

5.0 GROUND MODEL

5.1 Made Ground

Surfacing

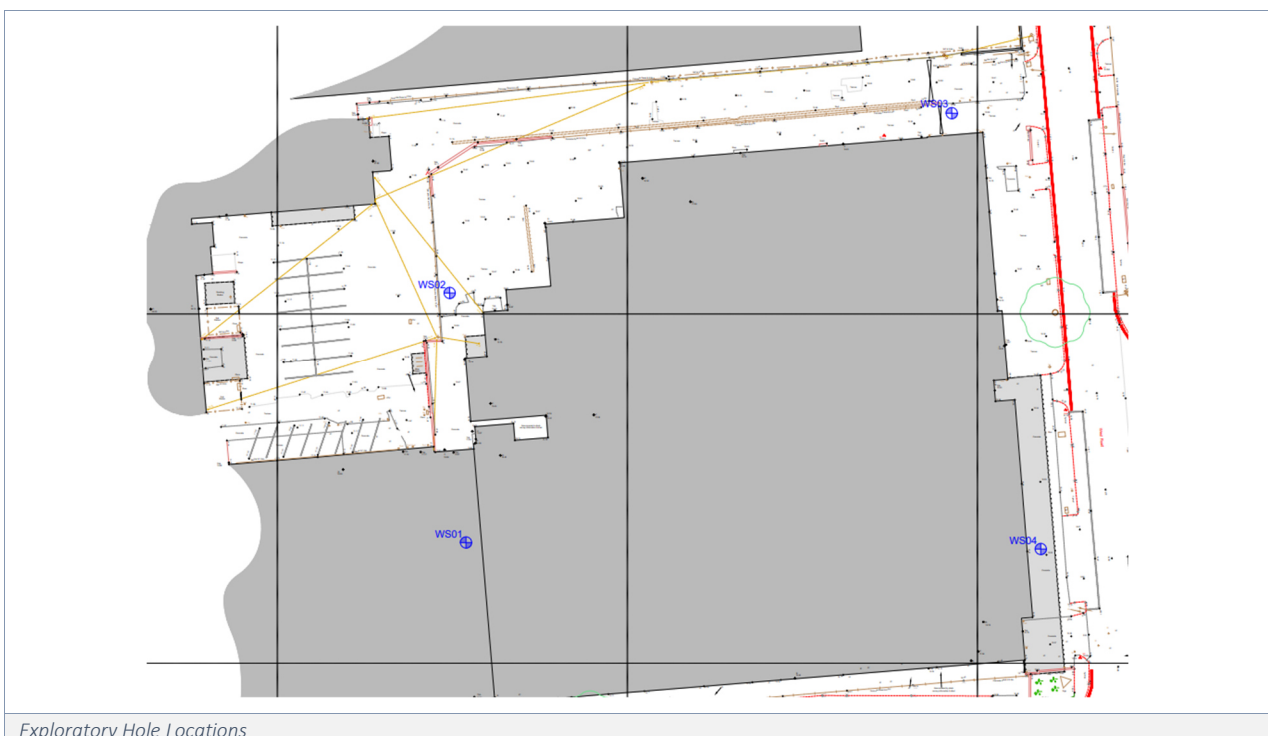
The majority of site was surfaced by concrete to depths of between 0.2m and 0.42m begl. In WS02 and WS03, tarmac surfacing was present above the concrete to a depth of 0.05m begl. No areas of soft landscaping was observed on the site.

In WS01, two concrete slabs were encountered from the surface to 0.42m begl, the thickness of the slabs was 0.2m and 0.22m. No material was present between the slabs which were lain directly on top of each other. The condition of the second, deeper, slab had deteriorated significantly and was destroyed when cored.

Made Ground

Made Ground was encountered beneath the surfacing population to depths of between 0.8m and 2.0m begl. In general, Made Ground was encountered at depths of less than 1.0m begl, with the exception of WS01 where the deepest Made Ground was encountered to a depth of 2.0m begl in the south west. Two main Made Ground populations were encountered during the investigation and are described below:

1. *Grey, brown sandy angular to subangular fine to coarse GRAVEL/gravelly SAND of brick, concrete and occasional tarmac in WS01, WS02 and WS04 from between 0.2m and 0.42m begl to depths of between 0.5m and 1.0m begl. A moderate cobble content of brick and concrete was recorded in this population locally to WS01. This population is indicated to be subbase.*
2. *Firm to stiff dark brown and black sandy gravelly CLAY with minor constituents of brick, concrete and coal in WS01, WS02, WS03 from depths of between 0.27m and 1.0m begl to between 0.8m and 2.0m begl.*



Red angular to subangular fine to coarse gravel of brick with cobbles of brick was encountered locally to WS03 at depths of between 0.2m and 0.27m begl. This is likely associated with an old wall or road, not historic footings.

5.2 Natural Ground

The natural strata encountered generally confirmed the published geological records which are recorded to be Kempton Park Gravel Member and Enfield Silt Member with a mixture of granular and cohesive soils being encountered. The two main natural stratification encountered during the investigation are described below:

1. *Medium dense to very dense brown sandy angular to subangular fine to coarse GRAVEL of flint in WS01 to WS04 from between 1.0m and 2.6m begl to depths of between 1.5m and 4.0m begl. (Kempton Park Member)*
2. *Firm brown slightly sandy occasionally gravelly CLAY in WS01, WS03 and WS04 from depths of between 2.0m and 4.0m begl to between 4.0m and 5.0m begl. (Enfield Silt Member)*

5.3 Bedrock

Bedrock was not encountered during the Ground Investigation.

5.4 Groundwater

Groundwater seepages were encountered in all exploratory holes between 1.5m and 2.4m begl:

Exploratory Hole Location	Depth of Groundwater (m)	Strike/Seepage	Strata
WS01	2.00	Seepage	Gravel
WS02	1.50	Seepage	Gravel
WS03	2.40	Seepage	Gravel
WS04	2.00	Seepage	Gravel

5.5 Watching Brief

A watching brief was in place for the duration of the Ground Investigation in order to identify any visual or olfactory evidence of contamination.

Black staining and a strong hydrocarbon odour were encountered in WS01 between the depths of 2.0m and 4.0m begl in the natural Gravel deposits. A sheen was also recorded on the groundwater at this location which was recorded at 2.0m begl. A PID reading of 52.5ppm was recorded in WS01 at 2.0m begl, the PID readings reduced with depth to 8ppm at 4.0m begl. All PID readings are presented on the exploratory hole logs attached.

A moderate hydrocarbon odour was recorded in WS02 between 1.0m and 1.8m begl in the natural Gravel deposits. A PID of 35ppm was also recorded at this location. No staining was present in this borehole and a sheen was not observed on the groundwater here.

A faint hydrocarbon odour was recorded in WS03 was recorded between 2.5m and 3.5m begl in the natural Gravel deposits with low PID values of between 2ppm and 4ppm. No staining or sheen was present in this borehole.



No other visual or olfactory contamination was encountered during the investigation, no impactation was noted in WS04 in the south east.

6.0 GROUND ENGINEERING

6.1 Geotechnical Testing Results

Comparison of water content and the value of 0.4 times the Liquid Limit in accordance with BRE Digest 412 'Desiccation in Clay Soils' suggests significant desiccation has taken place when 0.4 times the Liquid Limit is greater than the actual water measured water content. This is a rudimentary method but also a good guide.

Results of the plasticity testing and the volume change potential of the Clay is summarised in the table below:

Reference	Depth	Modified PI	Volume Change Potential	Desiccated
WS01	4.00	42.00	High	Yes
WS03	1.00	23.00	Medium	Yes
WS03	2.00	28.00	Medium	Yes
WS04	1.00	16.00	Low	Yes

6.2 Assessment Background

The ground engineering investigation has been undertaken to formulate an accurate ground model in order to undertake preliminary foundation design. The ground model has been constructed with a moderate level of confidence, the ground model has evolved from the information obtained by the PRA.

Background

The proposed development is for the demolition of the existing wholesale unit and construction of an industrial unit with associated infrastructure. The site is currently utilised by a wholesale distribution warehouse comprised of several adjoining buildings which have been built at separate points throughout the sites history. A car park is present in the north west and east of site and an access road is present along the north of the site.

Ground Conditions

Made Ground was encountered in all exploratory hole locations generally to a depth of less than 1.0m begl but was located to a maximum depth of 2.0m begl in WS01. The Made Ground comprised dark brown black slightly clayey gravelly Sand and sandy gravelly Clay with minor constituents of brick, concrete and coal. Superficial deposits comprising brown sandy angular to subangular fine to coarse Gravel of flint and firm brown slightly sandy occasionally gravelly Clay was encountered in all exploratory hole locations from minimum depths of between 0.8m and 2.0m begl to a maximum depth of 5.0m begl. The cohesive deposits were mostly present above the gravel except for WS01 where clay was below. Bedrock was not encountered during the Ground Investigation.

Groundwater seepages were encountered at depths of between 1.5m and 2.4m begl in the natural granular Gravel deposits.

Olfactory evidence of hydrocarbon contamination was encountered in WS01 to WS03 in the natural Gravel deposits between 1.0m and 4.0m begl, a sheen was also observed on the groundwater in WS01.

Limitations

The main limitation of the Ground Investigation is the limited coverage available due to the warehouse building. The warehouse building occupies the majority of the site area and remained operational at the time of the Ground Investigation. It is recommended that further investigation is carried out post demolition to confirm the ground conditions and get better coverage across the site and undertake deeper boreholes.

A watching brief should also be in place for the demolition and enabling works to confirm that ground conditions remain the same as encountered during the Ground Investigation.

Evidence of hydrocarbon contamination was identified during the Ground Investigation in the form of black staining and a strong hydrocarbon odour in WS01 and faint to moderate hydrocarbon odour in WS02 and WS03 within the natural gravel deposits. As a minimum, any free phase product should be remediated and removed offsite to a suitably licensed waste disposal facility.

Loose Gravel was encountered in WS01 at 2.0m begl and soft Clay was encountered in WS03 at 2.0m begl and WS04 at 1.2m begl. Loose and soft deposits are not considered to be a suitable bearing stratum. The loose granular deposits in WS01 are likely associated with the groundwater present at this depth and not representative of this stratum.

The existing buildings are to be demolished prior to the development. All below ground substructure, including relic foundations, associated with the existing warehouse will require grubbing up prior to development. It is recommended that the material is crushed to 6F2 classification for reuse or export from site. Supplementary investigation is required post demolition to obtain a better coverage and greater depth.

An asbestos demolition survey will also be required prior to demolition if not already undertaken and appropriate industry practice including stripping of any Asbestos Containing Materials (ACMs) undertaken.

Along the eastern and southern boundary of the site, the site lies within Flood Zone 2, which has a medium probability of flooding from rivers and the sea. A Flood Risk Assessment is recommended for the Site.

6.3 Geotechnical Parameters

The geotechnical test results have been evaluated to derive geotechnical parameters for the soils underlying the site. A 'depth to SPT N value' graph is presented on GRO-25311-P03 in Appendix 1 to provide a generalised ground model for the site.

Characterisation of the geotechnical parameters above has been undertaken to select a characteristic value, which is a cautious estimate of the value affecting the occurrence of the limit state. The characteristic values have been calculated based on the correlation with SPT values and using empirical rules. The characteristic values for the Ultimate Limit State (ULS) conditions selected are presented in the table below:

Stratum	Parameter	Selected Characteristic Value
<i>Firm sandy gravelly Clay</i>	<i>Undrained Shear Strength (C_u)</i>	<i>55kPa</i>
<i>Medium dense granular deposits</i>	<i>Drained angle of friction (ϕ')</i>	<i>32°</i>
<i>Very dense granular deposits</i>	<i>Drained angle of friction (ϕ')</i>	<i>35°</i>

6.4 Preliminary Foundation Design

The following foundation recommendations are based on existing site levels.

The proposed development is for the demolition of existing industrial buildings and construction of new industrial warehouse building. High loads are anticipated based on the type of proposed development, it is understood that preliminary structural design proposes pad foundations with a breadth of up to 5.5m.

The most suitable foundations for the proposed development are considered to be pad foundations for the steel structure and strip/trench foundations for the walls constructed in the medium dense to very dense Gravel. Foundations should be deepened to between 1.0m and 2.6m bgl through Made Ground, loose Gravel and soft Clay. Based on the high anticipated loadings, the cohesive deposits are not considered to be a suitable bearing stratum. Foundations should extend a minimum of 150mm into the proposed bearing stratum.

Preliminary foundation design has been undertaken by calculation, a safe Allowable Bearing Pressure (ABP) of 200kN/m² is provided for ultimate limit state design based on a pad foundation constructed in the medium granular deposits. The safe ABP will vary depending on the dimensions of the pad.

The depth of investigation is not considered sufficient for the large dimension pads and deeper investigation is required to confirm the design meets both ULS and SLS conditions.

Explicit settlement calculations estimate the settlement will be less than 25mm and Serviceability Limit State (SLS) conditions will be satisfied. When the foundation layout is available, the angle of distortion should be assessed to confirm it is within the criteria of 1/150 for structural damage and 1/500 for cracking walls and partitions. As discussed above, deeper investigation is required to confirm SLS conditions are satisfied.

Groundwater has been encountered beneath the site in the granular deposits at depths of between 1.4m and 2.5m bgl. Foundations are to be constructed in the Gravel deposits and groundwater will be encountered. Dewatering during foundation excavations will likely be required as discussed in *Section 6.6*.

Evidence of collapse has been recorded in the natural granular deposits, shoring may be required during excavations and should be included in the method statements.

The groundwater recorded in WS01 is indicated to contain an oily sheen during the investigation. Any evidence of free phase contamination should be removed from excavations during the enabling works in accordance with an approved remediation specification.

Supplementary investigation is required post demolition to obtain a better coverage of site and inform the foundation design.

Vibro Stone Columns (VSCs) and Controlled Modulus Columns (CMCs)

A specialist vibro contractor has been consulted and concluded that the low SPT values recorded preclude the use of VSCs as there would be a significant risk of bulging in the softer layers. The contractor has confirmed that alternatively, Controlled Modulus Columns (CMCs) will be suitable for the proposed development.

A CMC foundation solution will enable the construction of conventional shallow foundations with footings designed for an SLS bearing pressure of 200kPa and a ground-bearing slab.

The CMC solution would allow for a thinner ground bearing slab or between 150-200mm with lighter reinforcement.

Construction Recommendations

The recommendations in this appraisal are preliminary and the detailed design should be developed in advance and during the construction phase. If the ground conditions or groundwater regime encountered during the construction phase differ significantly to the conditions encountered during the Ground Investigation, work should cease and Groundtech Consulting contacted for further advice.

During the construction phase, supervision by a suitably qualified geotechnical engineer should be on a continuous basis to check the design assumptions are correct and construction conforms to design in accordance with EC7. Supervision should include inspections, Control Ground Investigations and monitoring by a suitably qualified geotechnical engineer.

6.5 Building Near Trees

If foundation excavations encounter cohesive strata in the vicinity of existing, proposed or recently removed trees, foundations should be adjusted in full accordance with NHBC Standards Chapter 4.2. Sparse semi-mature tree is present offsite near the eastern and southern boundaries.

All foundations should be deepened below roots of greater than 5mm diameter during excavations for footings. The clay is of a medium volume change potential.

A survey of all trees and hedges on the site and within 30m of the site boundary should be undertaken to identify tree species, locations and heights. This information will be required in order to assess the effects of trees on the cohesive strata and inform a foundation schedule.

Where foundation depths due to trees already present or recently removed exceeds 1.5m there is a possibility for heave to occur on removal of the tree. NHBC Guidance states that heave precautions are required for medium volume change potential Clay in the form of a 25mm void against the side of foundations and ground beams.

6.6 Floor Slabs

A ground bearing floor slab is likely to be adopted for the site to conform with the proposed commercial units usage. Material beneath the slab should be reengineered to an agreed specification and compliance testing undertaken to confirm the performance of the platform.

Suspended floor slabs are not required for CMCs and ground bearing floor slabs can be utilised where CMCs are adopted apart from within the influence of trees.

The clay beneath the site is of medium volume change potential, NHBC guidance states that suspended in-situ concrete ground floors with a minimum void of 100mm should be utilised or a void of 250mm is recommended beneath suspended precast concrete should be utilised where heave precautions are required.

6.7 Construction

Instability of the Made Ground is a possibility and should be considered in the groundworks method statements. Collapse was recorded in the natural granular deposits in WS03 and WS04 between 2.5m and 4.0m bgl therefore is likely to be encountered during excavations on site.

Tracked high specification plant is recommended to maintain the build programme. Breaking equipment may also be required locally to penetrate the dense natural granular deposits encountered in WS02 at 1.8m bgl where an SPT refusal was recorded. The existing building is also proposed to be demolished and breaking equipment will be required to break up any below ground substructures during the demolition.

Groundwater seepages were encountered in all exploratory hole locations between 1.5m and 2.4m bgl in the natural granular deposits. It is anticipated that groundwater will be encountered during foundation excavations and dewatering will be required.

6.8 Concrete Classification

Made Ground

Water soluble sulphate testing was undertaken on seven samples of the Made Ground. The range of soluble sulphate (SO_4) recorded is 18.5mg/l to 356.1mg/l. Associated pH values ranged between 7.36 and 9.15 indicating slightly alkaline conditions.

For a dataset containing five to nine results, the mean of the highest two soluble sulphate values are taken as the characteristic value along with the mean of the lowest two pH results. For the Made Ground the characteristic soluble sulphate value is 235.6mg/l and associated pH value is 7.39.

Natural Strata

Water soluble sulphate testing was undertaken on four samples of the natural strata. The range of soluble sulphate (SO_4) recorded is 9.5mg/l to 173.4mg/l. Associated pH values ranged between 7.8 and 10.39 indicating slightly alkaline conditions.

For a dataset containing less than five results, the highest soluble sulphate results is taken as the characteristic value along with the lowest of the pH results. For the natural strata the characteristic soluble sulphate value is 173.4mg/l and associated pH value is 7.8.

Granular deposits was encountered during the Ground Investigation and the groundwater is considered to be mobile.

The results of laboratory pH and sulphate content indicate that ACEC Class AC-1 and sulphate class DS-1 conditions prevail in accordance with BRE Special Digest 1 "Concrete in aggressive ground" 2005. The specific concrete mixes (the Design Concrete Class) to be used on site will be determined by the site specific concrete requirements in terms of the durability and structural performance. These are assessed in terms of the Structural Performance Level (SPL) and any need for Additional Protective Measures (APM) detailed in Part D of BRE Special Digest 1 with further guidance in Pt E and F.

Additional testing is to be undertaken during the supplementary investigation to confirm the recommendations.

6.9 Highway Design

CBR values of 2% to 3% are likely to be achieved in undisturbed natural cohesive soils and CBR values of greater than 5% in granular soils for pavement design purposes, unless proven otherwise by in-situ testing at sub-base level by a specialist geotechnical engineer. As a minimum the subgrade should be proof rolled prior to construction. Some reengineering of the subgrade is required prior to highway construction to achieve the required design CBR value.

Untreated Made Ground should be assumed to have a CBR value of <2.5%, unless proven otherwise. Highways Agency document HD25 'Interim Advice Note 73/06 Revision 1' (2009) states that where a subgrade has a CBR value lower than 2.5%, it is considered unsuitable support for a pavement foundation since it would tend to deform under construction traffic, and must be improved.



The soils are considered to frost susceptible due to the fines content, highway construction should be a minimum thickness of 450mm to mitigate against the risk.

6.10 Sustainable Urban Drainage System (SuDS)

The use of SuDS drainage is not considered to be suitable for the site due to the shallow groundwater encountered in the boreholes which would not provide the required 1.0m freeboard. The presence of cohesive impermeable deposits across the site also poses poor infiltration rates.

Shallow drainage may be a possibility, it is recommended that soil percolation testing is undertaken to confirm.

Contaminated material has also been recorded beneath the site which limits the potential of SuDS drainage system.

7.0 LAND QUALITY

7.1 Geo-Environmental Testing Results - Soils

Samples of Made Ground and natural strata have been tested for a range of relevant Contaminants of Concern. In accordance with LCRM, a Generic Quantitative Risk Assessment (GQRA) has been undertaken to determine the significance of the concentrations as derived through Geo-Environmental testing.

The GQRA process comprises the comparison of the actual concentrations measured on site with Generic Assessment Criteria (GACs) for the protection of human health.

The GACs used for the assessment of soil concentrations have been derived using the CLEA model. The GACs used are listed below:

- *Soil Guideline Values (SGVs) which demonstrate minimal risk*
- *LQM/CIEH S4ULs which use the same toxicological data as the SGVs but different exposure criteria*
- *C4SLs which demonstrate low risk*

In deriving the GACs for use on Brownfield sites we have assumed a 1% Soil Organic Matter, unless the results indicate otherwise.

The proposed end-use for the site is a commercial development industrial land use will associated hardstanding. We have therefore undertaken the GQRA on the basis that the proposed development site falls under the Commercial (1%) land-use scenario as defined in SR3 (EA, 2009b).

The strata or sources of contamination targeted by the laboratory testing scheduled is summarised in the table below:

Strata	Number of Samples Tested	Locations
<i>Cohesive Made Ground</i>	4	WS01, WS02, WS03, WS04
<i>Natural Clay</i>	1	WS03
<i>Natural Sand/Gravel</i>	2	WS01 and WS02
<i>Olfactory evidence of contamination</i>	3	WS01, WS02 and WS03

A summary of the Geo-Environmental Testing results is presented below and the GQRA screening values are presented in *Appendix 8*:

Metals				
Contaminant	Range (mg/kg)	Screening value (mg/kg)	Exceedances	Locations
<i>Arsenic</i>	5.9 - 17.6	640	0	-
<i>Cadmium</i>	<0.3 - 0.8	190	0	-
<i>Chromium</i>	23.3 - 90.0	8600	0	-
<i>Hexavalent Chromium</i>	<0.3	33	0	-
<i>Copper</i>	11 - 247	68000	0	-
<i>Lead</i>	10 - 362	2300	0	-
<i>Mercury</i>	<0.1 - 0.8	26	0	-
<i>Nickel</i>	14.5 - 36.3	980	0	-
<i>Selenium</i>	<1	12000	0	-

Zinc	29 - 777	730000	0	-
Polycyclic Aromatic Hydrocarbons (PAHs)				
Contaminant	Range (mg/kg)	Screening value (mg/kg)	Exceedances	Locations
Naphthalene	<0.04 – 1.20	1600	0	-
Acenaphthylene	<0.03 – 0.21	83000	0	-
Acenaphthene	<0.05 – 1.39	84000	0	-
Fluorene	<0.04 – 0.92	63000	0	-
Phenanthrene	<0.03 – 14.06	22000	0	-
Anthracene	<0.04 – 3.88	520000	0	-
Fluoranthene	0.04 – 24.19	23000	0	-
Pyrene	0.03 – 20.49	54000	0	-
Benzo(a)anthracene	<0.06 – 11.38	170	0	-
Chrysene	<0.02 – 10.87	350	0	-
Benzo(bk)fluoranthene	<0.07 – 18.04	44	0	-
Benzo(a)pyrene	<0.04 – 12.30	35	0	-
Indeno(123cd)pyrene	<0.04 – 7.56	500	0	-
Dibenzo(ah)anthracene	<0.04 – 1.32	3.5	0	-
Benzo(ghi)perylene	<0.04 – 6.35	3900	0	-
TPH CWG - Aliphatics				
Contaminant	Range (mg/kg)	Screening value (mg/kg)	Exceedances	Locations
>C5-C6	<0.10	3200	0	-
>C6-C8	<0.10 – 0.3	7800	0	-
>C8-C10	<0.10 – 7.8	2000	0	-
>C10-C12	<0.20 – 180.2	9700	0	-
>C12-C16	<4.00 - 597	59000	0	-
>C16-C21	<7.00 - 500	1600000	0	-
>C21-C35	15 - 293	1600000	0	-
Total aliphatics C5-35	<19.00 - 1443	-	-	-
TPH CWG - Aromatics				
Contaminant	Range (mg/)	Screening value (mg/kg)	Exceedances	Locations
>C5-EC7	<0.10	26000	0	-
>EC7-EC8	<0.10	56000	0	-
>EC8-EC10	<0.10 – 0.3	3500	0	-
>EC10-EC12	<0.20 – 241.00	16000	0	-
>EC12-EC16	<4.00 – 872.00	36000	0	-
>EC16-EC21	9 - 871	28000	0	-
>EC21-EC35	<7.00 - 543	28000	0	-
Total aromatics C5-35	19.00 - 2527	-	-	-
Total aliphatics and aromatics(C5-35)	<38.00 - 3610	-	-	-
MTBE	<2.00 ug/kg	7900	0	-
Benzene	<3.00 ug/kg	27	0	-
Toluene	<3.00 ug/kg	56000	0	-

<i>Ethylbenzene</i>	<3.00 ug/kg	5700	0	-
<i>m/p-Xylene</i>	<5.00 ug/kg	5900	0	-
<i>o-Xylene</i>	<5.00 ug/kg	6600	0	-
Others				
<i>Organic Matter</i>	<0.2 – 7.8%			
Asbestos Screen				
Position	Depth (m bgl)	Result	Quantification	
WS01	1.00	None Detected	n/a	
WS02	0.50	None Detected	n/a	
WS03	0.70	None Detected	n/a	
WS04	0.60	None Detected	n/a	

The following Semi-Volatile Organic Compounds (SVOCs) have been recorded above laboratory detection limits:

- *2-Methylnaphthalene* - WS01 at 1.0m (0.076mg/kg), WS02 at 0.5m (0.018mg/kg), WS02 at 1.50m (1.326mg/kg)
- *Carbazole* - WS01 at 1.0m (0.32mg/kg), WS02 at 0.5m (0.033mg/kg)
- *Dibenzofuran* - WS01 at 1.0m (0.134mg/kg), WS02 at 0.5m (0.018mg/kg)

The following Volatule Organic Compounds (VOCs) have been recorded above laboratory detection limits:

- *Chloromethane* - WS02 at 0.5m (0.004mg/kg)
- *Trichloroethene (TCE)* - WS01 at 1.0m (0.007mg/kg)
- *Isopropylbenzene* - WS01 at 2.0m (0.022mg/kg), WS02 at 1.5m (0.041mg/kg)
- *Propylbenzene* - WS01 at 2.0m (0.026mg/kg), WS02 at 1.5m (0.056mg/kg)
- *tert-Butylbenzene* - WS01 at 2.0m (0.041mg/kg), WS02 at 1.5m (0.049mg/kg)
- *sec-Butylbenzene* - WS01 at 2.0m (0.159mg/kg), WS02 at 1.5m (0.440mg/kg), WS03 at 2.5m (0.010mg/kg)
- *n-Butylbenzene* - WS01 at 2.0m (0.125mg/kg), WS02 at 1.5m (0.339mg/kg), WS03 at 2.5m (0.015mg/kg)

7.2 Generic Quantitative Risk Assessment - Soils

Made Ground was encountered in all exploratory hole locations to a maximum depth of between 0.8m and 2.0m begl and generally comprised both granular and cohesive soils with minor constituents of brick, concrete and coal. The Made Ground was generally less than 1.0m deep.

Olfactory evidence of hydrocarbon contamination was recorded in WS01 to WS03 in the form of a faint to strong odour in the natural Gravel deposits. Black staining was noted in WS01 and a sheen was also recorded on the groundwater at this location.

Sources of contamination have been identified on site based on the heavy industrial use of the site and immediate surrounding area throughout history. The site has been utilised as a distribution warehouse for wholesalers and Contaminants of Concern (CoC) include metals, hydrocarbons, asbestos, speciated PAHs, VOC/SVOCs and asbestos. Sources of mobile contamination including SVOC/VOCs and hydrocarbons have been identified in the surrounding area through the desk-based information. No tanks were observed onsite through the desk based walkover or site investigation and no inspection pits were identified.

Metals

Based on the site being developed commercially with an industrial unit, no elevated levels of heavy metals have been recorded in the samples tested when compared with commercial screening values.

Made Ground associated with the past and current development was encountered during the Ground Investigation and could be a source of heavy metals, however the concentrations were generally low.

Speciated Polycyclic Aromatic Hydrocarbons (PAHs)

When compared with commercial screening values, no elevated concentrations of speciated PAHs have been recorded by the laboratory testing.

Concentrations of speciated PAHs above detection limits have been recorded in both the Made Ground and natural strata associated with the minor constituents in the Made Ground and offsite impacted groundwater.

Total Petroleum Hydrocarbons (TPH CWG)

No elevated concentrations of speciated hydrocarbons have been recorded above commercial screening values.

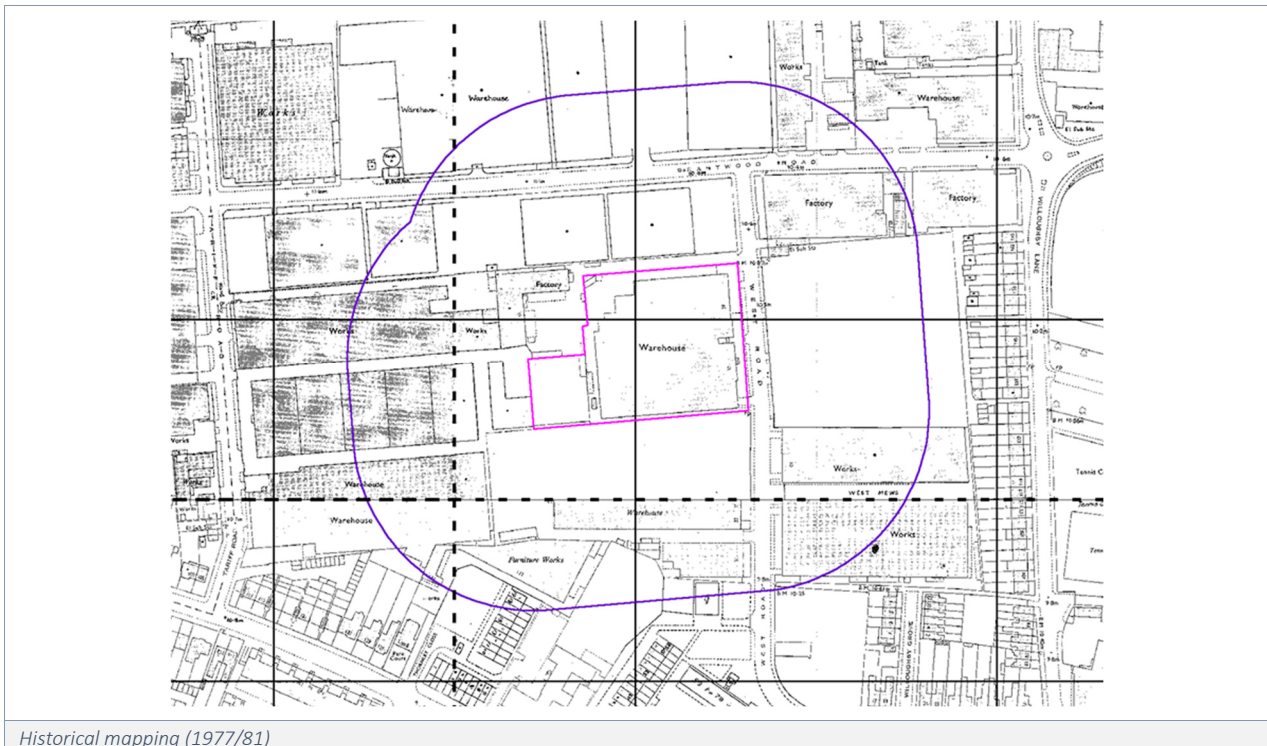
Evidence of hydrocarbons have been recorded during the Ground Investigation in the form of a faint to strong hydrocarbon odour in WS01 to WS03 and black staining and a sheen noted on the groundwater in WS01. The evidence of contamination was recorded in the natural groundwater and natural granular soils, it is a possibility that the groundwater is the source of the impact as discussed further in the following sections. No source identified on the site to date, the staining and sheen was only present at groundwater level.

Concentrations of both aliphatic and aromatic hydrocarbons have been recorded through laboratory testing in the natural granular deposits of WS01 at 2.0m bgl and WS02 at 1.5m bgl where the olfactory evidence of contamination was noted. PID concentrations of up to 52ppm were also recorded. Interpretation of these results indicate that the concentrations relate to potential diesel contamination.

The majority of volatile range of hydrocarbons were recorded below laboratory detection limits with the exception of Aliphatic C6-8 and C8-10 in WS01 and WS02 and Aromatic EC8-10 in WS01. The vapour saturation limit was exceeded in aliphatic range C10-12 and a vapour risk may be present at the site.

All BTEX and MTBE were recorded below laboratory limits of detection for all samples tested.

The generally low levels of speciated hydrocarbons in the Made Ground and natural soils support the indication that the source of contamination is offsite. As shown on the image below, the surrounding area is heavily industrial with several ASTs, engineering works, factories, depots and other unspecified works present in the surrounding area. These are potentially to be the source of the impacted groundwater which has impacted the soils beneath the site.



Volatile Organic Compounds (VOCs)

The majority of VOCs were recorded below laboratory limits of detection with the exception of those outlined in Section 7.1. The majority of detections were recorded in the granular natural ground of WS01 and WS02 where the hydrocarbon contamination was noted. The VOCs recorded are generally byproducts of benzene compounds and are associated with the diesel contamination recorded in the groundwater likely associated with offsite sources of contamination. Supplementary investigation is required to delineate the contamination and obtain a better coverage.

A single detection in Trichloroethene (TCE) was recorded in WS01 at 1.0m bgl in the cohesive Made Ground at a concentration of 0.007mg/kg. The commercial screening value for TCE as given in the SoBRA Category 4 Screening Levels document for TCE is 0.73mg/kg and is therefore not elevated. A single detection of chloromethane was also detected in WS02 at 0.5m bgl in the cohesive Made Ground at a concentration of 0.004mg/kg. No screening value is available for this compound however has been recorded at significantly low concentration and is not considered to be a risk. The source of these compounds are considered to be solvents associated with the cleaning processes used at the site, although it is a possibility that the nearby historic furniture works is the source based on the only detections being recorded in WS01 and WS02 on the western extent of the site.

Additional investigation is required to obtain a better coverage and confirm the risk.

Semi Volatile Organic Compounds (SVOCs)

All SVOCs were recorded below laboratory limits of detection, apart from those derived from PAHs such as carbazole and dibenzofuran and does not affect this assessment.

Asbestos

No asbestos fibres were detected in any of the four samples screened through laboratory testing. Possible asbestos cement roofing has been observed on the site and an asbestos survey is required.

7.3 Geo-Environmental Testing Results - Groundwater

Three samples of groundwater were taken from WS01, WS02 and WS03 and were tested for the same suite of determinands as the soils and the results compared with reference to a selection of guidance documents as detailed at the rear of this report. EQS screening values have been utilised as the screening criteria and are accepted by the EA. WHO screening values have been used to assess the hydrocarbon screening values in accordance with current guidance.

The implementation of the Water Framework Directive (WFD) is to protect and enhance the quality of groundwater and groundwater-dependent ecosystems. The objective of the WFD requires all groundwater bodies (GWBs) are of 'good' status in terms of water quality. This status is based on thresholds for the chemical constituents of groundwater and their impact on ecosystems. Preventing pollution is by far the most sustainable and cost-effective way of maintaining good groundwater quality. The EA are committed to the 'prevent or limit' approach reflected in EU and domestic legislation.

Priority is under the Water Framework Directive to protect water supplies intended for human consumption and ensure protection of groundwater quality that supplies dependent ecosystems. After first guidance in 1992 the following significant guidance has been introduced:

- Water Framework Directive (2000/60/EC) and the Water Act 2003.
- The State of Groundwater in England and Wales 2006.
- Second phase of the environmental permitting regime in 2010 replacing the Groundwater Regulations (1999, 2009).
- Groundwater Daughter Directive.

Pollutants can be divided into those that break down easily (degradable pollutants) and those that do not (non-degradable pollutants). The Water Framework Directive introduced the concept of 'hazardous substances' and 'non-hazardous pollutants', which replaced the previous List I and List II of substances considered to pose the greatest threat to the environment.

- *Hazardous substances* are the most toxic and must be prevented from entering groundwater. Substances in this list may be disposed of to the ground, under a permit, but must not reach groundwater. They include pesticides, sheep dip, solvents, hydrocarbons, mercury, cadmium and cyanide.
- *Non-hazardous pollutants* are less dangerous and can be discharged to groundwater under a permit but must not cause pollution. Examples include sewage, trade effluent and most wastes. Non-hazardous pollutants include any substance capable of causing pollution and the list is much wider than the previous List II of substances. For example, nitrate is now a non-hazardous pollutant whereas before it was not a List II substance.

Polluting substances in groundwater can occur as a gas (gaseous phase) or dissolved in water (aqueous phase), or as a non-aqueous phase liquid (NAPL). Some pollutants include substances that dissolve readily in water. These are said to have high solubility; an example is MTBE. Substances that have low solubility (such as oil) are referred to as non-aqueous phase liquids (NAPLs). NAPLs behave differently in groundwater depending on whether they are lighter or heavier than water. Light non-aqueous phase liquids (LNAPLs) may float on the water table whereas dense non-aqueous phase liquids (DNAPLs) may sink through the aquifer until they reach an impermeable layer. They may then generate plumes of contamination. In both cases, the slowly dissolving pollutant may form a plume of dissolved contamination which moves with the groundwater flow.

A table summarising the groundwater testing results is presented below:

Metals				
Contaminant	Range (ug/l)	EQS (ug/l)	Exceedances	Locations
Arsenic	<2.5	50	-	-
Cadmium	<0.5	5	-	-
Chromium	<1.5	50	-	-
Hexavalent Chromium	<0.006	12	-	-
Copper	<7	20	-	-
Lead	<5	50	-	-
Mercury	<1	1	-	-
Nickel	3 – 12	50	-	-
Selenium	<3	10	-	-
Zinc	5 – 7	3000	-	-
Polycyclic Aromatic Hydrocarbons (PAHs)				
Contaminant	Range (ug/l)	EQS (ug/l)	Exceedances	Locations
Benzo(a)pyrene	<0.005 – 2.145	1.2	1	WS01
Indeno(123cd)pyrene	<0.005 – 1.461	0.00017	2	WS01, WS02
Benzo(ghi)perylene	<0.005 – 1.301	0.00017	2	WS01, WS02
Benzo(b)fluoranthene	<0.008 – 2.226	0.00017	2	WS01, WS02
Benzo(k)fluoranthene	<0.008 – 0.865	0.00017	2	WS01, WS02
TPH CWG – Aliphatics				
Contaminant	Range (ug/l)	EQS (ug/l)	Exceedances	Locations
>C5-C6	<10	15,000	-	-
>C6-C8	<10 – 22	15,000	-	-
>C8-C10	<10 – 649	300	2	WS01, WS02
>C10-C12	<15 – 1265	300	2	WS01, WS02
>C12-C16	<30 – 4500	300	2	WS01, WS02
>C16-C35	<30 – 5770	300	2	WS01, WS02
Total aliphatics C5-35	<30 – 11,939	-	-	-
TPH CWG - Aromatics				
Contaminant	Range (ug/l)	EQS (ug/l)	Exceedances	Locations
>C5-EC7	<10	10	-	-
>EC7-EC8	<10	74	-	-
>EC8-EC10	<10 – 26	300	-	-
>EC10-EC12	<15 – 590	90	2	WS01, WS02
>EC12-EC16	<30 – 2980	90	2	WS01, WS02
>EC16-EC21	<30 – 2850	90	2	WS01, WS02
>EC21-EC35	<30 – 1620	90	2	WS01, WS02
Total aromatics C5-35	<30 – 8057	-	-	-
Total aliphatics and aromatics(C5-35)	<30 – 19996	-	-	-
MTBE	<0.1	15	-	-

<i>Benzene</i>	<0.5	10	-	-
<i>Toluene</i>	<5	74	-	-
<i>Ethylbenzene</i>	<1	20	-	-
<i>m/p-Xylene</i>	<2	30	-	-
<i>o-Xylene</i>	<1	30	-	-

All of the VOCs and SVOCs tested for were recorded at concentrations below the laboratory limits of detection apart from those outlined below:

- *2-Methylnaphthalene* - WS02 at 84ug/l
- *Isopropylbenzene* - WS01 at 4ug/l
- *Propylbenzene* - WS01 at 5ug/l
- *n-Butylbenzene* - WS01 at 7ug/l

All PolyChlorinated Biphenyls (PCBs) were recorded below laboratory detection limits.

7.4 Generic Quantitative Risk Assessment - Groundwater

Made Ground was encountered beneath the site to a maximum depth of between 0.8m and 2.0m begl and comprised granular subbase underlying the tarmac and concrete surfacing with cohesive Made Ground beneath with minor constituents of brick, concrete and coal.

Superficial deposits comprising angular to subangular fine to coarse Gravel of flint (Kempton Gravel Member) and firm brown sandy gravelly Clay (Enfield Silt Member) were encountered at minimum depths of between 0.8m and 2.0m begl to a depth of between 1.8m and 5.0m begl where the boreholes were terminated. The Enfield Silt Member was encountered above the Kempton Gravel Member apart from WS01. No bedrock was encountered during the Ground Investigation.

Groundwater seepages were encountered in all exploratory hole locations between 1.5m and 2.4m begl in the superficial granular deposits. There is no continuity in the groundwater based on ground conditions encountered.

The Kempton Gravel Member is classified as a Secondary A Aquifer and the Enfield Silt Member is classified as an Unproductive Aquifer. The bedrock deposits are indicated to be the London Clay Formation which is also classified as an Unproductive Aquifer. The site lies in a Source Protection Zone (Zone II) Outer Catchment for a groundwater abstraction point circa 1km north east of the site at Coca Cola Enterprises from within the Chalk bedrock at circa 40m bgl. The nearest named surface water feature is the Pymmes Brook located 706m south east of the site.

The topography of the site and surrounding area is generally level, the groundwater flow direction is indicated to be easterly based on investigation and monitoring data.

Heavy Metals

All metals tested for apart from nickel and zinc were recorded below laboratory detection limits. The locations where nickel was above detection limits were still recorded below the relevant EQS screening value.

The concentrations of nickel and zinc are likely to be indicative of the wider area and sourced from the works and tanks offsite.

Speciated Polycyclic Aromatic Hydrocarbons (PAHs)

When screened against the relevant screening values, elevated levels of benzo(a)pyrene, Indeno(123cd)pyrene, Benzo(ghi)perylene, Benzo(b)fluoranthene and Benzo(k)fluoranthene have been detected in WS01 and WS02. All PAH concentrations in WS03 were recorded below laboratory detection limits.

The EQS screening values are based on salmonoid uptake in a river and are extremely stringent, the elevated concentrations are related to the hydrocarbon contamination and surrounding land use due to the stringent screening values. Therefore, values such as speciated PAHs are considered to be highly sensitive as these have detrimental effects on these receptors. The Pymmes Brook does not contain these receptors (i.e salmon) and the screening values are not representative of the site.

The source of the speciated PAHs are indicated to be diesel derived associated with offsite sources of diesel contamination. The potential diesel source is discussed further below.

Total Petroleum Hydrocarbons inc BTEX (TPH CWG)

Elevated concentrations of several aliphatic and aromatic hydrocarbons have been recorded above the relevant screening values in WS01 and WS02. Interpretation of the results indicate that the source of the concentrations are from degraded diesel, which is in line with the interpretation from the natural granular soils at these depths.

A sheen was also recorded on the groundwater encountered in WS01 during the Ground Investigation, visual/olfactory evidence of contamination was also recorded in the natural granular soils beneath the site. PID concentrations of up to 52ppm was recorded in the granular soils and no PID concentrations were recorded above the limit of detection (0.1ppm) in the Made Ground, further supporting an offsite source. No evidence of impactation was recorded in the Made Ground beneath the site suggesting that the source is groundwater from offsite. The volatile sources are indicated to be related to degradation of diesel. The hydrocarbon contamination in the soils is likely indicated to be part of a smear zone.

The location of the visual/olfactory evidence of contamination and the elevated CoC in the groundwater is provided on *GRO-25311-P04*.

No concentrations of BTEX have been recorded above the laboratory limit of detection indicating the degraded diesel source is likely from offsite sources of contamination such as the engineering works, depot and tanks. The groundwater flow is indicated to be in an easterly direction, this supports the source being from the western industry.

WS03 was also tested for hydrocarbons which recorded all concentrations below laboratory detection limits, this indicates that the impactation is localised. The lack of impactation at WS03 may also be due to the presence of the impermeable Enfield Silt Member above the gravel acting as a barrier. In WS01 and WS02, this Enfield Silt Member was absent or recorded below the gravel.

All of speciated hydrocarbon groundwater testing results do not exceed the SoBRA screening values for vapours in groundwater and therefore do not pose a vapour risk to Human Health.

Supplementary investigation is required to delineate the extent of the contamination and obtain a better coverage.

Volatile and Semi Volatile Organic Compounds (VOCs and SVOCs)

All VOCs and SVOCs were recorded below laboratory limits of detection apart from those outlined in Section 7.3. No screening values are available for the compounds detected and they are not considered to be priority substances. These substances are still at low concentrations.

7.5 Permanent Ground Gases

Two ground gas monitoring visits have been carried out between 23rd October and 6th November 2025 and a further two visits are scheduled.

Methane (CH₄) was detected in WS02 and WS04 on both the first and second monitoring visits at a maximum concentration of between 21.8%v/v and 93.9%v/v. The peak and steady state methane was recorded at similar concentrations. The methane concentration recorded in the second monitoring visit was at a maximum concentration of 58.7%v/v. These concentrations are likely due to the hydrocarbon contamination.

Carbon Dioxide (CO₂) was detected in the standpipes between concentrations of 0.1%v/v and 4.8%v/v with associated oxygen concentrations of minimum 1.8%v/v. The steady state values of carbon dioxide and oxygen were generally consistent with peak levels. Depleted oxygen was recorded in WS02 and WS04 only, associated with the higher methane concentrations recorded in these boreholes.

Hydrogen sulphide concentrations of 25ppm was recorded in WS03 only in the first monitoring visit and carbon monoxide concentrations of 18ppm were recorded in WS03 on the second monitoring visit.

A positive gas flow rate of 0.3l/hr was recorded in the first monitoring visit in WS04.

The atmospheric pressure ranged between 979 and 1006mb and the monitoring was carried out during periods of steady barometric pressure.

Groundwater was encountered in all exploratory hole locations between 0.93m and 1.95m begl and was recorded slightly above the response zone in WS02 only.

Characterisation of the Gas Screening Value

Based upon the results recorded, in accordance with BS 8485:2019 and CIRIA Report C665, the risk to the site from ground gases has been assessed by converting the results to gas screening values (GSVs), calculated by multiplying the typical maximum gas concentrations with the recorded maximum positive flow rates.

$$GSV (l/hr) = \text{max borehole flow rate (l/hr)} \times \text{max gas concentration (\%)}$$

For this interim assessment, the maximum recorded concentration of carbon dioxide of 4.8%v/v and methane concentration of 93.9% has been used, the gas flow rate of 0.3l/hr has been adopted to calculate the GSV.

$$\text{Methane GSV} = 0.939 (93.9\%) \times 0.3 = 0.2817 \text{ l/hr}$$

$$\text{Carbon Dioxide GSV} = 0.048 (4.8\%) \times 0.1 = 0.0144 \text{ l/hr}$$

In order to assess the ground gas regime beneath the site and the need to incorporate ground gas precautions, guidance was taken from BS 8485:2019. Based on the site being developed for industrial end use, the Wilson and Card method has been used to carry out the assessment.

Characteristic Situation 2

The GSVs for carbon dioxide are below the assessment GSV of 0.07l/hr and generally below the typical maximum concentration assessment criteria. However the GSV for methane falls above 0.007l/hr and the site falls within Characteristic Situation 2. In addition, concentrations of methane above the typical maximum concentration assessment criteria of 1%v/v have been recorded in WS02 and WS04 in the first two monitoring visits and an increase to CS3 is appropriate. The flow rate also supports precautionary CS3 conditions as negligible to low flow rates have been observed during the monitoring.

The high methane is assumed to be associated with methanogenesis and degrading compounds based on the contamination identified on site. The degrading compounds are associated with the likely offsite diesel contamination which has migrated onsite through the permeable Kempton Park Gravels.

Assessment of the methane concentrations indicates a LEL of greater than 100% and typically do not pose an explosive risk. However, if diluted could still provide an explosive risk and should be treated as such.

Based on the high methane concentrations recorded beneath the site, a vapour membrane is required as part of the proposed development. The vapour membrane can be installed as part of the CS3 gas precautions and should be specified to mitigate against permanent ground gases as well as vapours.

The proposed development is classified as a Building Type D in accordance with BS 8485:2019, the site has been classified as CS3 therefore, 2.5 points of protection are required for the proposed development.

The points can be achieved by a one or more of the following three types of protection measures to achieve that score:

Protection Measure	Details	Points of Protection
Structural Barrier/Floor Slab	Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetration	1.5
Ventilation Protection Measures	Passive sub floor dispersal layer of good performance	1.5
Gas resistant Membrane	Gas resistant membrane (including methane) meeting the criteria outlined in Table 7 of BS 8485:2020	2.0

The vapour membrane can be installed as part of the CS3 gas precautions and should be specified to mitigate against permanent ground gases as well as vapours.



Following demolition of the building, further Ground Investigation is to be carried out in order to gather a better coverage and better understanding of site conditions. Based on the findings of the further investigation and any remedial action carried out at the site removing the source of the elevated concentrations, the characterisation for the site may be able to be reduced. The requirement of a vapour membrane may be changed depending on findings of the supplementary investigation and effectiveness of the remedial works.

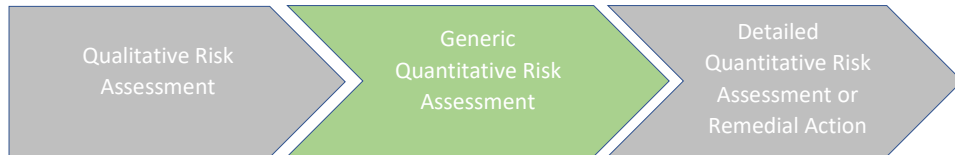
Radon

The site is not in an area requiring radon precautions within the foundations.

7.6 Revised Pollution Linkage Assessment

The CSM has been revised based on the Ground Investigation and testing using Source-Pathway-Receptor assessment criteria that is applicable in the UK, a risk assessment has been completed to determine if a plausible pollution linkage exists between the identified contaminants and receptors. The CIRIA Risk Assessment Methodology is provided in *Appendix 9*. A revised illustrative CSM is provided in *GRO-25311-P05*.

Human Health Pollution Linkage Assessment



- The table below represents the second stage in the land quality risk assessment process - **the Generic Quantitative Risk Assessment**.
- In order for a development site to be deemed 'suitable for use' the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

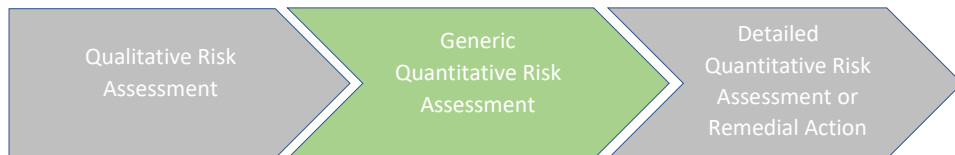
Conceptual Site Model					Generic Quantitative Risk Assessment	
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	Rationale and Action
PL1	Contaminated Soils	Ingestion of soil and dust. Dermal contact with soil.	Unlikely	Medium	Low	Pollution Linkage 1 refers to proposed site users coming into contact with contaminated soils on the site. Sources of contamination have been identified on site and in the surrounding area associated with the former and current industrial use as cardboard works, manufacturing and wholesale distribution works buildings. Made Ground has been encountered beneath the site to between 0.8m and 2.0m begl. Visual and olfactory evidence of hydrocarbon contamination was recorded in the natural granular deposits in WS01 to WS03 in the form of black staining and a faint to strong hydrocarbon odour. A sheen was also recorded on the groundwater in WS01. Based on the site being developed commercially, no elevated concentrations of heavy metals, PAHs, speciated hydrocarbons, VOCs or SVOCs have been recorded. No asbestos has been detected in any of the samples screened through laboratory testing.

Conceptual Site Model					Generic Quantitative Risk Assessment	
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	Rationale and Action
						The proposed development comprises the demolition of the existing unit and the construction of an industrial unit in its place and no soft landscaping will be included in the proposed development. As no sources of contamination are present, no realistic pollution linkage is considered to exist at this stage. Supplementary investigation is required to obtain a better coverage and confirm the risk.
PL2	Contaminated Soils	Inhalation of vapour.	Likely	Medium to Severe	Moderate	Evidence of hydrocarbon contamination has been encountered in WS01 to WS03 during the Ground Investigation and laboratory testing indicated that diesel was present in both the soils and groundwater in WS01 and WS02. The vapour saturation limit for aliphatic C10-12 has been exceeded in WS01 however the source of contamination is indicated to be groundwater. PID concentrations of up to 52ppm have been recorded associated with degradation of diesel. All of speciated hydrocarbon groundwater testing results do not exceed the SoBRA screening values for vapours in groundwater and are not indicated to pose a vapour risk to Human Health. Nevertheless, high methane concentrations have been recorded in the ground gas monitoring wells associated with degrading volatile vapours from the offsite diesel groundwater source. At present, a minor pollution linkage is considered to exist.

Conceptual Site Model					Generic Quantitative Risk Assessment	
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	Rationale and Action
						Further Ground Investigation is recommended following the demolition of the existing warehouse building to confirm the risk and locate the source.
PL3	Contaminated Soils	Inhalation of soil dust by adjacent site users.	Unlikely	Medium	Low	The land use of the surrounding area is indicative to that of site and no pollution linkage is considered to exist. Identifiable offsite sources of contamination are more harmful than the subject site and are indicated to have impacted site. Appropriate asbestos mitigation measures including dust suppression should be undertaken during the demolition and enabling works phases.
PL4	Contaminated Soils	Attacking potable water supply pipe.	Likely	Medium	Moderate	Pollution Linkage 4 refers to the possible contaminants permeating potable water pipes and consumption by the future site end users of the tainted water supply. Made Ground is present beneath the site to a maximum concentration of 2.0m begl in WS01 and is therefore likely to be present at installation depth. Organic contamination in the form of a faint to strong hydrocarbon odour has been recorded during the Ground Investigation and laboratory testing results confirm the source of the odour is diesel contamination. If water pipes are to be installed as part of the proposed development, a local water company risk assessment should be carried out in order to confirm the appropriate pipe material.

Conceptual Site Model					Generic Quantitative Risk Assessment	
PL	Potential Source	Pollution Linkage	Likelihood	Consequence/ Severity	Risk Rating	Rationale and Action
						A realistic pollution linkage identified and barrier pipe likely required.
PL5	Ground Gas	Migration and accumulation of ground gas in internal spaces.	Likely	Medium to Severe	Moderate to High	Made Ground has been encountered beneath the site to a maximum depth of between 0.8m and 2.0m begl. Hydrocarbon contamination has been recorded during the Ground Investigation in WS01 to WS03. High methane concentrations have been recorded in WS02 and WS04 in the first two monitoring visits associated with methanogenesis relating to the degradation of hydrocarbon contamination. Based on the concentration of methane being recorded above GSV and the typical maximum concentration, the site is classified as CS3 and gas protection measures will be required in the proposed development. Based on the source being a vapour source, a vapour resistant membrane is also required. This will be confirmed on completion of the monitoring. Further investigation following demolition and remediation may reduce the classification and requirement for gas protection measures and a vapour membrane. At present a pollution linkage is considered to exist. The site is not within an area requiring radon precautions within foundations.

Controlled Waters Pollution Linkage Assessment



- The table below represents the second stage in the land quality risk assessment process – **Generic Quantitative Risk Assessment**.
- In order for a development site to be deemed ‘suitable for use’ the level of risk needs to be reduced to an acceptable level - low to negligible risk. The purpose of each stage of risk assessment is to establish if there is a requirement for additional stages of assessment in order to have sufficient confidence to support a risk characterisation or remedial action.

Conceptual Site Model					Generic Quantitative Risk Assessment	
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	Rationale
PL6	Contaminated Soils	Impaction of groundwater from soil contamination (diffuse and point). Impaction of groundwater from groundwater plume.	Low Likelihood to Likely	Medium	Moderate to Low	Made Ground has been encountered beneath the site to a maximum depth of 2.0m begl and comprised granular subbase overlying cohesive Made Ground with minor constituents of brick, concrete and coal. Evidence of hydrocarbon contamination was also recorded in WS01 to WS03 during the Ground Investigation in the form of black staining and sheen on the groundwater in WS01 and a faint to strong hydrocarbon odour in WS01 to WS03. Laboratory testing on the soils concluded that the contamination correlated with diesel impaction. This is likely associated with the highly industrial surrounding land use. No significant onsite sources of contamination have been recorded during the Ground Investigation or Desk Based Assessment. However further coverage of the site is required. The Kempton Gravel Member superficial deposits are classified as a Secondary A Aquifer and the Enfield Silt Member is classified as an Unproductive Aquifer. The bedrock underlying the site is the London Clay Formation and is classified as an Unproductive Aquifer. The site lies within a SPZ Zone II Outer Catchment relating to a groundwater

Conceptual Site Model					Generic Quantitative Risk Assessment	
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	Rationale
						abstraction well within the Upper Chalk bedrock below the London Clay Formation at circa 40.0m bgl. Groundwater testing results show elevated concentrations in PAHs and speciated hydrocarbons in WS01 and WS02. Interpretation of the results show this is correlated with degraded diesel, this is indicated to be from an offsite source. No evidence of contamination has been recorded in the shallow Made Ground. No elevated concentrations were recorded in the groundwater in WS03 in the north east of the site, showing that the contamination is localised. This also supports the source being westwards, based on the groundwater flow being towards the east. The Enfield silt member was also recorded above the clay in WS03 which may have restricted the movement of contaminants compared to WS01 and WS02 where the clay was below the gravel or absent. BGS records in the area show that The London Clay Formation is present beneath the underlying area with a general thickness of between 5m and 10m which will provide a sufficient aquitard to reduce the migration of contamination into the underlying Upper Chalk bedrock which corresponds with the groundwater abstraction and SPZ. Further investigation is recommended post demolition to obtain a better coverage of site. Based on the source being offsite, treatment of the onsite groundwater would be ineffective. It is anticipated that all free phase will be removed during the enabling works as a minimum. At present a minor pollution linkage exists between the impacted ground and the superficial Secondary A Aquifer beneath the site.

Conceptual Site Model					Generic Quantitative Risk Assessment	
PL	Potential source	Pollution linkage	Likelihood	Severity	Level of risk	Rationale
PL7	Contaminated Soils	Migration of soil and groundwater contamination impacting surface waters.	Unlikely	Medium	Low	Pollution linkage 7 refers to the impaction of the Pymmes Brook located 706m south east of the site from contaminated soils and groundwater. Mobile contamination has been encountered beneath the site, however groundwater the source of contamination is not considered to be an on site source but rather an offsite source associated with the industrial land use in the surrounding area. Surface water features are at a significant distance to allow for attenuation and a pollution linkage is not considered to exist. In addition, the Kempton Park Gravel is not indicated to be in continuity with watercourse.

7.7 Outline Remedial Strategy

Soils

Made Ground has been encountered across the site to between 0.8m and 2.0m begl and comprises granular subbase overlying cohesive Made Ground with minor constituents of brick, concrete and coal. The Made Ground was generally present to depths of less than 1.0m begl. Evidence of hydrocarbon contamination has been identified in WS01 in the form of staining and a sheen on the groundwater, and strong hydrocarbon odour and a moderate to faint hydrocarbon odour in WS02 and WS03 within the natural Gravel deposits.

Geo-Environmental testing recorded no elevated CoC when compared with commercial screening values however relatively high concentrations of speciated PAHs and hydrocarbons have been recorded associated with the contamination identified. No asbestos was detected in any of the samples screened through laboratory testing.

The site is indicated to be entirely hardsurfaced which will act as a cover system and no remedial measures are required with respect to soils.

Further investigation is required to obtain a better coverage of site and as a minimum free phase product removed.

Vapours

The vapour saturation limit for aliphatic C10-12 has been exceeded in WS01 and PID readings of up to 52ppm have been recorded. High concentrations of methane have been recorded during the monitoring period associated with the degradation of vapours and a vapour risk exists.

Specific remedial measures comprising a vapour resistant membrane is required at this stage.

Further investigation required to assess and design remedial measures to determine if effective remediation can remove the requirement for a vapour membrane.

Ground Gas

Interim gas monitoring results place the site in Characteristic Situation 3 (CS3) based on high concentrations of methane being recorded in WS02 and WS04 in the first two monitoring visits and gas protection measures will be required in the proposed development.

The points can be achieved by a one or more of the following three types of protection measures to achieve that score:

Protection Measure	Details	Points of Protection
Structural Barrier/Floor Slab	Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetration	1.5
Ventilation Protection Measures	Passive sub floor dispersal layer of good performance	1.5
Gas resistant Membrane	Gas resistant membrane (including methane) meeting the criteria outlined in Table 7 of BS 8485:2020	2.0

The level of precautions will be confirmed upon completion of the monitoring, additional coverage is also required.

Controlled Waters

The results from the groundwater testing indicate that the groundwater beneath the site has been impacted by diesel contamination possibly from an offsite source as elevated concentrations of speciated PAHs and hydrocarbons have been recorded in WS01 and WS02.

Specific remedial measures will likely be required with respect to controlled waters, this will be confirmed upon completion of the supplementary investigation. As a minimum, all free phase product should be removed.

Further Investigation

Further investigation is required post demolition of the existing building in order to gain a better coverage of site conditions and delineate the contamination identified.

Watching Brief and Regulatory Compliance

A watching brief should be in place during ground works and construction. If previously unidentified contamination is encountered, work should cease in that area and Groundtech Consulting contacted for advice.

Regulatory compliance should be obtained pre-commencement to avoid delays during the construction phase which will have cost implications.

7.8 Asbestos in Soils

No asbestos fibres have been identified in the four samples screened by the laboratory testing, no control measures required at this stage, additional testing to be undertaken.

A demolition asbestos survey should be carried out prior to the demolition of the existing warehouse building to inform the strip and appropriate mitigation measures should be in place during demolition.

7.9 Health and Safety - Construction and Ground Workers

During the reclamation and construction phases of the site development it will be necessary to protect the health and safety of site personnel. The risk to construction and ground workers is assessed in the table below:

PL Ref	Potential Source	Pollution Linkage	Likelihood	Severity	Level of Risk
PL8	Made Ground	Ingestion, direct contact, inhalation of dusts.	Likely	Medium	Moderate
PL8	Asbestos	Ingestion, direct contact, inhalation of dusts.	Likely	Medium	Low

Evidence of contamination has been identified in the soils in WS01 to WS03 and groundwater in WS01 and WS02, hydrocarbon odours and high concentrations of speciated hydrocarbons have been identified. No asbestos has been detected in any of the samples screened. The risk to ground workers should be communicated through the site induction and through information on noticeboards.

General guidance on these matters is given in the Health and Safety Executive (HSE) document “Protection of Workers and the General Public during the Redevelopment of Contaminated Land”. In summary, the following measures are suggested to provide a minimum level of protection:

- *All ground workers should be issued with the relevant protective clothing, footwear and gloves. These protective items should not be removed from the site and personnel should be instructed as to why and how they are to be used.*
- *Hand-washing and boot-washing facilities should be provided.*
- *Care should be taken to minimise the potential for off-site migration of contamination by the provision of dust suppression control and wheel cleaning equipment during the construction works.*
- *Good practices relating to personal hygiene should be adopted on the site.*
- *The contractor shall satisfy the Health and Safety Executive with regard to any other matters concerning the health, safety and welfare of persons on the site.*

7.10 Waste Classification by Assessment

We have reviewed the testing results and inputted them into the HazWasteOnline model which allows users to code and classify waste as defined in the EWC (European Waste Catalogue 2002) based on EC Regulation 1272/2008 on the Classification, labelling and packaging of substances and mixtures (CLP) and latest Environment Agency guidance (WM3 “Guidance on the classification and assessment of waste (1st edition 2015)-Technical Guidance”).

This is a useful tool as waste producers have the legal responsibility to classify any waste they produce.

Seven samples were tested to assess whether they contained any contaminants in the hazardous range when screened against assessment criteria within WM3. The results are presented in the Waste Classification Report presented in *Appendix 10*.

Based on the assessment tool the Made Ground has been classified as *Non-Hazardous*.

The natural Gravel in WS01 at 2.0m and WS02 at 1.5m bgl has been classified as *Hazardous* for waste disposal purposes. The hazardous classification has been assigned based on HP3 (Flammable), HP7 (Carcinogenic) and HP11 (Mutagenic) associated with the high TPH concentrations and related VOC byproducts. This material should be segregated prior to disposal from site.

No asbestos has been detected in any of the samples screened and does not impact the waste classification.

7.11 Waste Acceptance Criteria (WAC) Results

The Landfill Directive (Directive 1999/31/EC on the landfilling of waste) led to the establishment of a methodology for classifying wastes. Wastes can only be accepted at a landfill if they meet the relevant Waste Acceptance Criteria (WAC) for that type of landfill. There are three different WAC, these are for:

- *Inert waste*
- *Non-Hazardous waste*
- *Hazardous waste*

Wastes should first be classified based on their total concentrations as detailed in the previous section. WAC testing is then required if the end disposal route is a landfill.

Waste Acceptance Criteria (WAC) testing was outside the scope of this investigation and the guidance given below is general.

The possibility of automatic inert classification of the natural soils should be explored in accordance with Section 4.3 of the EA guidance document. The Council Decision includes a list of wastes in Section 2.1.1 of the document that are assumed to be inert and therefore acceptable at a landfill for inert waste without testing, this is the case if:

- *They are single stream waste of a single waste type (although different waste types from the list may be accepted together if they are from a single source)*
and
- *There is no suspicion of material or substances such as metals, asbestos, plastics, chemicals, etc to an extent which increases the risk associated with the waste sufficiently to justify contamination and they do not contain other their disposal in other classes of landfill.*

If any organic contaminated material is encountered during the construction phase, it is possible that this may be classified as hazardous and testing should be undertaken at that time.

Materials should be segregated and where necessary sufficient time is allowed to further classify the material properly, including discussion with landfill sites and waste transfer stations to find the best disposal route. It is recommended that where possible the soils could be recycled at a suitable local waste treatment plant or transfer station rather than a landfill disposal route.

The reuse of soils on the site should be done in accordance with the CL:AIRE “Development Industry Code of Practice for the Definition of Waste” (CL:AIRE CoP). Any re-use scheme should be designed to minimise disposal costs.

After a cut and fill balance plan/volume calculation has been carried out, a U1 and T5 exemption could be registered. This will allow the use of the following soils without a waste permit or under Dow CoP MMP:

- *1,000 tonnes (c. 600m³) of non-hazardous soil*
- *5,000 tonnes (c. 3,000m³) of natural sand and gravels.*
- *50,000 tonnes (c. 25,000m³) of bituminous material to be used in roadways.*
- *5,000 tonnes (c. 3,000m³) of crushed concrete/stone.*

8.0 FINAL APPRAISAL

8.1 Land Quality

Historic maps indicate that the site was formerly utilised as a box factory building in the south east and manufactory building in the north from 1935. Several buildings are shown to be constructed adjoining onto the manufactory buildings from 1935 onwards. By 1964, the site is shown in its current configuration and remains unchanged. The site is currently occupied by a wholesalers warehouse with associated car parking and office space. No onsite point sources have been identified, no inspection pits or tanks have been recorded onsite. No onsite sources of contamination have been identified at this stage through the consultations or Ground Investigation.

Made Ground has been encountered beneath the site to a maximum depth of 2.0m begl and comprised granular subbase comprising Sand and Gravel with minor constituents of concrete and brick underlying dark brown to black cohesive Made Ground with minor constituents of brick, concrete and coal. Superficial deposits comprising brown sandy angular to subangular fine to coarse Gravel of flint and firm brown slightly sandy occasionally gravelly Clay was encountered in all exploratory hole locations from minimum depths of between 0.8m and 2.0m begl to a maximum depth of 5.0m begl. Groundwater seepages were observed in all exploratory hole locations between 1.5m and 2.4m begl in the natural granular Gravel deposits. Groundwater was recorded in the monitoring visits between 0.93m begl and 1.95m begl.

Visual evidence of hydrocarbon contamination was encountered in WS01 in the form of black staining and a sheen on the groundwater. Olfactory evidence of contamination was encountered in WS01 to WS03 in the form of a faint to strong hydrocarbon odour. The source of contamination is indicated to be the engineering works to the west of the site.

No elevated levels of heavy metals, speciated PAHs or hydrocarbons have been encountered in the soils across the site when compared with commercial screening values. No asbestos fibres have been detected in any of the samples screened. The proposed development will likely be covered with hardsurfacing and the risk to Human Health is considered to be *Low*.

The risk from vapours is considered to be *Moderate* due to high concentrations of methane in the first two monitoring visits in WS02 and WS04 and also the vapour saturation limit for aliphatic C10-12 has been exceeded in WS01. PID levels of up to 52ppm have been recorded in the natural granular material.

The risk from ground gas is considered to be *Moderate to High* based on interim gas monitoring results placing the site in Characteristic Situation 3 (CS3) and gas protection measures are required for the proposed development.

Groundwater testing results recorded elevated concentrations of speciated PAHs and hydrocarbons in WS01 and WS02 with interpretation showing that the source is from degraded diesel. At this stage, this is considered to be an offsite source. The risk to controlled waters is considered to be *Moderate to Low*.

Further investigation and remediation is required, as a minimum free product removal should be carried out.

The contamination in the soils is indicated to be associated with the groundwater as part of the smear zone.

The Made Ground has been classified as *Non-Hazardous* for waste disposal purposes. The natural granular strata in WS01 and WS02 at 2.0m and 1.5m begl respectively has been classified as *Hazardous* for Waste disposal purposes.

8.2 Ground Engineering

The most suitable foundations for the proposed development are considered to be pad and strip trench foundations constructed in the medium dense to very dense Gravel deposits. A safe allowable bearing pressure of 200kN/m² is provided for a pad foundation constructed in the granular deposits. Based on the anticipated high loadings, the Clay beneath the site is not considered to be a suitable bearing stratum. The depth of investigation is not considered sufficient for the large dimension pads and deeper investigation is required to confirm the design meets both ULS and SLS conditions.

Alternatively to pad foundations, CMCs are considered to be suitable for the proposed development.

The results of laboratory pH and sulphate content indicate that ACEC Class AC-1 and sulphate class DS-1 conditions prevail in accordance with BRE Special Digest 1 "Concrete in aggressive ground" 2005.

The Site is predominantly within Flood Zone 1, which has a low probability of flooding. Along the eastern and southern boundary of the Site, the Site lies within Flood Zone 2, which has a medium probability of flooding from rivers and the sea. Therefore, a Flood Risk Assessment is recommended for the Site.

Additional investigation is required post demolition of the existing warehouse building to confirm the ground conditions and get a better coverage across the site.

8.3 Required Further Work

The following further work is considered necessary to progress the site to construction phase:

Completion of gas monitoring programme

Issue gas assessment

Intrusive site investigation, monitoring and possible remediation following demolition of existing warehouse building

Demolition Asbestos survey

Tree survey by qualified arboriculturist

Detailed Foundation design

Confirmation of recommendations made in this appraisal with regulators

9.0 RELEVANT INDUSTRY REFERENCES

- British Standards Institution. *Investigation of Potentially Contaminated sites - code of practice*. BS 10175:2017.
- British Standards Institution '*Code of Practice for Site Investigations*' BS 5930:2020.
- British Standards Institution "*Geotechnical investigation and testing – Identification and classification of soil*" BS EN ISO 14688:2002.
- British Standards Institution "*Geotechnical investigation and testing – Identification and classification of rock*" BS EN ISO 14689:2002.
- BRE Report BR211 '*Radon – Guidance on protective measures for new buildings*' 2015 Edition.
- BRE Special Digest 1: "*Concrete in Aggressive Ground*" 3rd Ed 2005.
- CIRIA 552 "*Contaminated Land Risk Assessment – A guide to good practice*" 2001.
- CIRIA C665 "*Assessing Risks Posed by Hazardous Ground Gases to Buildings*" 2007.
- Wilson & Card "*Proposed method classifying gassing sites*" Ground Engineering 1999.
- Card & Steve Wilson in "*A pragmatic approach to ground gas risk assessment for the 21st Century*" - CIRIA/Environmental Protection UK Ground gas seminar 2011
- BS 8576:2013 '*Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)*'
- BS 8485:2015 '*Code of practise for the design of protective measures for methane and carbon dioxide ground gases for new buildings*'
- The Hazardous Waste (England) Regulations 2005.
- Environment Agency Hazardous Waste: "*Guidance on the classification and assessment of waste*" WM3 ver 1 May 2015.
- The National Planning Policy Framework (NPPF) March 2012
- DETR. Circular 02/2000 Contaminated Land.
- Environment Agency, 2009 'Using Soil Guideline Values'.
- Environment Agency, 2009 'Updated Technical Background to the CLEA model'.
- Environment Agency, 2009 'Human health toxicological assessment of contaminants in soil'.
- Department of the Environment, 1994, CLR Report No 1 'A framework for assessing the impact of contaminated land on groundwater and surface water'.
- Department of the Environment, 1994, CLR Report No 2 'Guidance on Preliminary Site Inspection of Contaminated Land'.
- Department of the Environment, 1994, CLR Report No 3 'Documentary research on Industrial Sites'.
- Department of the Environment, 1994, CLR Report No 4 'Sampling Strategies for Contaminated Land'.
- DEFRA and the Environment Agency, 2002-2004, CLR10 'Soil Guideline Value Reports for Individual Soil Contaminants'.
- Land Contamination Risk Management (LCRM), April 2021.
- Nathanail, C. P., McCaffrey, C., Gillett, A., Ogden, R. C. and Nathanail, J.F. 2015. The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, Nottingham.
- CL:AIRE, 2014 'Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination'.
- Water Framework Directive.
- Environmental Quality Standards.

UK Drinking Water Standards: Water Supply (Water Quality) Regulations 1989 (SI 1989/1147) and Water Supply (Water Quality) Regulations

UKWIR Report 10/WM/03/21 2010 "Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites"

Health & Safety Executive, 1991. 'Protection of Workers & the General Public during the Development of Contaminated Land'.

Environment Agency & NHBC, 2000. R&D Publication 66. Guidance for the Safe Development of Housing on Land Affected by Contamination.

Environment Agency "Guidance on the classification and assessment of waste (1st edition 2015) Technical Guidance WM3"

NHBC Standards 2025.

CL:AIRE "*The Definition of Waste: Development Industry Code of Practice*" Version 2 March 2011.

CIRIA "*Asbestos in soil and made ground: a guide to understanding and managing risks*" C733 2014

Control of Asbestos Regulations (CAR) 2012

Harris, M R, Herbert, S. M, Smith, M A 'Remedial Treatment for Contaminated Land' (twelve volumes), special publications 101-112, CIRIA 1996.

Department of the Environment. 1995. Industry Profiles - 48 separate publications available from The Stationery Office, London

BRE Digest 365 "Soakaway Design" 2016.

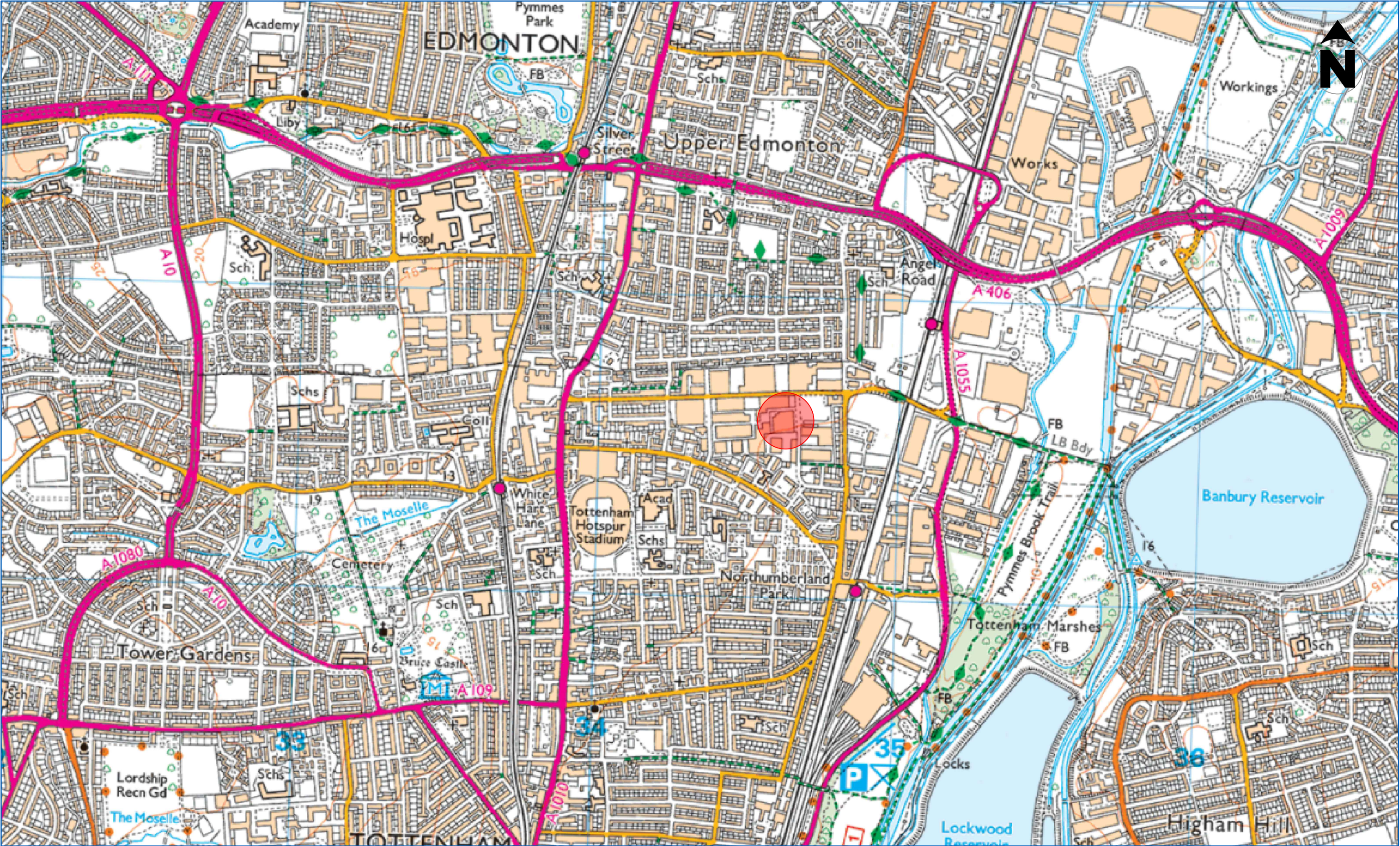
Environment Agency. R&D Publication 20. Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources. 1999.

Environment Agency Technical Guidance Note 01. Hydrogeological Risk Assessment for Landfills.

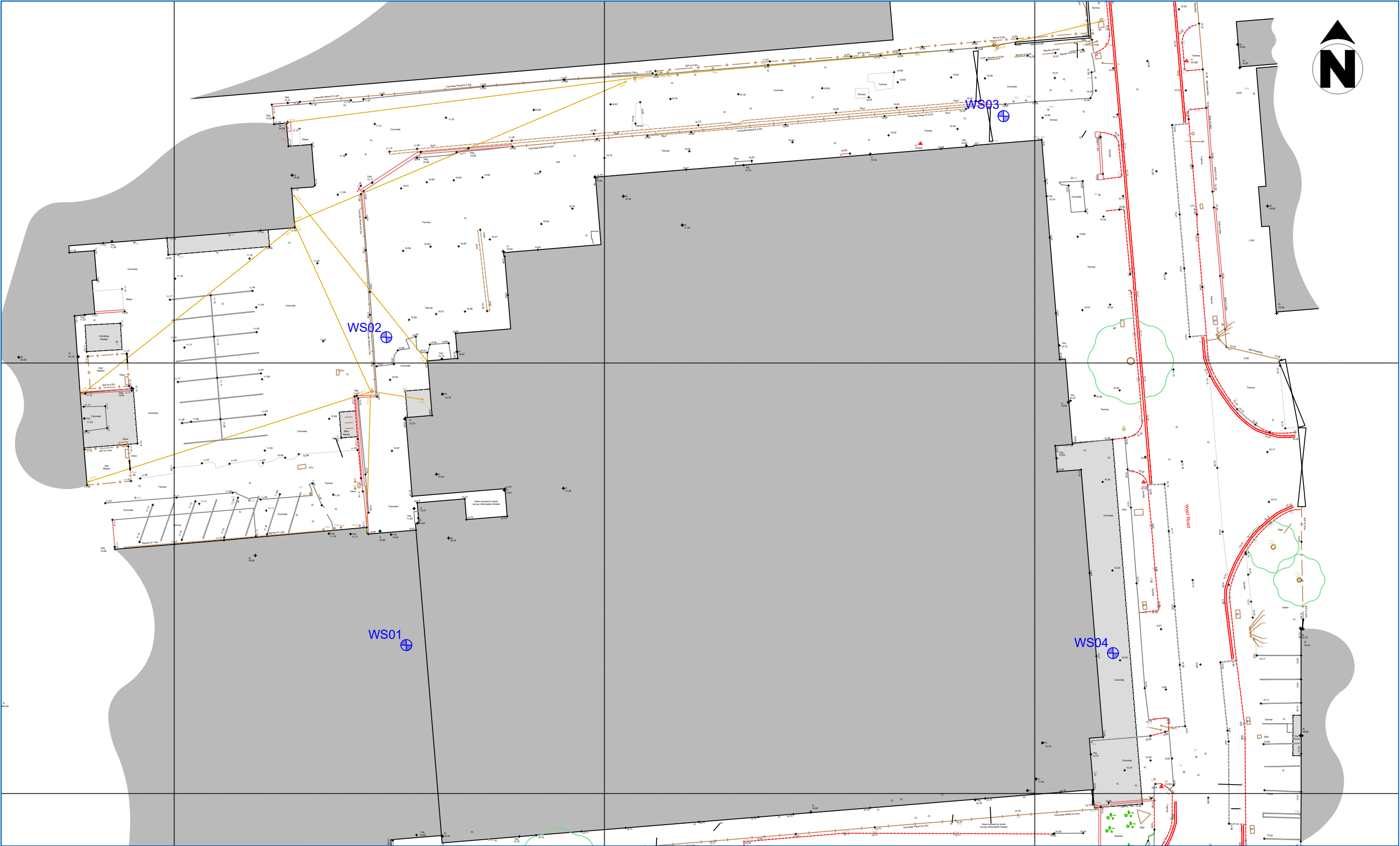
Specification for Highways Works – Series 600 Earthworks November 2016.



APPENDIX 1 - Plans



GROUNDTECH CONSULTING	CLIENT	DATE				Status		Notes Site Location
	HE5 UK ENTERPRISES 25 GP LIMITED	NOVEMBER 2025				Preliminary		
	PROJECT TITLE	SCALE				Draft		
	37-39 WEST ROAD, TOTTENHAM	NTS				Issued		
	PLAN TITLE	PLAN NUMBER				For Comment		
	PROJECT LOCATION PLAN	GRO-25311-P01	Rev.	Details	Date	Approved		



GROUNDTECH CONSULTING	CLIENT	DATE				Status	Notes Windowless Sample Borehole Location
	HE5 UK ENTERPRISES 25 GP LIMITED	NOVEMBER 2025				Preliminary	
	PROJECT TITLE	SCALE				Draft	
	37-39 WEST ROAD, TOTTENHAM	NTS				Issued	
	PLAN TITLE	PLAN NUMBER				For Comment	
	EXPLORATORY HOLE LOCATION PLAN	GRO-25311-P02	Rev.	Details	Date	Approved	

