment Model (CLEA)

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

The CLEA Guidance comprises the following documents:

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

The CLEA guidance and tools:

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

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

1.2 Land-use Scenarios

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

1.2.1 Residential (with home grown produce) (RwHP)

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

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

A sub-set of this land-use is residential apartments with communal landscaped gardens where the consumption of home grown vegetables will not occur. (Residential without homegrown produce (RwoHP)).

1.2.2 Allotments

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

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

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

1.2.3 Commercial/Industrial

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

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

2 LQM/CIEH Suitable 4 Use Levels (S4UL)

For derivation of these S4UL reference must be made to:

Nathanial, P., McCaffrey, C., Gillet, A., Ogden, R., Nathanial, J., *The LQM/CIEH S4UL's for Human Health Risk Assessment*. Land Quality Press. 2015

2.1 S4UL Background

The Land Quality Management/Chartered Institute of Environmental Health (LQM/CIEH) S4UL for a given land use is the concentration of the contaminant in soil at which the predicted daily exposure, as calculated by the CLEA software, equals the Health Criteria Value. The S4ULs have been derived for substances based on various generic land use and soil organic matter contents.

The final output for each contaminant represents a synthesis of new toxicological (and fate and transport) reviews published since the preparation of the 2nd edition LQM/CIEH GAC's (Nathanial et al., 2009).

In the derivation of LQM/CIEH S4UL's the principles of 'minimal' or 'tolerable' risk enshrined in SR2, which has not been withdrawn, has been maintained.

2.2 S4UL Land-use

S4UL's have been derived for the basic CLEA land-uses, as described in section 1.2, and for two new land uses:

- Public Open Spaces near Residential Housing (POSresi).
- Public Park (POSpark).

2.2.1 Public Open Spaces near Residential Housing (POSresi)

Includes the predominantly grassed areas adjacent to high density housing, the central green area on many 1930's – 1970's housing estates, and smaller areas commonly incorporated in newer developments as informal grassed areas or more formal landscaped areas with a mixture of open space and covered soils with planting. It is assumed that the close proximity to the place of residence will allow tracking back of soil to occur.

2.2.2 Public Park (POSpark)

An area of open space, usually owned and maintained by the local authority, provided for recreational uses including family visits and picnics, children's play area, informal sporting activities (not a dedicated sports pitch), and dog walking. It is assumed that tracking back of soils into places of residence will be negligible.

The following LQM/CIEH S4ULs (Copyright Land Quality Management Limited) have been reproduced with permission, to the publication number S4UL3072.

3 Category 4 Screening Levels (C4SLs)

In the case of Lead, no SGV or GAC has been published to date. This is likely to be due to the toxicity review that is currently being undertaken by the Environment Agency. In the absence of updated toxicity information the SGV derived using CLEA 1.06 methodology and related toxicity will be used.

The overall objective of the C4SLs research project was to assist the provision of technical guidance in support of Defra's revised Statutory Guidance (SG) for Part 2A of the Environmental Protection Act 1990 (Part 2A) (Defra, 2012a). Specifically, the project aimed to deliver:

- A methodology for deriving C4SLs for four generic land-uses comprising residential, commercial, allotments and public open space; and
- A demonstration of the methodology, via the derivation of C4SLs for six substances – arsenic, benzene, benzo(a)pyrene, cadmium, chromium (VI) and lead.

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

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

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

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

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

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

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

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

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

“The new statutory guidance will bring about a situation where the current SGVs/GACs are replaced with more pragmatic (but still strongly precautionary) Category 4 screening levels (C4SLs) which will provide a higher simple test for deciding that land is suitable for use and definitely not contaminated land.”

A key distinction between the Soil Guideline Values (SGVs) and the C4SLs is the level of risk that they describe. As described by the Environment Agency (2009a):

“SGVs are guidelines on the level of long-term human exposure to individual chemicals in soil that, unless stated otherwise, are tolerable or pose a minimal risk to human health.”

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

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

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

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

The suggested approach to the development of C4SLs consists of the retention and use of the CLEA framework, modified according to considerations of the underlying science within the context of Defra's policy objectives relating to the revised SG. Within this context, it is suggested that the development of C4SLs may be achieved in one of three ways, namely:

- By modifying the toxicological parameters used within CLEA (while maintaining current exposure parameters);
- By modifying the exposure parameters embedded within CLEA (while maintaining current toxicological “minimal risk” interpretations); and
- By modifying both toxicological and exposure parameters.

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

It is suggested that a new term is defined for the toxicological guidance values associated with the derivation of C4SLs – a Low Level of Toxicological Concern (LLTC). A LLTC should represent an intake of low concern that remains suitably protective of health, and definitely does not approach an intake level that could be defined as SPOSH.

4 CL:AIRE Generic Assessment Criteria (GAC)

For derivation of the CL:AIRE Generic Assessment Criteria (GAC) reference should be made to the following report:

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

Within this report, Contaminated Land: Applications in Real Environments (CL:AIRE) provided Generic Assessment Criteria (GAC) in accordance with the CLEA software and the principles outlined previously for a further 35 contaminants sometimes encountered on land affected by contamination.

5 SoBRA Acute GAC

The Society of Brownfield Risk Assessment (SoBRA) identified that most human health risk assessments focus on the chronic risks arising from long-term exposure to specific substances. As chronic risks often occur at lower doses than acute risks, they are often the key drivers, however, in some instances the acute dose may also be an important consideration within risk assessments.

The methodology for deriving the acute GAC were related to two distinct receptor groups:

- Members of the public, where the 'critical' receptor for this group will typically be a female child, which is consistent with CLEA residential and Public Open Space/allotments land-uses;
- Workers involved with excavations. The critical receptor for this group is assumed to be a female working adult, without the use of PPE.

The acute GACs relate to short term exposure of high concentrations of a substance that lead to acute effects. They are not considered to be average exposures across a specific / defined area. As a result, the GACs should be normally be compared with the maximum likely concentration that the individual may be exposed to, and not the average concentration within a specific area.

The SoBRA acute GAC will primarily be used for contaminants that do not currently have any GAC, most notably Cyanide.

6 Detailed Quantitative Risk Assessments (DQRA)

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

- | | |
|---|--|
| ⇒ | Establishing the plausibility that generic exposure pathways exist in practice by measurement and observation. |
| ⇒ | Developing more accurate parameters using site data. |

7 Phytotoxicity

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

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

8 Statistical Tests

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

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

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

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

CL:AIRE published guidance in 2020, *Guidance in comparing soil contamination data with a critical concentration*, superseding the CL:AIRE/CIEH 2008 report of the same name. The guidance provides ways to assist land contamination stakeholders to apply statistical

methods to their data to enable decisions under the legislative framework; either planning system or Part 2A of the Environmental Protection Act 1990.

The use of the statistical tests should only be applied if the following statements are valid for the datasets:

- Averaging areas, as well as the smallest area of concern have been identified on the basis of the CSM, including the desk study and/or the site walkover;
- The sample locations were chosen using a simple random, stratified random or stratified systematic (square, herringbone or triangular grid) sampling pattern, rather than being targeted to locations suspected of being contaminated;
- The sample locations are relatively evenly spread across the area and are not clustered, to avoid giving undue weight to some parts of the site over others in the calculated statistics;
- The analyses do not suggest a hotspot or outlier of contamination that should be treated as a separate zone. This has been established by a histogram and/or a names statistical test;
- The sample locations are all taken from one population (i.e. the same material);
- Where an averaging zone encompasses several averaging areas, analyses do not show a spatial trend or other spatial pattern across that zone; and
- The number of samples has been shown to be sufficient for a statistical analysis.

Any included statistical spreadsheet is based on an in-house method of statistical analysis, in line with those outlined within the CL:AIRE guidance (2020).

Treatment of Hot-Spots

- ⇒ A statistical test is applied to establish whether the data is a part of a single set, or whether data outliers are present.
- ⇒ Provided that the data is based on random sampling and no distinct contamination source was present at the sampling location, the hot-spot(s) may be excluded and the mean of the remaining data assessed.

9 Ground and Water Limited Soil Assessment Criteria

The Soil Assessment Criteria used in the preparation of the Generic Quantitative Risk Assessment are tabulated in the following pages, where the source of each has been outlined in the previous sections.

9.1 Inorganics

SoBRA – Acute Generic Assessment Criteria						
Determinand	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Cyanide	24	24	24	1400	24	24

9.2 Metals

C4SL Low Level of Toxicological Concern						
Determinand	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Lead	<200	<310	<80	<2300	<630	<1300

LQM/CIEH Suitable 4 Use Levels – Metals and Semi-metals						
Determinand	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Arsenic	37	40	43	640	79	170
Beryllium	1.7	1.7	35	12	2.2	63
Boron	290	11000	45	240000	21000	46000
Cadmium	11	85	1.9	190	120	532
Chromium (III)	910	910	18000	8600	1500	33000
Chromium (VI)	6	6	1.8	33	7.7	220
Copper	2400	7100	520	68000	12000	44000
Elemental Mercury	1.2	1.2	21	58	16	30
Inorganic Mercury	40	56	19	1100	120	240
Methylmercury	11	15	6	320	40	68
Nickel	130	180	53	980	230	800
Selenium	250	430	88	12000	1100	1800
Vanadium	410	1200	91	9000	2000	5000
Zinc	3700	40000	620	730000	81000	170000

Phytotoxicity Recommendations – ICRL 70/90 Restoration of metalliferous mining areas

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

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

ND – Not derived

9.3 Total Petroleum Hydrocarbons (TPHs)

9.3.1 BTEX Compounds

LQM/CIEH Suitable 4 Use Levels – BTEX Compounds							
Determinand	Soil Organic Matter	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Benzene	1.0% SOM	0.087	0.38	0.017	27	72	90
	2.5% SOM	0.170	0.70	0.034	47	72	100
	6.0% SOM	0.370	1.40	0.075	90	73	110
Toluene	1.0% SOM	130	880	22	56000	56000	87000
	2.5% SOM	290	1900	51	110000	56000	95000
	6.0% SOM	660	3900	120	180000	56000	100000
Ethylbenzene	1.0% SOM	47	83	16	5700	24000	17000
	2.5% SOM	110	190	39	13000	24000	22000
	6.0% SOM	260	440	91	27000	25000	27000
o-Xylene	1.0% SOM	60	88	28	6600	41000	17000
	2.5% SOM	140	210	67	15000	42000	24000
	6.0% SOM	330	480	160	33000	43000	33000
m-Xylene	1.0% SOM	59	82	31	6200	41000	17000
	2.5% SOM	140	190	74	14000	42000	24000
	6.0% SOM	320	450	170	31000	43000	33000
p-Xylene	1.0% SOM	56	79	29	5900	41000	17000
	2.5% SOM	130	180	69	14000	42000	23000
	6.0% SOM	310	430	160	30000	43000	31000

SOM = Soil Organic Matter Content (%)

9.3.2 Total Petroleum Hydrocarbons – Aliphatic

LQM/CIEH Suitable 4 Use Levels For TPH							
Aliphatic		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
EC 5-6	1.0% SOM	42	42	730	3,200 (304) ^{sol}	570,000 (304) ^{sol}	95,000 (304) ^{sol}
	2.5% SOM	78	78	1,700	5,900 (558) ^{sol}	590,000	130,000 (558) ^{sol}
	6.0% SOM	160	160	3,900	12,000 (1150) ^{sol}	600,000 ^l	180,000 (1150) ^{sol}
EC >6-8	1.0% SOM	100	100	2,300	7,800 (144) ^{sol}	600,000	150,000 (144) ^{sol}
	2.5% SOM	230	230	5,600	17,000 (322) ^{sol}	610,000	220,000 (322) ^{sol}
	6.0% SOM	530	530	13,000	40,000 (736) ^{sol}	620,000	320,000 (736) ^{sol}
EC >8-10	1.0% SOM	27	27	320	2,000 (78) ^{sol}	13,000	14,000 (78) ^{sol}
	2.5% SOM	65	65	770	4,800 (118) ^{vap}	13,000	18,000 (118) ^{vap}
	6.0% SOM	150	150	1,700	11,000 (451) ^{vap}	13,000	21,000 (451) ^{vap}
EC >10-12	1.0% SOM	130 (48) ^{vap}	130 (48) ^{vap}	2,200	9,700 (48) ^{sol}	13,000	21,000 (48) ^{sol}
	2.5% SOM	330 (118) ^{vap}	330 (118) ^{vap}	4,400	23,000 (118) ^{vap}	13,000	23,000 (118) ^{vap}
	6.0% SOM	760 (283) ^{vap}	760 (283) ^{vap}	7,300	47,000 (283) ^{vap}	13,000	24,000 (283) ^{vap}
EC >12-16	1.0% SOM	1,100 (24) ^{sol}	1,100 (24) ^{sol}	11,000	59,000 (24) ^{sol}	13,000	25,000 (24) ^{sol}
	2.5% SOM	2,400 (59) ^{sol}	2,400 (59) ^{sol}	13,000	82,000 (59) ^{sol}	13,000	25,000 (59) ^{sol}
	6.0% SOM	4,300 (142) ^{sol}	4,400 (142) ^{sol}	13,000	90,000 (142) ^{sol}	13,000	26,000 (142) ^{sol}
EC >16-35	1.0% SOM	65,000 (8.48) ^{sol}	65,000 (8.48) ^{sol}	260,000	1,600,000	250,000	450,000
	2.5% SOM	92,000 (21) ^{sol}	92,000 (21) ^{sol}	270,000	1,700,000	250,000	480,000
	6.0% SOM	110,000	110,000	270,000	1,800,000	250,000	490,000
EC >35-44	1.0% SOM	65,000 (8.48) ^{sol}	65,000 (8.48) ^{sol}	260,000	1,600,000	250,000	450,000
	2.5% SOM	92,000 (21) ^{sol}	92,000 (21) ^{sol}	270,000	1,700,000	250,000	480,000
	6.0% SOM	110,000	110,000	270,000	1,800,000	250,000	490,000

SOM = Soil Organic Matter Content (%)

^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.

^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.

9.3.3 Total Petroleum Hydrocarbons – Aromatic

LQM/CIEH Suitable 4 Use Levels For TPH

Aromatic		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
EC 5-7 (Benzene)	1.0% SOM	70	370	13	26,000 (1220) ^{sol}	56,000	76,000 (1220) ^{sol}
	2.5% SOM	140	690	27	46,000 (2260) ^{sol}	56,000	84,000 (2260) ^{sol}
	6.0% SOM	300	1,400	57	86,000 (4710) ^{sol}	56,000	92,000 (4710) ^{sol}
EC >7-8 (Toluene)	1.0% SOM	130	860	22	56,000 (869) ^{vap}	56,000	87,000 (869) ^{sol}
	2.5% SOM	290	1,800	51	110,000 (1920) ^{sol}	56,000	95,000 (1920) ^{sol}
	6.0% SOM	660	3,900	120	180,000 (4360) ^{vap}	56,000	100,000 (4360) ^{vap}
EC >8-10	1.0% SOM	34	47	8.6	3,500 (613) ^{vap}	5,000	7,200 (613) ^{vap}
	2.5% SOM	83	110	21	8,100 (1500) ^{vap}	5,000	8,500 (1500) ^{vap}
	6.0% SOM	190	270	51	17,000 (3850) ^{vap}	5,000	9,300 (3580) ^{vap}
EC >10-12	1.0% SOM	74	250	13	16,000 (364) ^{sol}	5,000	9,200 (364) ^{sol}
	2.5% SOM	180	590	31	28,000 (899) ^{sol}	5,000	9,700 (889) ^{sol}
	6.0% SOM	380	1,200	74	34,000 (2150) ^{sol}	5,000	10,000
EC >12-16	1.0% SOM	140	1,800	23	36,000 (169) ^{sol}	5,100	10,000
	2.5% SOM	330	2,300 (419) ^{sol}	57	37,000	5,100	10,000
	6.0% SOM	660	2,500	130	38,000	5,000	10,000
EC >16-21	1.0% SOM	260	1,900	46	28,000	3,800	7,600
	2.5% SOM	540	1,900	110	28,000	3,800	7,700
	6.0% SOM	930	1,900	260	28,000	3,800	7,800
EC >21-35	1.0% SOM	1,100	1,900	370	28,000	3,800	7,800
	2.5% SOM	1,500	1,900	820	28,000	3,800	7,800
	6.0% SOM	1,700	1,900	1,600	28,000	3,800	7,900
EC >35-44	1.0% SOM	1,100	1,900	370	28,000	3,800	7,800
	2.5% SOM	1,500	1,900	820	28,000	3,800	7,800
	6.0% SOM	1,700	1,900	1,600	28,000	3,800	7,900
EC >44-70	1.0% SOM	1,600	1,900	1,200	28,000	3,800	7,800
	2.5% SOM	1,800	1,900	2,100	28,000	3,800	7,800
	6.0% SOM	1,900	1,900	3,000	28,000	3,800	7,900

SOM = Soil Organic Matter Content (%)

^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.

^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.

9.4 Polycyclic Aromatic Hydrocarbons (PAHs)

LQM/CIEH Suitable 4 Use Levels For Polycyclic Aromatic Hydrocarbons (PAHs)							
Determinands		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Acenaphthene	1.0% SOM	210	3,000 (57.0) ^{sol}	34	84,000(57.0) ^{sol}	15,000	29,000
	2.5% SOM	510	4,700(141) ^{sol}	85	97,000(141) ^{sol}	15,000	30,000
	6.0% SOM	1100	6,000(336) ^{sol}	200	100,000	15,000	30,000
Acenaphthylene	1.0% SOM	170	2,900(86.1) ^{sol}	28	83,000(86.1) ^{sol}	15,000	29,000
	2.5% SOM	420	4,600(212) ^{sol}	69	97,000(212) ^{sol}	15,000	30,000
	6.0% SOM	920	6,000(506) ^{sol}	160	100,000	15,000	30,000
Anthracene	1.0% SOM	2,400	31,000(1.17) ^{vap}	380	520,000	74,000	150,000
	2.5% SOM	5,400	35,000	950	540,000	74,000	150,000
	6.0% SOM	11,000	37,000	2,200	540,000	74,000	150,000
Benzo(a)anthracene	1.0% SOM	7.20	11	2.90	170	29	49
	2.5% SOM	11	14	6.50	170	29	56
	6.0% SOM	13	15	13	180	29	62
Benzo(a)pyrene	1.0% SOM	2.20	3.20	0.97	35	5.70	11
	2.5% SOM	2.70	3.20	2.00	35	5.70	12
	6.0% SOM	3.00	3.20	3.50	36	5.70	13
Benzo(b)fluoranthene	1.0% SOM	2.60	3.90	0.99	44	7.10	13
	2.5% SOM	3.30	4.00	2.10	44	7.20	15
	6.0% SOM	3.70	4.00	3.90	45	7.20	16
Benzo(ghi)perylene	1.0% SOM	320	360	290	3,900	640	1,400
	2.5% SOM	340	360	470	4,000	640	1,500
	6.0% SOM	350	360	640	4,000	640	1,600
Benzo(k)fluoranthene	1.0% SOM	77	110	37	1,200	190	370
	2.5% SOM	93	110	75	1,200	190	410
	6.0% SOM	100	110	130	1,200	190	440
Chrysene	1.0% SOM	15	30	4.10	350	57	93
	2.5% SOM	22	31	9.40	350	57	110
	6.0% SOM	27	32	19	350	57	120
Dibenzo(ah)anthracene	1.0% SOM	0.24	0.31	0.14	3.50	0.57	1.10
	2.5% SOM	0.28	0.32	0.27	3.50	0.57	1.30
	6.0% SOM	0.30	0.32	0.43	3.60	0.58	1.40

SOM = Soil Organic Matter Content (%)

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^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.

PAH table continued overleaf

PAH table continued from previous page

LQM/CIEH Sutable 4 Use Levels For Polycyclic Aromatic Hydrocarbons (PAHs)							
Determinands		RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Flouranthene	1.0% SOM	280	1,500	52	23,000	3,100	6,300
	2.5% SOM	560	1,600	130	23,000	3,100	6,300
	6.0% SOM	890	1,600	290	23,000	3,100	6,300
Flourene	1.0% SOM	170	2,800 (30.9) ^{sol}	27	63,000(30.9) ^{sol}	9,900	20,000
	2.5% SOM	400	3,800(76.5) ^{sol}	67	68,000	9,900	20,000
	6.0% SOM	860	4,500(183) ^{sol}	160	71,000	9,900	20,000
Indeno(123-cd)pyrene	1.0% SOM	27	45	9.50	500	82	150
	2.5% SOM	36	46	21	510	82	170
	6.0% SOM	41	46	39	510	82	180
Napthalene	1.0% SOM	2.30	2.6	4.10	190 (76.4) ^{sol}	4,900	1,200(76.4) ^{sol}
	2.5% SOM	5.60	5.6	10	460 (183) ^{sol}	4,900	1,900(183) ^{sol}
	6.0% SOM	13	13	24	1,100 (432) ^{sol}	4,900	3,000
Phenanthrene	1.0% SOM	95	1,300(183) ^{sol}	15	22,000	3,100	6,200
	2.5% SOM	220	1,500	38	22,000	3,100	6,200
	6.0% SOM	440	1,500	90	23,000	3,100	6,300
Pyrene	1.0% SOM	620	3,700	110	54,000	7,400	15,000
	2.5% SOM	1200	3,800	270	54,000	7,400	15,000
	6.0% SOM	2000	3,800	620	54,000	7,400	15,000
Coal Tar (Benzo(a)pyrene used as marker compound)	1.0% SOM	0.79	1.2	0.32	15	2.20	4.40
	2.5% SOM	0.98	1.2	0.67	15	2.20	4.70
	6.0% SOM	1.10	1.2	1.20	15	2.20	4.80

SOM = Soil Organic Matter Content (%)

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^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.

9.5 Volatile and Semi-volatile Organic Compounds

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds						
Determinands	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Chloroalkanes & alkenes						
1,2 Dichloroethane						
1.0% SOM	0.0071	0.0092	0.0046	0.67	29	21
2.5% SOM	0.011	0.013	0.0083	0.97	29	24
6.0% SOM	0.019	0.023	0.016	1.70	29	28
1,1,2,2 Tetrachloroethane						
1.0% SOM	1.60	3.90	0.41	270	1,400	1,800
2.5% SOM	3.40	8.00	0.89	550	1,400	2,100
6.0% SOM	7.50	17	2.00	1,100	1,400	2,300
1,1,1,2 Tetrachloroethane						
1.0% SOM	1.20	1.50	0.79	110	1,400	1,500
2.5% SOM	2.80	3.50	1.90	250	1,400	1,800
6.0% SOM	6.40	8.20	4.40	560	1,400	2,100
Tetrachloroethene						
1.0% SOM	0.18	0.18	0.65	19	1,400	810 ^{sol} (424)
2.5% SOM	0.39	0.40	1.50	42	1,400	1,100 ^{sol} (951)
6.0% SOM	0.90	0.92	3.60	95	1,400	1,500
1,1,1 Trichloroethane						
1.0% SOM	8.80	9.00	48	660	140,000	57,000 ^{vap} (1425)
2.5% SOM	18	18	110	1,300	140,000	76,000 ^{vap} (2915)
6.0% SOM	39	40	240	3,000	140,000	100,000 ^{vap} (6392)
Tetrachloromethene						
1.0% SOM	0.026	0.026	0.45	2.90	890	190
2.5% SOM	0.056	0.056	1.00	6.30	920	270
6.0% SOM	0.130	0.130	2.40	14	950	400
Trichloroethene						
1.0% SOM	0.016	0.017	0.041	1.20	120	70
2.5% SOM	0.034	0.036	0.091	2.60	120	91
6.0% SOM	0.075	0.080	0.210	5.70	120	120
Trichloromethane						
1.0% SOM	0.91	1.20	0.42	99	2,500	2,600
2.5% SOM	1.70	2.10	0.83	170	2,500	2,800
6.0% SOM	3.40	4.20	1.70	350	2,500	3,100
Vinyl Chloride						
1.0% SOM	0.00064	0.00077	0.00055	0.059	3.50	4.80
2.5% SOM	0.00087	0.00100	0.00100	0.077	3.50	5.00
6.0% SOM	0.00014	0.00150	0.00180	0.120	3.50	5.40

^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.

^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds						
Determinands	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Explosives						
2,4,6 Trinitrotoluene						
1.0% SOM	1.60	65	0.24	1,000	130	260
2.5% SOM	3.70	66	0.58	1,000	130	270
6.0% SOM	8.10	66	1.40	1,000	130	270
RDX (Hexogen/Cyclonite/1,3,5-trinitro-1,3,5-triazacyclohexane)						
1.0% SOM	120	13,000	17	210,000	26,000	49,000(18.7) ^{sol}
2.5% SOM	250	13,000	38	210,000	26,000	51,000
6.0% SOM	540	13,000	85	210,000	27,000	53,000
HMX (Octogen/1,3,5,7-tetrenitro-1,3,5,7-tetrazacyclo-octane)						
1.0% SOM	5.70	67,00	0.86	110,000	13,000	23,000(0.35) ^{vap}
2.5% SOM	13	67,00	1.90	110,000	13,000	23,000(0.39) ^{vap}
6.0% SOM	26	67,00	3.90	110,000	13,000	24,000(0.48) ^{vap}
Atrazine						
1.0% SOM	3.30	610	0.50	9,300	1,200	2,300
2.5% SOM	7.60	620	1.20	9,400	1,200	2,400
6.0% SOM	17.40	620	2.70	9,400	1,200	2,400
Pesticides						
Aldrin						
1.0% SOM	5.70	7.30	3.20	170	18	30
2.5% SOM	6.60	7.40	6.10	170	18	31
6.0% SOM	7.10	7.50	9.60	170	18	31
Dieldrin						
1.0% SOM	0.97	7.00	0.17	170	18	30
2.5% SOM	2.00	7.30	0.41	170	18	30
6.0% SOM	3.50	7.40	0.96	170	18	31
Dichlorvos						
1.0% SOM	0.032	6.40	0.0049	140	16	26
2.5% SOM	0.066	6.50	0.0100	140	16	26
6.0% SOM	0.140	6.60	0.0220	140	16	27
Alpha - Endosulfan						
1.0% SOM	7.40	160(0.003) ^{vap}	1.20	5,600(0.003) ^{vap}	1,200	2,400
2.5% SOM	18	280(0.007) ^{vap}	2.90	7,400(0.007) ^{vap}	1,200	2,400
6.0% SOM	41	410(0.016) ^{vap}	6.80	8,400(0.016) ^{vap}	1,200	2,400

^{vap} – GAC presented exceeds the vapour saturation limit, which is presented in brackets.

^{sol} – GAC presented exceeds the soil saturation limit, which is presented in brackets.

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds						
Determinands	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Pesticides						
Beta - Endosulfan						
1.0% SOM	7.00	190(0.00007) ^{vap}	1.10	6,300(0.00007) ^{vap}	1,200	2,400
2.5% SOM	17	320(0.0002) ^{vap}	2.70	7,800(0.0002) ^{vap}	1,200	2,400
6.0% SOM	39	440(0.0004) ^{vap}	6.40	8700	1,200	2,500
Alpha - Hexachlorocyclohexanes						
1.0% SOM	0.23	6.90	0.035	170	24	47
2.5% SOM	0.55	9.20	0.087	180	24	48
6.0% SOM	1.20	11	0.210	180	24	48
Beta - Hexachlorocyclohexanes						
1.0% SOM	0.085	3.70	0.013	65	8.10	15
2.5% SOM	0.200	3.80	0.032	65	8.10	15
6.0% SOM	0.460	3.80	0.077	65	8.10	16
Gamma - Hexachlorocyclohexanes						
1.0% SOM	0.06	2.90	0.0092	67	8.2	14
2.5% SOM	0.14	3.30	0.0230	69	8.2	15
6.0% SOM	0.33	3.50	0.0540	70	8.2	15
Chlorobenzenes						
Chlorobenzene						
1.0% SOM	0.46	0.46	5.90	56	11,000	1,300(675) ^{sol}
2.5% SOM	1.00	1.00	14	130	13,000	2,000(1520) ^{sol}
6.0% SOM	2.40	2.40	32	290	14,000	2,900
1,2-Dichlorobenzene						
1.0% SOM	23	24	94	2,000 (571) ^{sol}	90,000	24,000(571) ^{sol}
2.5% SOM	55	57	230	4,800 (1370) ^{sol}	95,000	36,000(1370) ^{sol}
6.0% SOM	130	130	540	11,000 (3240) ^{sol}	98,000	51,000(3240) ^{sol}
1,3-Dichlorobenzene						
1.0% SOM	0.40	0.44	0.25	30	300	390
2.5% SOM	1.00	1.10	0.60	73	300	440
6.0% SOM	2.30	2.50	1.50	170	300	470
1,4-Dichlorobenzene						
1.0% SOM	61	61	15	4,400 (224) ^{vap}	17,000 ^g	36,000 (224) ^{vap}
2.5% SOM	150	150	37	10,000 (540) ^{vap}	17,000 ^g	36,000 (540) ^{vap}
6.0% SOM	350	350	88 ^g	25,000 (1280) ^{vap}	17,000 ^g	36,000 (1280) ^{vap}
1,2,3,-Trichlorobenzene						
1.0% SOM	1.50	1.50	4.70	102	1,800	770(134) ^{vap}
2.5% SOM	3.60	3.70	12	250	1,800	1,100(330) ^{vap}
6.0% SOM	8.60	8.80	28	590	1,800	1,600(789) ^{vap}

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds						
Determinands	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Chlorobenzenes						
1,2,3,- Trichlorobenzene						
1.0% SOM	1.50	1.50	4.70	102	1,800	770(134) ^{vap}
2.5% SOM	3.60	3.70	12	250	1,800	1,100(330) ^{vap}
6.0% SOM	8.60	8.80	28	590	1,800	1,600(789) ^{vap}
1,2,4,- Trichlorobenzene						
1.0% SOM	2.60	2.60	55	220	15,000	1,700(318) ^{vap}
2.5% SOM	6.40	6.40	140	530	17,000	2,600(786) ^{vap}
6.0% SOM	15	15	320	1,300	19,000	4,000(1880) ^{vap}
1,3,5,- Trichlorobenzene						
1.0% SOM	0.33	0.33	4.70	23	1,700	380(36.7) ^{vap}
2.5% SOM	0.81	0.81	12	55	1,700	590(90.8) ^{vap}
6.0% SOM	1.90	1.90	140	130	1,800	860(217) ^{vap}
1,2,3,4,- Tetrachlorobenzene						
1.0% SOM	15	24	4.40	1,700(122) ^{vap}	830	1,500(122) ^{vap}
2.5% SOM	36	56	11	3,080(304) ^{vap}	830	1,600
6.0% SOM	78	120	26	4,400(728) ^{vap}	830	1,600
1,2,3,5,- Tetrachlorobenzene						
1.0% SOM	0.66	0.75	0.38	49(39.4) ^{vap}	78	110(39) ^{vap}
2.5% SOM	1.60	1.90	0.90	120(98.1) ^{vap}	79	120
6.0% SOM	3.70	4.30	2.20	240(235) ^{vap}	79	130
1,2,4, 5,- Tetrachlorobenzene						
1.0% SOM	0.33	0.73	0.06	42(19.7) ^{sol}	13	25
2.5% SOM	0.77	1.70	0.16	72(49.1) ^{sol}	13	26
6.0% SOM	1.60	3.50	0.37	96	13	26
Pentachlorobenzene						
1.0% SOM	5.80	19	1.20	640(43.0) ^{sol}	100	190
2.5% SOM	12	30	3.10	770(107) ^{sol}	100	190
6.0% SOM	22	38	7.00	830	100	190
Hexachlorobenzene						
1.0% SOM	1.80(0.20) ^{vap}	4.10 (0.20) ^{vap}	0.47	110(0.20) ^{vap}	16	30
2.5% SOM	3.30(0.50) ^{vap}	5.70 (0.50) ^{vap}	1.10	120	16	30
6.0% SOM	4.90	6.70 (1.2) ^{vap}	2.50	120	16	30

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

LQM CIEH General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds						
Determinands	RwHP (mg/kg)	RwoHP (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)	POSresi (mg/kg)	POSpark (mg/kg)
Phenols & Chlorophenols						
Phenols						
1.0% SOM	280	750	66	760 ^{dir} (31,000)	760 ^{dir} (11,000)	760 ^{dir} (8,600)
2.5% SOM	550	1,300	140	1,500 ^{dir} (35,000)	1,500 ^{dir} (11,000)	1,500 ^{dir} (9,700)
6.0% SOM	1100	2,300	280	3,200 ^{dir} (37,000)	3,200 ^{dir} (11,000)	3,200 ^{dir} (11,000)
Chlorophenols (4 Congeners)						
1.0% SOM	0.87	94	0.13	3,500	620	1,100
2.5% SOM	2.00	150	0.30	4,000	620	1,100
6.0% SOM	4.50	210	0.70	4,300	620	1,100
Pentachlorophenols						
1.0% SOM	0.22	27(16.4) ^{vap}	0.03	400	60	110
2.5% SOM	0.52	29	0.08	400	60	120
6.0% SOM	1.20	31	0.19	400	60	120
Others						
Carbon Disulphide						
1.0% SOM	0.14	0.14	4.80	11	11,000	1,300
2.5% SOM	0.29	0.29	10	22	11,000	1,900
6.0% SOM	0.62	0.62	23	47	12,000	2,700
Hexachloro-1,3-Butadiene						
1.0% SOM	0.29	0.32	0.25	31	25	48
2.5% SOM	0.70	0.78	0.61	68	25	50
6.0% SOM	1.60	1.80	1.40	120	25	51

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Determinands	Residential (mg/kg)	Residential without plant uptake (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)
1,1,2 Trichloroethane				
1.0% SOM	0.60	0.88	0.28	94
2.5% SOM	1.20	1.8	0.61	190
6.0% SOM	2.70	3.9	1.40	400
1,1-Dichloroethane				
1.0% SOM	2.40	2.50	9.20	280
2.5% SOM	3.90	4.10	17	450
6.0% SOM	7.40	7.70	35	850
1,1-Dichloroethene				
1.0% SOM	0.23	0.23	2.80	26
2.5% SOM	0.40	0.41	5.60	46
6.0% SOM	0.82	0.82	12	92
1,2,4-Trimethylbenzene				
1.0% SOM	0.35	0.41	0.38	42
2.5% SOM	0.85	0.99	0.93	99
6.0% SOM	2.00	2.30	2.20	220
1,2-Dichloropropane				
1.0% SOM	0.024	0.024	0.62	3.3
2.5% SOM	0.042	0.042	1.20	5.9
6.0% SOM	0.084	0.085	2.60	12
2,4-Dimethylphenol				
1.0% SOM	19	210	3.10	16000*
2.5% SOM	43	410	7.20	24000*
6.0% SOM	97	730	17	30000*
2,4-Dinitrotoluene				
1.0% SOM	1.50	170*	0.22	3700*
2.5% SOM	3.20	170	0.49	3700*
6.0% SOM	7.20	170	1.10	3800*
2,6-Dinitrotoluene				
1.0% SOM	0.78	78	0.12	1900*
2.5% SOM	1.70	84	0.27	1900*
6.0% SOM	3.90	87	0.61	1900*
2-Chloronapthalene				
1.0% SOM	3.70	3.80	40	390*
2.5% SOM	9.20	9.30	98	960*
6.0% SOM	22	22	230	2200*

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

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

*Soil concentration above soil saturation limit

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Determinands	Residential (mg/kg)	Residential without plant uptake (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)
Dichloromethane				
1.0% SOM	0.58	2.10	0.10	270
2.5% SOM	0.98	2.80	0.19	360
6.0% SOM	1.70	4.50	0.34	560
Diethyl Phthalate				
1.0% SOM	120*	1800*	19*	150000*
2.5% SOM	260*	3500*	41*	220000*
6.0% SOM	570*	6300*	94*	290000*
Di-n-butyl phthalate				
1.0% SOM	13*	450*	2.00	15000*
2.5% SOM	31*	450*	5.00	15000*
6.0% SOM	67*	450*	12	15000*
Di-n-octyl phthalate				
1.0% SOM	2300*	3400*	940*	89000*
2.5% SOM	2800*	3400*	2100*	89000*
6.0% SOM	3100*	3400*	3900*	89000*
Hexachloroethane				
1.0% SOM	0.20	0.22	0.27	22*
2.5% SOM	0.48	0.54	0.67	53*
6.0% SOM	1.10	1.30	1.60	120*
Isopropylbenzene				
1.0% SOM	11	12	32	1400*
2.5% SOM	27	28	79	3300*
6.0% SOM	64	67	190	7700*
Methyl tert-butyl ether				
1.0% SOM	49	73	23	7900
2.5% SOM	84	120	44	13000
6.0% SOM	160	220	90	24000
Propylbenzene				
1.0% SOM	34	40	34	4100*
2.5% SOM	82	97	83	9700*
6.0% SOM	190	230	200	21000*
Styrene				
1.0% SOM	8.10	35	1.60	3300*
2.5% SOM	19	78	3.70	6500*
6.0% SOM	43	170	8.70	11000*

*Soil concentration above soil saturation limit

VOC and SVOC table continued overleaf

VOC and SVOC table continued from previous page

CL:AIRE General Assessment Criteria: Volatile and Semi-Volatile Organic Compounds				
Determinands	Residential (mg/kg)	Residential without plant uptake (mg/kg)	Allotment (mg/kg)	Commercial (mg/kg)
Total Cresols (2-, 3-, and 4-methylphenol)				
1.0% SOM	80	3700	12	160000
2.5% SOM	180	5400	27	180000*
6.0% SOM	400	6900	63	180000*
Trans 1,2 Dichloroethene				
1.0% SOM	0.19	0.19	0.93	22
2.5% SOM	0.34	0.35	1.90	40
6.0% SOM	0.70	0.71	0.24	81
Tributyl tin oxide				
1.0% SOM	0.25	1.40	0.042	130*
2.5% SOM	0.59	3.10	0.100	180*
6.0% SOM	1.30	5.70	0.240	200*

*Soil concentration above soil saturation limit

APPENDIX F
Hazard Waste Assessment



Project:

Land to the rear of 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR

Client:

Balwinder Gill c/o Gill Builders Limited

Date:

January 2021

Site Location Plan

Ref:

GWPR3961

Figure 1





Project:
Land to the rear of 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR

Client:
Balwinder Gill c/o Gill Builders Limited

Date:
January 2021

Site Development Area

Ref:
GWPR3961

Figure 2





Project:
Land to the rear of 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR

Client:
Balwinder Gill c/o Gill Builders Limited

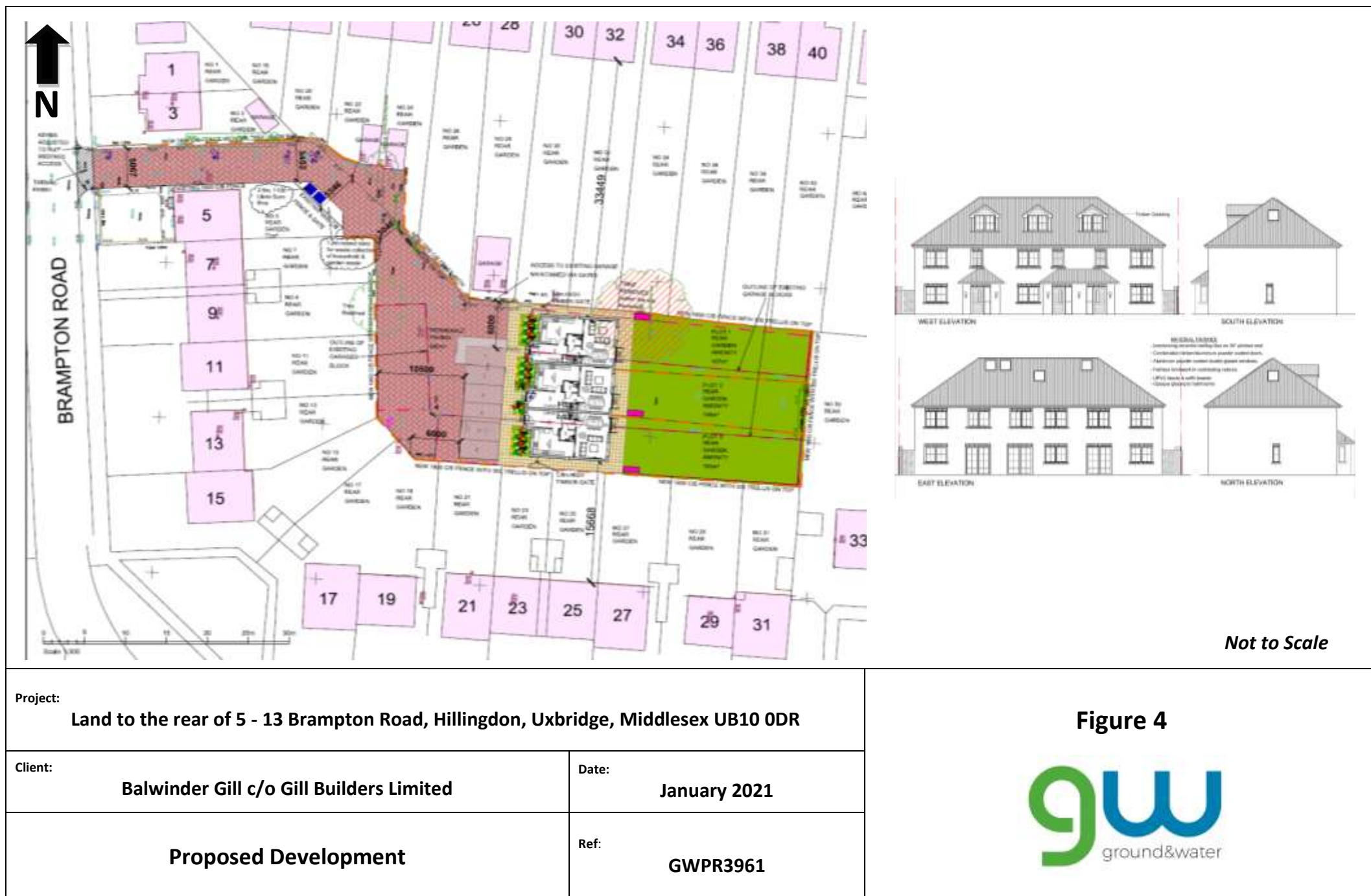
Date:
January 2021

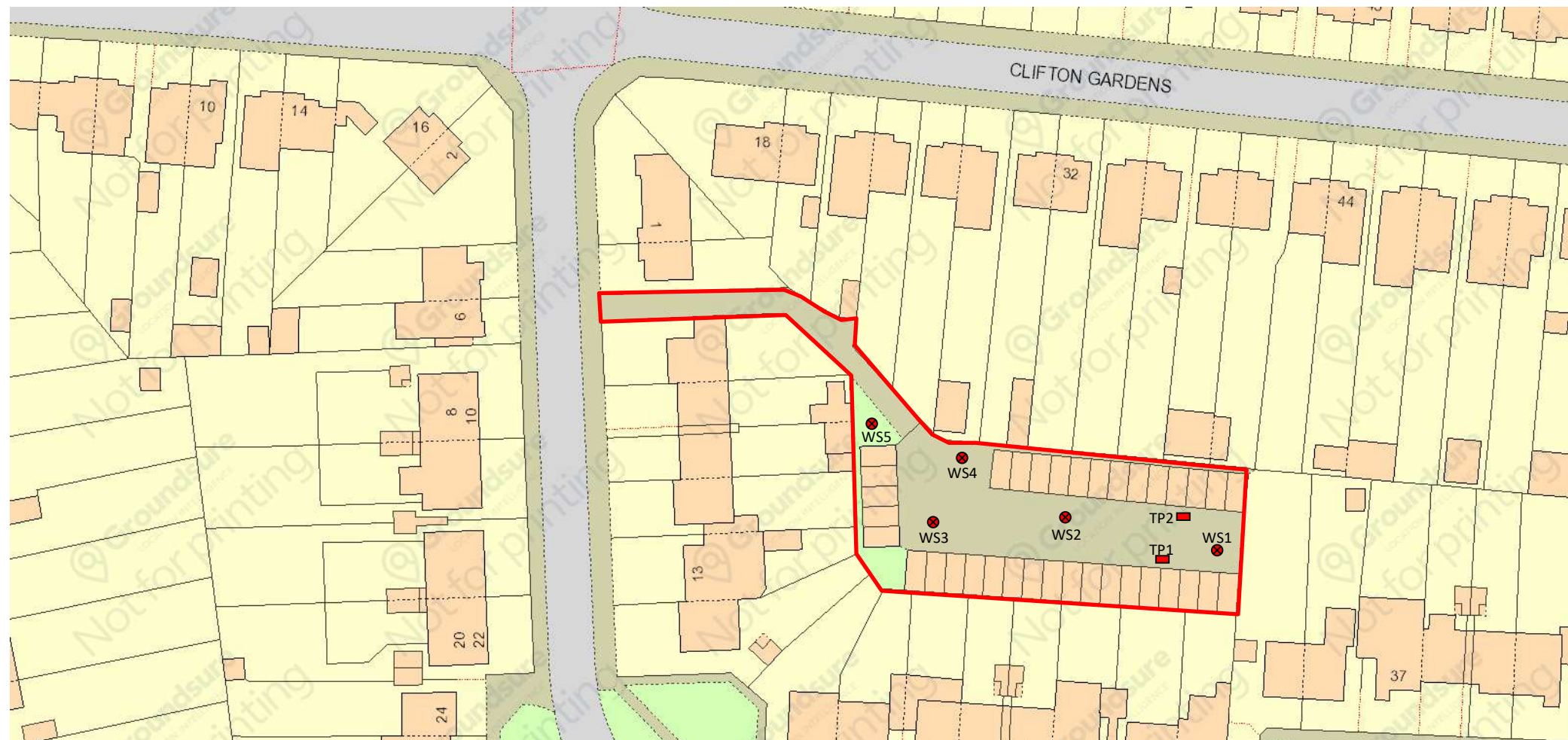
Site Aerial View

Ref:
GWPR3961

Figure 3







Project:
Land to the rear of 5 - 13 Brampton Road, Hillingdon, Uxbridge, Middlesex UB10 0DR

Client:
Balwinder Gill c/o Gill Builders Limited

Date:
January 2021

Trial Hole Location Plan

Ref:
GWPR3961

Figure 5

