

LAND AT BLACKLEY MERE UPPER RESERVOIR MANCHESTER

GEO-ENVIRONMENTAL INVESTIGATION

Job Number: LKC 19 1139

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INCREASING LAND VALUE

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1 Introduction

1.1 Background

LK Consult Ltd (LKC) has been commissioned by Blackley Developments Ltd to carry out a Geo-Environmental Investigation for land at Blackley Mere Upper Reservoir, Manchester.

The following work has previously been undertaken on the site:

- Phase 1 and Phase 2 Geo-Environmental Site Assessment, undertaken by E3P (ref: 11-164-R1, dated October 2016).
- Ground Gas Addendum Report, undertaken by E3P (ref: 11-164-R2, dated 20th April 2017).
- Remediation Report, undertaken by Salford Excavations Ltd (no reference or date supplied).
- Land at Blackley Mere Lower, Manchester Geo-Environmental Investigation, undertaken by LKC (ref: CL-602-LKC 17 1257-01 [R0], dated April 2019).

The site currently comprises two parcels of vacant land with stockpiles of material across the eastern lower part of the site and former reservoirs in the west of the site which have now been infilled. The site slopes down towards the east with a significant difference in site levels between the far west (c. 6-7m higher in elevation) and far east of the site.

The end use is to develop residential properties with associated gardens, car parking and areas of soft landscaping on the site. In order to provide a development platform the site requires a substantial material import to achieve the increase in levels.

An investigation was required in order to provide contamination, waste acceptance criteria and grading testing for material that has infilled the reservoir in the west of the site (the Upper Reservoir) to identify if it is suitable for use in the required level raising exercise.

1.2 Site Details

A summary of the site details is presented in Table 1-1. Figure 1 indicates the site location and the full site boundary is illustrated on Figure 2.

Location	Site is located south of Blackley New Road, north east of Bowker Bank Avenue, Blackley, Manchester. The study area is the former reservoir on the western area. National Grid Reference:383951E 403025N.
Topography	56-63 metres above ordnance datum (AOD) (northern extent). The site slopes moderately down towards the east.
Land Use	<u>Site</u> The Blackley Mere site is split into two areas with the eastern area a former industrial site which is now vacant and stockpiled with material. The western area of site and the study area comprises an infilled reservoir. <u>Surrounding Area</u> North: River Irk and residential properties. East: River Irk and woodland. South: Woodland, railway line and residential properties. West: Reservoir, woodland and residential properties.
Proposed Development	Residential properties and associated gardens.

Table 1-1: Summary of site details.

2 Previous Work

2.1 Summary of Existing Information

A Phase 1 and Phase 2 Geo-Environmental Site Assessment (ref: 11-164-R1, dated October 2016) and Ground Gas Addendum Report (ref: 11-164-R2, dated 20th April 2017) have previously been undertaken by E3P and is summarised in Section 2.2-2.3. A summary of the report undertaken by LKC on the stockpiles in the east of site (ref: CL-602-LKC 17 1257-01 [R0], dated April 2019) is provided in Section 2.4.

2.2 Site History and Environmental Setting

The below information has been taken directly from the E3P site assessment.

EXECUTIVE SUMMARY		
Site Address	Blackley Mere, Bowker Bank Avenue, Manchester M8 4LL	
Grid Reference	E 383980, N 403010	
Site Area	3.16 Ha	
Current Site Use	The site is an irregular shaped parcel of land located off Bowker Bank Avenue, Blackley approximately 4km north of Manchester City Centre. The site comprises two distinct sectors; the western portion predominantly occupied by a drained reservoir basin which sits c. 4-5m higher in elevation than the eastern sector which comprises a concrete slab associated with the former site works.	
Proposed Development	E3P understands that site will be developed with the construction of 76 No. dwellings with associated access and estate roads, driveways, garden and landscaped areas and adopted utility infrastructure.	
Previous Reports	E3P has not been provided with any previous reports for the site.	
Environmental Setting	Drift Geology	West - Glacial Till (Clay) East - Alluvium (Sand & Gravel)
	Bedrock Geology	Cheshire Pebble Beds Formation (Sandstone).
	Hydrogeology	Unproductive (west) / Secondary A (east) overlying Principal Aquifer (bedrock).
	Groundwater Source Protection	The site is not located within a Groundwater Source Protection Zone or Drinking Water Safeguard Zone.
	Hydrology	The River Irk lies downgradient immediately adjacent to the north and eastern site boundary.
	Flood Risk	The SE sector is affected by flooding from rivers (FZ3). Remaining area unaffected by flooding (FZ1).
	Ecology	Potential risk to ecological and aquatic ecosystems within River Irk.
	Sensitive Land Uses	The River Irk is considered a critical receptor.
	Industrial Land Use	No industrial land uses identified on-site or the immediate locality that may potentially prejudice the future development of the site for residential use.
	Subsidence Hazard	Moderate compressible ground hazard to the NE; Moderate landslide hazard to the SE.
Site History	A review of the pertinent Ordnance Survey mapping dating from late 1850s confirms the presence of the reservoir and print works which later became a bleach works and more recently a textile works.	
Utility Locations	A review of service plans has indicated that drainage infrastructure is present within Bowker Bank Avenue to the west.	
Landfill Sites & Ground Gases	A historic landfill site is located to the northeast of the site on the opposite side of the River Irk. Made Ground associated with the landfill to the NE and in-filled reservoirs on-site may be a sources of hazardous ground gas and may pose a low-level risk to construction workers and residential end users.	
Radon	Unaffected – No special precautions required.	
Coal Mining / Land Stability	The site is not located within an area deemed to be at risk from ground instability arising from historic coal mining activities.	

2.3 E3P Intrusive Ground Investigation

The below information has been taken directly from the E3P site assessment.

Ground Conditions	E3P completed a Ground Investigation comprising 12 No. Window Sample Probeholes and 25 No. mechanically excavated Trial Pits. The ground conditions encountered are summarised below: Topsoil A 250mm horizon of gravelly SILT (Topsoil) was encountered at TP114. Made Ground Made Ground was encountered within all exploratory locations to a maximum proven depth of 3.45m bgl (WS112) underlying the former bleach works, although generally to depths in excess of 1.0m bgl across the wider site. Made Ground deposits were generally uniform and comprised a silty and/or sandy gravel of concrete, brick, ash, mudstone, sandstone, slate, plastic, timber and metal believed to be associated with historic fill material resulting from construction and demolition activities. Localised discontinuous sandy and/or gravelly clay soils and reworked sand were recorded. Drift Drift deposits were encountered within all exploratory hole locations where the Made Ground could be fully penetrated to a proven depth of 5.45m bgl and generally comprised a silty and/gravelly dense SAND with localised areas of sandy SILT within the eastern portion in close proximity to the River Irk. A number of stiff to very stiff medium to high strength gravelly CLAY bands were recorded underlying the Made Ground soils, typically across the central portion of the site. Solid No solid geology was encountered as part of the site investigation. Groundwater Groundwater has been recorded at depths of 0.50-3.50m bgl; generally shallower in close proximity to the River Irk.
Human Health	The preliminary Tier I Human Health risk assessment has identified the presence of site wide elevated heavy metals, non-volatile PAHs / TPH compounds and asbestos within the Made Ground soils. Asbestos has been identified within the shallow Made Ground, and as such it will be necessary to carefully manage these impacted soils and place them in a legislatively compliant manner that will negate any possibility of future exposure. External areas will be covered by hard-standing or a chemically suitable cover system within all private garden and landscaped areas thereby removing the exposure pathway to future site users. It is possible that as yet unidentified hydrocarbon impact is present within localised hotspots underlying the existing structures and location of former tanks. It is considered that any such contamination could be addressed by the delineation, excavation and treatment of impacted soils.
Controlled Waters	Given the absence of any elevated soluble contaminants within the groundwater or River Irk and thus a complete pollutant linkage the site is not deemed to pose a significant degree of risk to controlled waters.

Ground Gas	Ground gas monitoring to date (ongoing) indicates the site falls into classification Characteristic Situation 2 / Amber 1 due to elevated carbon dioxide concentrations and special precautions will be required as part of the residential development.
Radon	Unaffected – No special protection measures required.
Potable Water Infrastructure	It is considered that a well designed and implemented programme of remediation and enabling works should negate the need for contaminant resistant infrastructure. A full UKWIR assessment will be required.
Geotechnical Assessment	
Underground Obstructions	Extensive buried obstructions have been encountered and the presence of further relict foundations is anticipated. These features pose a constraint and will require grubbing out in their entirety as part of the proposed residential development to facilitate the construction of a suitable development platform.
Allowable Bearing Pressure (ABP)	It is anticipated that on completion of the proposed site remediation and enabling works, the ground will generally comprise circa 2.00-3.00m of variable Made Ground. The Made Ground is not considered suitable founding stratum (in its current condition) due to its inherent variability and unquantifiable potential for long term total and differential settlement. The natural stiff to very stiff medium-high strength gravelly CLAY and loose to medium dense SAND have been assessed and at a depth of between 3.00-5.45m bgl a variable ABP of between 50-190kN/m² can be achieved.
Foundation Options	The presence of variable Made Ground and localised very loose sands within the near surface drift deposits to depths of ~3.0m would indicate that (based on current elevations) the depth to competent founding stratum would preclude the use of a traditional spread (strip / trench fill) type foundation. It is therefore recommended that due consideration be given to the use of vibro replacement stone columns or a piled foundation capable of transferring structural loads to competent stratum. However, the final foundation solution will be dependent on the structural loadings and elevation and should be designed by a suitably qualified structural engineer.
Building Floor Slabs	Ground bearing floor slabs are not viable given the depth of Made Ground and compressible alluvial deposits.
Heave Precautions	Given the localised underlying clay is of low plasticity and low volume change potential, heave precautions will not be required to the internal face of a foundation. However, heave precautions will be required to the underside of floor slabs (where there is no 200mm void) or ground beams within the modelled influencing distance of trees.
Soakaway Drainage	The underlying predominantly granular drift deposits are likely to provide the required degree of infiltration to make soak-away drainage infrastructure viable on this site. However full BRE 365 test will be required if the use of soak-away drainage is considered.
Sulphate Assessment	This site meets Class DS-1 and (ACEC) AC-1s. However, localised areas which meet Class DS-2 and (ACEC) AC-2s have been encountered.

CBR Design %	It is considered that the shallow Made Ground soils can be re-engineered in accordance with Class 1 (a-c) material under favourable climatic conditions to achieve a CBR of 2-4%. Where compressible ground is present to the northeast of the site, beneath proposed roads, adopted drainage infrastructure, driveways and hard stand consideration must be given to the potential for consolidation which will induce unacceptable degrees of total and differential settlement at the surface. It is therefore likely that the compressible alluvial deposits will need to be excavated where present beneath proposed infrastructure.
Cut / Fill	Development levels unknown at this time, however due to significant elevation changes between the eastern and western sector, a substantial cut / fill exercise will be required in order to create a suitable graded development platform for the proposed residential development.
Waste Characterisation	Stable Non-Reactive - Non-Hazardous / Inert; and ACM may be Hazardous (depending on quantification analysis).
Invasive Plants	Extensive infestations of Japanese Knotweed are present at the site boundaries with the adjacent river. A programme of treatment, eradication and continued control will need to be established prior to the commencement of any works in this area. All invasive plant species should be fenced at the first available opportunity.
Recommendations	Based on the findings of the intrusive site investigation, the following additional works are recommended to be completed in due course: 🔧 Specification for the eradication of invasive plants and long term maintenance; 🔧 Further assessment for Sodium Hypochlorite and SVOCs within footprint of former the bleach works (post sub-structure demolition); 🔧 Further assessment for PCBs in proximity to electrical substation (post demolition); 🔧 Remediation & Enabling Works Strategy; 🔧 Arboriculture Survey; 🔧 Plot Specific Foundation Schedule (upon receipt FFLs); 🔧 Geotechnical Earthworks Compaction Specification (Infrastructure); 🔧 Foundations to be designed by suitably qualified Structural Engineer.

2.4 Material Source

2.5 Previous LKC Investigation – Eastern Lower Area

An intrusive investigation was carried by LKC in March 2018 and involved sampling material from 31no. trial pits to depths of 2.00-4.70m from the top of the stockpiles of imported material to provide information for offsite waste disposal and potential reuse.

Information pertaining to the source and volume of the stockpiled materials in the eastern lower area was collated by the client. This included source site addresses, supporting ground investigation reports and consignment notes.

Stockpiled material comprised a gravelly sandy clay / gravelly clayey sand with brick, concrete (gravel to cobble size) with inclusions of waste wrappers, ash, clinker, metal and ceramics.

The material was subjected to a variety of tests:

- » 31no. samples (1 per pit) subjected to contamination testing with elevated PAHs and metals identified in numerous locations as well as fibres / clumps of Chrysotile identified in TP104 only.
- » All samples subjected to contamination testing were identified as non hazardous waste.
- » 13no. samples were subjected to Waste Acceptance Criteria testing and when comparing results to Landfill Waste Acceptance Criteria Limits, the samples exceeded various criteria for inert waste at hazardous waste landfills. From TP126, sample S126 exceeds the hazardous waste criteria for Total Organic Carbon. The testing results appear to be of a lower magnitude than existing on site soils as demonstrated by the previous investigation.
- » 16no. samples were subjected to leachate testing. Generally elevated concentrations of inorganic contaminants were widespread across the samples with limited and localised elevated levels of heavy end petroleum hydrocarbons. It is considered that the localised organic contamination is related to the leaching test analytical method and not representative of site conditions. The material is not considered to comprise a significant risk to River Irk or the underlying aquifers as rainfall infiltration and leaching potential will be limited and controlled by development surface water drainage infrastructure.
- » Grading tests were carried out on 23no. samples. This demonstrated much of the material was broadly cohesive in nature with a limited number of stockpiles complying with a granular specification.

3 Ground Investigation

3.1 Site Investigation Design and Methodology

In order to identify the contamination and geotechnical characteristics of the material, sampling was undertaken.

The investigation was carried out on 9th and 10th April 2019 and comprised the following:

- 19no. trial pits (using mechanical excavator) excavated to depths of 1.40-2.40m from the top of the infilled material (ref. TP101 to TP119). The trial pits were extended through the infilled material in order to characterise the material.

Sampling locations are illustrated in Figure 2. The investigation strategy was to provide lateral and vertical coverage of the placed material which has been quantified as approximately 7,100m³. This provides a sampling rate of 1no. trial pit per 375m³ of material.

Profile logs are provided in Appendix A.

3.2 Sampling Protocol

3.2.1 Soil Sampling (Contamination)

Standard sampling protocol and preservation of samples was undertaken as described in the EA guidance on site investigation¹.

Soil samples of approximately 500g were recovered in amber jars, amber vials for volatile analysis and plastic tubs. All the samples were labelled and stored in cool boxes prior to being collected by courier at the end of the day for delivery to the Chemtest laboratory in Newmarket for chemical testing. Samples were tracked using appropriate Chain of Custody forms provided by Chemtest.

Many of the contamination tests are UKAS or MCERTS accredited and further details are given in the Certificate of Analysis presented in Appendix B.

The sampling suites for the samples was determined with recourse to the on-site visual and olfactory assessment of the material.

¹ EA (2000). "Technical Aspects of Site Investigation. Volumes 1 & 2 Text Supplements Research and Development Technical Report." P5-065/Tr.

Suites and Contaminants	No. Samples	Location & Depth		Justification
Metals / metalloids, pH, water soluble sulphate, cyanide suite, phenol, TPHCWG, BTEX, MTBE, speciated PAHs, SOM and asbestos screen.	22	TP101 0-0.8m TP102 0-1.0m TP102 1.0-1.8m TP103 0.1-1.2m TP103 1.2-2.3m TP104 0-2.4m TP105 0-0.5m TP105 0.5-2.1m TP106 0-0.8m TP107 0-0.6m TP107 0.6-2.2m	TP108 0-0.7m TP108 0.7-1.8m TP109 0-0.9m TP110 0-2.0m TP111 0-2.0m TP113 0-2.2m TP114 0-1.7m TP115 0-1.9m TP116 0-2.4m TP117 0-2.4m TP119 0-2.3m	Detailed suite undertaken to allow waste characterisation and human health risk assessment to be undertaken.
Metals / metalloids, pH, water soluble sulphate, cyanide suite, phenol, TPHCWG, BTEX, MTBE, speciated PAHs, VOCs, SVOCs, SOM and asbestos screen.	5	TP101 0.8-1.4m TP106 0.8-2.2m TP109 0.9-1.5m TP112 0-1.6m TP118 0-1.8m		Although no significant evidence of VOC/SVOCs, a more detailed suite undertaken on selected samples.

Table 3-1: Summary of soil sample testing undertaken.

Suites and Contaminants	No. Samples	Location & Depth		Justification
Waste Acceptance Criteria (WAC)	14	TP101 0-0.8m TP102 0-1.0m TP104 0-2.4m TP105 0.5-2.1m TP106 0-0.8m TP107 0-0.6m TP109 0-0.9m	TP110 0-2.0m TP111 0-2.0m TP112 0-1.6m TP113 0-2.2m TP115 0-1.9m TP116 0-2.4m TP119 0-2.3m	WAC testing undertaken to further characterise the material.

Table 3-1 (continued): Summary of soil sample testing undertaken.

Notes:

If asbestos present during screen identification and quantification will be undertaken.

Metal/metalloids=arsenic, cadmium, chromium, (total and hexavalent), copper, lead, mercury, nickel, selenium, vanadium, zinc and boron; TPHCWG=carbon banded and aromatic/aliphatic split petroleum hydrocarbons; PAH=polycyclic aromatic hydrocarbons, BTEX=benzene, toluene, ethylbenzene and xylenes; MTBE=Methyl tert-butyl ether; VOC=Volatile Organic Compounds; SVOC=Semi-volatile Organic Compounds; SOM=Soil Organic Matter.

3.2.2 Soil Sampling (Leaching)

Leaching tests were carried out on a number of samples across the site to further characterise the material. Sampling was carried out in accordance with BS5930² and BS5667-11³.

² British Standard (2015). "Code of Practice for Ground Investigations". BS5930:2015.

³ British Standard (2009). "Water Quality – Sampling. Part 11: Guidance on Sampling of Groundwaters". BS ISO 5667-11:2009.

Suites and Contaminants	No. Samples	Location & Depth		Justification
Metals / metalloids, pH, sulphate, cyanide suite, TPHCWG, BTEX, MTBE, speciated PAHs, phenol, TOC and hardness.	12	TP101 0-0.8m TP102 1.0-1.8m TP103 0.1-1.2m TP103 1.2-2.3m TP105 0-0.5m TP107 0.6-2.2m	TP108 0-0.7m TP108 0.7-1.8m TP111 0-2.0m TP114 0-1.7m TP115 0-1.9m TP117 0-2.4m	Detailed suite undertaken randomly across the site to confirm the presence / absence of contamination and to allow a controlled waters risk assessment to be undertaken.
Metals / metalloids, pH, sulphate, cyanide suite, TPHCWG, BTEX, MTBE, speciated PAHs, phenol, VOCs, SVOCs, TOC and hardness.	5	TP101 0.8-1.4m TP106 0.8-2.2m TP109 0.9-1.5m TP112 0-1.6m TP118 0-1.8m		Detailed suite undertaken on selected samples.

Table 3-2: Summary of leachate sampling tests undertaken.

Notes:

Metal/metalloids=arsenic, cadmium, chromium, (total and hexavalent), copper, lead, mercury, nickel, selenium, vanadium, zinc and boron; TPHCWG=carbon banded and aromatic/aliphatic split petroleum hydrocarbons; PAH=polycyclic aromatic hydrocarbons; BTEX=benzene, toluene, ethylbenzene and xylenes; MTBE=Methyl tert-butyl ether; VOC=Volatile Organic Compounds; SVOC=Semi-volatile Organic Compounds; TOC=Total Organic Carbon.

3.3 Geotechnical Testing

Bulk samples of the material were collected and subjected to Particle Size Distribution (PSDs) tests by Murray Rix of Stockport.

Full results are presented in Appendix C and summarised in Section 5.

4 Ground Conditions

4.1 Geology – Generalised Sequence

The ground conditions beneath the site comprised made ground with natural strata comprising soft to firm silty clay encountered in TP107-TP109. A summary section of the logs is provided in Plate 4-1, with additional comments below.

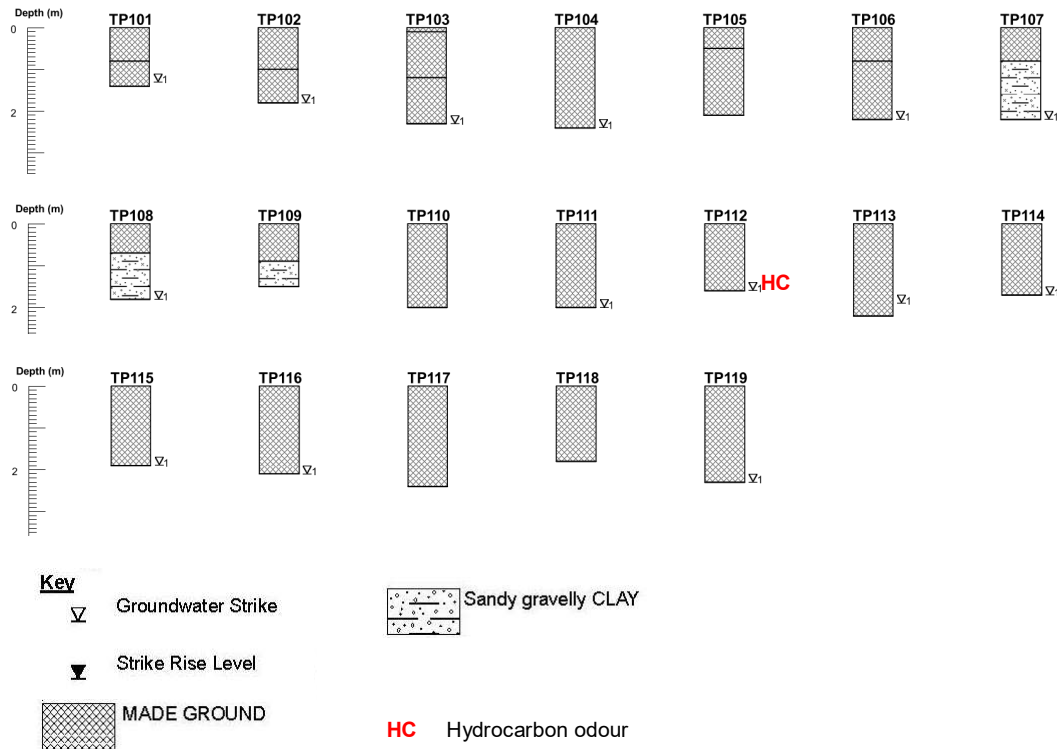


Plate 4-1: Summary of ground conditions.

Additional information on ground conditions:

- Made ground was recorded from depths of 1.2-2.4mbgl and generally consisted of sandy gravelly clay. In TP117-TP119 the made ground was generally a clayey gravelly sand. Many inclusions of demolition rubble and refuse including wrappers, wire, plastic, ash, clinker and metal were noted.
- Hydrocarbon odour noted in water at the base of TP112.
- Organic and putrid odour noted in each location.
- Many pieces of potential asbestos containing materials (ACMs) noted across the site surface and within the made ground profile.
- Potential ACMs noted in the base of TP118 and TP119.

4.2 Perched Water

Perched water was encountered during the investigation in the trial pits, generally at or just above the base of the fill materials.

5 Geotechnical Assessment

5.1 Particle Size Distribution

Particle Size Distribution tests were carried out on a number of samples and the results are summarised in Table 5-1.

Location	Ziplock Ref.	Material	Percent passing through sieve		
			50mm	2mm	0.063mm
TP101 0-0.8m	596621	Fill	93	54	23
TP102 0-1.0m	596622	Fill	71	30	27
TP102 1.0-1.8m	596623	Fill	100	82	59
TP103 0.1-1.2m	596624	Fill	88	45	14
TP104 0-2.4m	596625	Fill	68	28	9
TP105 0-0.5m	596626	Fill	77	48	15
TP105 0.5-2.1m	596627	Fill	64	26	11
TP106 0-0.8m	596628	Fill	65	27	9
TP107 0-0.6m	596629	Fill	96	57	35
TP107 0.6-2.2m	596630	Fill	100	92	13
TP108 0-0.7m	596631	Fill	67	42	22
TP109 0-0.9m	596632	Fill	85	37	10
TP110 0-2.0m	596633	Fill	100	55	22
TP111 0-2.0m	596634	Fill	91	58	23
TP112 0-1.6m	596635	Fill	75	43	13
TP113 0-2.2m	596636	Fill	87	51	21
TP114 0-1.7m	596637	Fill	79	45	17
TP115 0-1.9m	596638	Fill	94	43	14
TP116 0-2.1m	596639	Fill	95	59	25
TP117 0-2.4m	596640	Fill	90	59	22
TP118 0-1.8m	596641	Fill	87	47	22
TP119 0-2.3m	596641	Fill	85	58	25

Table 5-1: Summary of particle size distribution results.

Notes:

% passing: 2mm = gravel / sand boundary; 0.063mm = sand / silt boundary

The laboratory also provided a grading of each sample with recourse to the Specification for Highway Works Series 600⁴. The grading specification of each sample is summarised in Table 5-2.

⁴ Highways England (2009) "Manual of Contract Documents for Highway Works, Volume 1 Specification For Highway Works" Series 600, Table 6-1.

Sample	Grading Specification	General Material Description	Typical Use
TP101 0-0.8m	2C	Stony cohesive material	General Fill
TP102 0-1.0m	2C	Stony cohesive material	General Fill
TP102 1.0-1.8m	2A/2B	Wet / Dry cohesive material	General Fill
TP103 0.1-1.2m	1A	Well graded granular material	General Fill
TP104 0-2.4m	1A	Well graded granular material	General Fill
TP105 0-0.5m	2C	Stony cohesive material	General Fill
TP105 0.5-2.1m	1A	Well graded granular material	General Fill
TP106 0-0.8m	1A	Well graded granular material	General Fill
TP107 0-0.6m	2C	Stony cohesive material	General Fill
TP107 0.6-2.2m	1B	Uniformly graded material	General Fill
TP108 0-0.7m	2C	Stony cohesive material	General Fill
TP109 0-0.9m	1A	Well graded granular material	General Fill
TP110 0-2.0m	2C	Stony cohesive material	General Fill
TP111 0-2.0m	2C	Stony cohesive material	General Fill
TP112 0-1.6m	1A	Well graded granular material	General Fill
TP113 0-2.2m	2C	Stony cohesive material	General Fill
TP114 0-1.7m	2C	Stony cohesive material	General Fill
TP115 0-1.9m	1A	Well graded granular material	General Fill
TP116 0-2.1m	2C	Stony cohesive material	General Fill
TP117 0-2.4m	2C	Stony cohesive material	General Fill
TP118 0-1.8m	2C	Stony cohesive material	General Fill
TP119 0-2.3m	2C	Stony cohesive material	General Fill

Table 5-2: Summary of grading specification.

The grading tests indicate the majority of samples were cohesive in nature with sources of granular material present. However, it should be noted that unacceptable materials were abundant in the soils – these can be seen on the trial pit logs and photographs in Appendix A.

If the material was to be re-used then the results should be used by the earthworks contractor to provide an earthworks specification to place the material in the proposed level raising works. This should include a placement and compaction specification, modification where required and validation criteria.

5.2 Sulphate and pH

Water soluble sulphate and pH tests were carried out on soil samples. Full results are presented in Appendix B and summarised in Table 5-3.

Strata	pH	Sulphate (g/l)
Made Ground	7.9-10.0	0.034-1.6
Natural	7.4-7.8	0.049-0.072

Table 5-3: Summary of pH and sulphate results.

6 Generic Risk Assessment

6.1 Introduction

Current good practice requires that the findings from a site investigation should be evaluated on a site-specific basis, using a risk-based approach. Risk assessment involves identification and evaluation of the hazards presented by the concentrations of contaminants measured followed by an evaluation of the risks which are associated with these hazards (CLR11⁵).

6.2 Soil Risk Assessment

6.2.1 Methodology

With regards to the soil risk assessment LKC will use the following hierarchy:

- Category 4 Screening Levels (C4SLs).
- LQM Suitable 4 Use Levels (S4ULs).
- ATRISK Soil Screening Values (SSVs) and CL:AIRE Generic Assessment Criteria (GACs).

C4SLs were published in 2013^{6,7}. The change to the contaminated land guidance has changed the evaluation of risk from 'minimal' (referred to as Health Criteria values (HCVs))⁸ used to generate Soil Guideline Values (SGVs) to 'low' (referred to as Lowest Level of Toxicological Concern (LLTCs)). The policy companion document and supporting letter by Defra, dated 3rd September 2014, states that C4SLs *'could be used under the planning regime, as well as within Part 2A'*. Based on these comments LKC considers the justifications and assumptions used to generate 'low' risk are suitable for the planning regime.

Where no C4SLs have been generated LKC will use the LQM S4ULs⁹. Similar assumptions and land uses to C4SLs have been used. However, toxicological information has been based on 'minimal risk' as per previous guidelines and assumptions^{10,11,12,13}.

If contaminants are not present as C4SLs and S4ULs then LKC will use ATRISK SSVs or CL:AIRE GACs¹⁴. These follow the 'minimal' risk principle and more stringent exposure parameters and will be conservative.

LKC consider the main risk drivers for PAHs are benzo(a)pyrene (B(a)P) and naphthalene. This is due to B(a)P possibly being a carcinogen and most toxic of the

⁵ EA (2004). "Model Procedures for the Management of Land Contamination." R&D Publication CLR 11.

⁶ Defra (2014). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Policy Companion Document."

⁷ CL:AIRE (2013). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Final project Report."

⁸ EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.

⁹ LQM (2014). "The LQM/CIEH S4ULs for Human Health Risk Assessment."

¹⁰ EA (2008). "Updated Technical Background to the CLEA Model." Science Report – SC050021/SR3.

¹¹ EA (2008). "Human Health Toxicological Assessment of Contaminants in Soils." Science Report – SC050021/SR2.

¹² EA (2008). "A Review of Body Weight and Height Data used within the Contaminated Land Exposure Assessment Model (CLEA)." Project SC050021/Technical Review 1.

¹³ EA (2009). "Compilation of Data for Priority Organic Pollutants for Derivation of Soil Guideline Values." Science report SC050021/SR7.

¹⁴ CL:AIRE (2009). "The Soil Generic Assessment Criteria for Human Health Risk Assessment."

PAHs^{15,16} and naphthalene the most volatile and soluble¹⁷. The new C4SLs indicate B(a)P as a surrogate marker for carcinogenic PAHs, if it falls within appropriate limits, since the risk from other non-carcinogenic PAHs are considered negligible¹⁸. For B(a)P to be used as a surrogate marker it should follow the profile described by the HPA (2008)¹⁹ and CL:AIRE (2013). Naphthalene will be treated separately using the LQM S4ULs.

The proposed future development is for residential houses with gardens, therefore the assessment criteria for residential with plant uptake has been used.

All criteria have been generated using the CLEA V1.06 model²⁰ based either on 1%, 2.5% and 6% Soil Organic matter (SOM). Results will be compared to the nearest appropriate SOM.

A summary of the generic assessment criteria for C4SLs, S4ULs and CL:AIRE GACs are provided Appendix D.

B(a)P as Surrogate Marker

Based on the above assumption for PAHs, LKC undertook an assessment of the data for the site with regards to using B(a)P as a surrogate marker for carcinogenic PAHs as per HPA and CL:AIRE guidelines. The primary toxicological study related to Culp *et al.*²¹, which was based on coal tar mixtures (>80,000mg/kg of total PAHs) fed in food to mice over a two-year carcinogenicity study.

Graph 6-1 summarises the study site data with respect to how the ratios of carcinogenic PAHs relate to B(a)P, within the confidence limits provided in the HPA document.

¹⁵ EA (2002). "Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans. Benzo[a]pyrene." R&D Publication TOX2.

¹⁶ USEPA (1984). "Health Effects Assessment of Polycyclic Aromatic Hydrocarbons (PAHs). EPA 540/1-86-013."

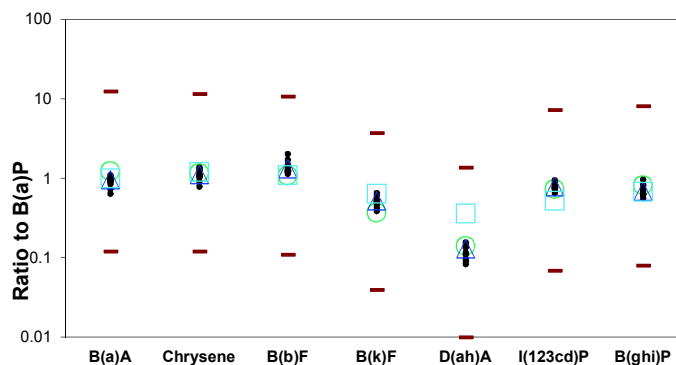
¹⁷ EA (2003). "Review of the Fate and Transport of Selected Contaminants in the Soil Environment." Draft technical report P5- 079/TR1.

¹⁸ CL:AIRE (2013). "SP1010: Development of Category 4 Screening Levels and Assessment of Land Affected by Contamination – Final project Report."

¹⁹ HPA (2010). "HPA Contaminated Land Information Sheet: Risk Assessment Approaches for Polycyclic Aromatic Hydrocarbons (PAHs)." Version 3.

²⁰ EA (2008). "CLEA Software (Version 1.05) Handbook." Science Report – SC050021/SR4.

²¹ Culp, S; Gaylor, D; Sheldon, W; Goldstein, L and Beland, F (1998). "A Comparison of Tumours Induced by Coal Tar and Benzo-a-pyrene in a 2-Year Bioassay." Carcinogenesis. **Vol 19**, no. 1, pp. 117-124.



Graph 6-1: The ratio of PAH to B(a)P in soil for all available data at the site based on 16 samples (where values were >LOD to allow the calculation of a ratio).

Notes:

B(a)P = Benzo(a)pyrene; D(ah)A = Dibenzo(ah)anthracene; B(a)A = Benzo(a)anthracene; B(b)F = Benzo(b)fluoranthene;
B(k)F = benzo(k)fluoranthene; I(123cd)P = Indeno(123cd)pyrene; B(ghi)P = Benzo(ghi)perylene
● = Ratio to B(a)P for all data ○ = Mean ratio to B(a)P for Culp data ▲ = Mean ratio to B(a)P from all data at the site
□ = Mean ratio to B(a)P for UK data presented by HPA ■ = Upper and Lower limits (order of magnitude from Culp data)

All the data points that could be used to calculate ratios fall inside the upper or lower limits.

Based on this distribution of data LKC considers B(a)P can be used as a surrogate marker for carcinogenic PAHs and the C4SL criteria is suitable for this dataset.

Where generic assessment criteria have not been derived (mainly due to insufficient toxicological data), the results were compared against contaminants of assumed likely similar toxicity (with some conservatism).

6.2.2 Soil Results Comparison against Assessment Criteria

All analysis sheets are presented in Appendix B. Elevated and pertinent results are presented in Table 6-1.

Contaminant	Units	No. of samples	Elevated Results	Sample Location	Criteria (1%/2.5%/6%)	Source of Criteria
Metals						
Arsenic	mg/kg	27	58	TP101 0-0.8m	37	C4SLs
			84	TP102 0-1.0m		
Lead	mg/kg	27	300	TP102 0-1.0m	200	C4SLs
			290	TP103 0.1-1.2m		
			310	TP104 0-2.4m		
			210	TP108 0-0.7m		
			270	TP110 0-2.0m		
			230	TP111 0-2.0m		
			230	TP112 0-1.6m		
			220	TP115 0-2.4m		
			210	TP116 0-2.4m		
			500	TP117 0.2-2.4m		
			240	TP118 0.1-1.8m		
PAHs						
Benzo(a)pyrene	mg/kg	27	8.3	TP103 1.2-2.3	5	C4SL
			8.7	TP104 0-2.4m		
			8.9	TP108 0-0.7m		

Contaminant	Units	No. of samples	Elevated Results	Sample Location	Criteria (1%/2.5%/6%)	Source of Criteria
			6.1	TP109 0-0.9m		
			5.1	TP110 0-2.0m		
			6.9	TP114 0.1-1.7m		
			7.2	TP115 0-1.9m		
Naphthalene	mg/kg	27	26	TP118 0.1-1.8m	13	S4UL
GENERAL						
pH	pH	27	Range 7.4 to 10.0			
SOM	%	27	Range 0.67 to 11			
Asbestos	N/A	27	Detected (see Table 6-2)			

Table 6-1: Summary of elevated and pertinent analytical results.

Notes:

Only results that exceeded assessment criteria have been shown and results from **all depths** are noted. Results have been compared to the nearest appropriate SOM.

Asbestos containing material was identified, as detailed in Table 6-2.

Sample Location	ID	Type	Concentration (%w/w)
TP101 0.8-1.4m	Chrysotile	Fibres / Clumps	0.004
TP102 0-1.0m	Chrysotile	Fibres / Clumps	0.002
TP103 1.2-2.3m	Chrysotile	Fibres / Clumps	<0.001
TP105 0-0.5m	Chrysotile	Fibres / Clumps	<0.001
TP105 0.5-2.1m	Chrysotile and Amosite	Fibres / Clumps	<0.001
TP106 0-0.8m	Chrysotile	Fibres / Clumps	0.002
TP106 0.8-2.2m	Chrysotile	Fibres / Clumps	<0.001
TP108 0-0.7m	Chrysotile	Fibres / Clumps	<0.001
TP111 0-2.0m	Chrysotile	Fibres / Clumps, bitumen	0.022
TP116 0-2.4m	Chrysotile	Cement, Fibres / Clumps	0.024
TP117 0.2-2.4m	Chrysotile	Cement, Fibres / Clumps	0.67 (visible)
TP118 0.1-1.8m	Chrysotile	Cement	5.7 (visible)

Table 6-2: Details of asbestos identified.

Elevated results in relation to a residential with plant uptake land use have been identified in trial pits TP101-TP105, TP108-TP112 and TP114-TP118.

ACMs were encountered in 12 out of 27 soil samples analysed.

6.2.3 Direct Contact Risk

Metals and PAHs

Elevated PAHs and metals (arsenic and lead) have been identified in the made ground. Given the number and location of elevated samples, the contamination is considered to be prevalent across the stockpiles.

At the concentrations identified, the contaminants are considered to pose a potential risk to future site users (residents) in private gardens and soft landscaped areas, where made ground may be exposed / in contact with vegetables. The principal pathways are the ingestion pathways (soil, dust and vegetables) and dermal contact.

The probability of PAH and metal contamination affecting future site users is likely. With a medium consequence, the risk is considered to be moderate and remediation is recommended.

Asbestos

Asbestos (Chrysotile) was identified in 12 out of 27 soil samples. This was mainly chrysotile as fibres / clumps with amosite also identified in TP105 (0.5-2.1m). Visible pieces of cement bound chrysotile was noted in the samples from TP117 (0.2-2.4m) and TP118 (0.1-1.8m).

Allied to this an abundance of likely cement bound asbestos pieces was noted across the surface of the site. This is illustrated on Plate 6-1 below.



Plate 6-1: Visible pieces of likely ACMs on the site surface.

Given the size of the site, the presence on the surface of ACMs and the number of samples containing asbestos (12 out of 27 samples), then ACMs are considered to be present in significant quantities across the site.

Asbestos may affect future site users in soft landscaping and garden areas. The probability is considered to be likely. With a severe consequence the risk is assumed to be high and remediation is recommended.

Additional consideration should also be given to the risk to workers and offsite receptors during groundworks and construction.

6.2.4 Risk from Inhalation of Vapours

Visual and olfactory evidence of contamination was noted in TP112; however, the results were below assessment criteria. Elevated naphthalene was encountered in TP118. This may pose a risk to site users via the inhalation of vapours.

LKC therefore consider the probability of volatile contaminants affecting site users as likely around TP118 and unlikely across the remainder of the site. The consequence is expected to be medium, therefore localised remediation is required with respect to vapours around TP118.

6.3 Gas Risk Assessment

On a qualitative basis, the infilling of c. 2.5m of made ground would require a gas risk assessment either by installation of boreholes or an assessment using a technique such as RB17²² or by the installation of appropriately designed and justified precautionary gas protection measures.

The existing investigation recommends Characteristic 2 / Amber 1^{23,24} protection measures. This would comprise a piled foundation with a passively ventilated subfloor void and a proprietary gas membrane.

The material did contain an organic and putrescible odour and this may be a source of hazardous gas.

Notwithstanding this, LKC note that the WAC testing has identified a number of exceedances of the sulphate and total organic carbon above the inert waste landfill criteria. LKC understand that these criteria values were set in order to prevent the risk of sulphate (such as gypsum in plasterboard) reacting with organic matter to create hydrogen sulphide gas.

LKC consider that the existing proposed gas protection recommendations are likely to be appropriate for this site; however, it is recommended that this is confirmed with gas monitoring following appropriate placement and compaction of the material. This monitoring will also determine if hydrogen sulphide and other hazardous gases are being generated by the placed material and any control measures that may be required in construction works.

6.4 Controlled Water Assessment

The previous investigation report indicates an unproductive (west) and Secondary A (east) Aquifer overlying a Principal Aquifer. In addition, the River Irk is present adjacent to the northern site boundaries. No nearby groundwater abstractions have been indicated.

The previous investigation determined that as no elevated soluble contaminants were present within samples of groundwater or the River Irk that the site did not “pose a significant degree of risk to controlled waters”.

LKC considers the River Irk as the primary receptor. The Secondary A and Principal Aquifers are also considered viable receptors.

Evidence of hydrocarbons was noted in TP112.

LKC have compared the leaching test results above Limits of Detection (LOD). Where relevant the review of priority substances take precedence considering threshold

²² CL:AIRE Research Bulletin 17. “A Pragmatic Approach to Ground Gas Risk Assessment”. November 2012.

²³ CIRIA (2007). “Assessing Risks Posed by Hazardous Ground Gases to Buildings.” CIRIA C665

²⁴ BSI (2015). “Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for new buildings.” BS8485:2015.

values for groundwater cannot be used '*as part of site specific investigations*'. The hierarchy is as follows:

- » River Basin District Standards²⁵ and updated Water Framework Directive²⁶ for Annual Average / Maximum Allowable Concentration Environmental Quality Standards (AA-MAC-EQS) for priority substances (surface water risk).
- » 2001 Environment Agency Values for Environmental Quality Standards (EQS) and UK Drinking Water Standard (UKDWS)²⁷.
- » 2009 UK Drinking Water Standard (UKDWS)²⁸.
- » Surface Water Abstraction Directive (SWAD)²⁹ based on A2 treatment (TPH only).
- » Resource Protection Values (RPVs)³⁰.
- » Minimal Reporting Values (MRVs).

The SWAD criteria are considered appropriate for TPH and would be more realistic criteria than UKDWS. For example the UKDWS for hydrocarbons (dissolved/emulsified) is 10µg/l, whereas it would be 200µg/l using SWAD for normal physical/chemical treatment (A2 treatment). This standard has been repealed in 2007³¹, but values have not been replaced currently in the Water Framework Directive. A recent document by the EA on risk from petroleum hydrocarbons in groundwater³² has not derived EQS values for emulsified hydrocarbons but state that it must not form distinctive films or produce harmful effect to fish. It is understood that the EA are working on providing guideline values for individual carbon bands. Until this has occurred LKC considers the use of SWAD to be still acceptable for TPH for surface waters.

The risk from List 2 compound (EC Dangerous Substance Directive 76/464/EEC) in a freshwater ecosystem is governed by the hardness of the water. Where applicable the hardness was taken into account for these contaminants.

Additionally, to run the M-BAT³³ model to take into account bioaccessibility of copper, zinc and nickel the Dissolved Oxygen Concentration (DOC), pH and calcium concentrations will be used.

In total 17no. leaching tests were undertaken. With regards to inorganic contaminants elevated concentrations of chromium (8no.), copper (11no.), lead (8no.), nickel (4no.), zinc (9no.) and sulphate (11no.) were encountered.

The leachate testing data included Total Organic Carbon (TOC). This data was included in the M-BAT model (Appendix E) in the absence of DOC data. This is a highly conservative approach as the TOC values used were often above the upper limit of the validated DOC range within the model. The M-BAT model shows 6no. copper exceedences and 1 no. nickel exceedance. No exceedences of zinc were noted.

²⁵ Defra (2010). "The River Basin Districts Typology, Standards and Groundwater Threshold Values". Water Framework Directive (England and Wales) Directions 2010.

²⁶ Defra (2015). "Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015".

²⁷ EA (2002). "Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the Environment Protection Act 1990."

²⁸ Statutory Instruments (2009). "The Private Water Supplies Regulation 2009." No. 3101

²⁹ Surface Water Directive (EC 75/440/EEC); Water Supply (Water Quality) Regulations 1989, as modified.

³⁰ SEPA (2010). "Assigning Groundwater Assessment Criteria for Pollutant Inputs." WAT-PS-10-01.

³¹ DWI (2008). "The 2009 Periodic Review of Prices – Guidance on Drinking Water Quality Requirements."

³² EA (2009). "Petroleum Hydrocarbons in Groundwater: Supplementary Guidance for Hydrological Risk Assessment."

³³ WFD (2014). "UKTAG River & Lake Assessment Method Specific Pollutants (Metal): Metal Bioavailability Assessment Tool (M-BAT)." Water Framework Directive.

Moreover, leachate testing is aggressive (de-ionised water) and is not in aqueous equilibrium (steady state) with the solid sample. This may cause rapid dissolution and overestimation of the aqueous phase concentrations compared to groundwater in contact with contaminated soils. Although dissolution may be reduced for highly hydrophobic contaminants³⁴, such as B(a)P it is likely that the initial leaching will remove the most readily available hydrocarbons and subsequent flushing would reduce the leachable concentrations³⁵. Traditionally the leaching test was developed for inorganic constituents and the leaching of organics is poorly understood³⁶.

With regards to organic contaminants elevated concentrations of lighter fraction aromatic petroleum hydrocarbons and naphthalene were encountered in TP118.

These exceedances are at or above theoretical solubility limits³⁷ and suggest free product. The soil from TP118 also had elevated levels of petroleum hydrocarbons.

The clay present below much of the site and above the Principal Aquifer should significantly reduce any sub-surface migration and processes including dilution, attenuation and biodegradation will reduce the concentrations of any contamination leaching from the material.

Post development rainfall may infiltrate the placed material and leach contaminants out of the placed soil prior to migrating to the receptors – key receptor being the River Irk.

The potential infiltration from rainfall will be also managed in the development by the surface water drainage strategy and the proposed development drainage infrastructure. Not all rainfall on site will be able to directly infiltrate site soils due to the presence of hard cover. This may comprise 55% of the development area.

It is not considered best practice to construct surface water soakaways within made ground where contaminants may be mobilised, so it is likely that for the purposes of the built development area (roofs, roads and driveways) that surface water (rainfall) will be collected by the site drainage and disposed of by methods other than infiltration directly into the placed material. This could be *inter alia* direct to the River Irk following a level of treatment or “polishing”, or via deeper soakaways directly into natural granular strata.

On the basis of the above the majority of the material is not considered to comprise a significant risk to the River Irk or the underlying Secondary A and Principal Aquifers. However, it would be prudent to remove or isolate hydrocarbon impacted material present in TP112 and TP118.

6.5 Sub Surface Concrete

The concentrations of soluble sulphate in the soil when contrasted to BRE Digest 2005³⁸ indicate that sulphate resistant concrete will be required across the site.

The specification should be determined by the appointed structural engineer.

³⁴ EA (1999). “Methodology for the Derivation of Remedial Targets for the Soil and Groundwater to Protect Water Resources.” R&D Technical Report, P20

³⁵ EA (2006). “Remedial targets Methodology: Hydrological Risk Assessment for Land Contamination.”

³⁶ EA (2009). “Petroleum Hydrocarbons in Groundwater: Supplementary Guidance for Hydrological Risk Assessment.”

³⁷ TPHCWG (1999). “Human Health Risk-Based Evaluation of Petroleum Release Sites: Implementing the Working Group Approach: Volume 5.”

³⁸ BRE (2005). “Concrete in Aggressive Ground.” Special Digest 1.

7 Waste Disposal Assessment

The soil contamination results as presented in Appendix A have been used to help determine the disposal route should any material be earmarked for off-site disposal. As an initial screen the soil results were inputted into '**HAZ-WASTE^{SOIL}**'. This is a web-based facility that allows an assessment of contaminant soils and classifies the soils as either hazardous or non-hazardous waste.

It is understood that **HAZ-WASTE^{SOIL}** has been designed to cover the European Waste Catalogue code number 17 05 03 "soil and stones containing dangerous substances" and follows current guidance^{39,40,41,42,43}.

Where less than limits of detection (LOD) were recorded, the value of the LOD was inputted. Where applicable relevant metal species were used relating to an ash source, such as metal oxides. This will provide a more realistic classification assessment.

The results show that the made ground in TP117 (0.2-2.4m) and TP118 (0.1-1.8m) are classified as **HAZARDOUS WASTE**. TP117 is due to the ACM content and TP118 is due to ACM and petroleum hydrocarbon content. The remaining samples based upon the analytical results would be classified as **NON-HAZARDOUS WASTE**. The output sheets are provided in Appendix E.

Notwithstanding the above sample classification as non-hazardous waste, there is an abundance of visible pieces of likely ACMs present across the site surface and within the soil itself. EA Technical Guidance WM3 states:

"If the waste contains fibres that are free and dispersed then the waste will be hazardous if the waste as a whole contains 0.1% or more asbestos. If the waste contains any identifiable pieces of suspected asbestos containing material they must be assessed as set out below. This would also apply to any dispersed fibres produced by deliberately breaking up such identifiable pieces.

Where the waste contains identifiable pieces of asbestos containing material (i.e. any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye), then these pieces must be assessed separately. The waste is hazardous if the concentration of asbestos in the piece of asbestos containing material is 0.1% or more. The waste is regarded as a mixed waste and classified accordingly."

Waste Acceptance Criteria testing has also been carried out on 14no. samples. After comparing the results to the Inert Waste Landfill Acceptance Criteria Limits exceedances of Total Organic Carbon (5no.), TPH Total WAC (3no.), Total PAH (2no.), Antimony (3no.), Sulphate (13no.) and Total Dissolved Solids (10no.) were identified.

LKC recommend that the analytical results should be sent through to the chosen landfill operator so that they may make a final decision on the destination of the waste from site.

³⁹ EA (2018). "Guidance on the Classification and Assessment of Waste (1st Edition v1.1)". Technical Guidance WM3.

⁴⁰ The Hazardous Waste Directive, (HWD, Council Directive 91/689/EC).

⁴¹ European Waste Catalogue, 2002 (EWC 2002, Commission Decision 2000/532/EC) as amended by Commission Decision 2001/118/EC, 2001/119/EC and Council Decision 2001/573/E.

⁴² List of Wastes (England) Regulations 2005.

⁴³ Approved Supply List (Eighth Edition), 2002. ISBN: 0 7176 2368 8.

8 Conclusions

LKC has been commissioned by Blackley Developments Ltd to undertake a trial pit investigation on material placed in the upper reservoir.

The investigation involved 19no. trial pits to provide soil sampling of the placed material to provide information for offsite waste disposal and potential reuse.

The material comprised a gravelly sandy clay / gravelly clayey sand with brick, concrete (gravel to cobble size) with inclusions of waste wrappers, ash, clinker, metal and plastics. An organic / putrid odour was noted in each trial pit and a hydrocarbon odour was noted in TP112.

Soils samples were taken from each location and subjected to contamination testing. Elevated PAHs and metals were identified in numerous locations and ACMs in the form of fibres / clumps of Chrysotile with some visible pieces of cement were noted in 12no. out of 27no. samples. One sample also included Amosite.

Many pieces of potential asbestos containing materials (ACMs) noted across the site surface and within the soil profile.

Two of the soil samples were identified as hazardous waste due to asbestos quantities. One sample was also classified as hazardous waste due to the petroleum hydrocarbons content. Notwithstanding this, with regards to the visible pieces of ACMs on the site surface and in the soil, WM3 notes that:

“Where the waste contains identifiable pieces of asbestos containing material (i.e. any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye), then these pieces must be assessed separately. The waste is hazardous if the concentration of asbestos in the piece of asbestos containing material is 0.1% or more. The waste is regarded as a mixed waste and classified accordingly.”

A total of 14no. samples were subjected to Waste Acceptance Criteria testing. When contrasted to Inert Landfill Waste Acceptance Criteria Limits exceedances of Total Organic Carbon (5no.), TPH Total WAC (3no.), Total PAH (2no.), antimony (3no.), sulphate (13no.) and total dissolved solids (10no.) were detected.

17no. samples were subjected to leachate testing. Generally elevated concentrations of inorganic contaminants were present across the samples with limited and localised elevated levels of naphthalene and lighter fraction petroleum hydrocarbons in TP118. The majority of the material is not considered to comprise a significant risk to River Irk or the underlying aquifers as rainfall infiltration and leaching potential will be limited and controlled by development surface water drainage infrastructure. However, it would be prudent to remove, or isolate hydrocarbon impacted material present in TP112 and TP118.

PSD and grading tests were carried out on 22no. samples. This demonstrated much of the material was broadly cohesive in nature with a limited number of stockpiles complying with a granular specification. The re-engineering of this material may be constrained by the presence of ACMs and the volume of deleterious material in the soils.

9 Recommendations

The recommendations provided below are considered appropriate for the sampled material based on the site investigation work undertaken. LKC should stress that no remediation, enabling works or designing works should take place until Regulatory approval has been obtained.

Overview

LKC consider the material presents an immediate risk to human health in its current state to nearby receptors and trespassers from airborne fibres and control measures including removal of visible surface pieces of asbestos and possible capping should be carried out to mitigate this risk.

In addition, hydrocarbon impacted material around TP112 and TP118 should also be removed from site or sealed to mitigate any unacceptable risk to controlled waters.

Reuse and Retention

The proposed development has a shortfall of materials. The ideal scenario would be for the material to be placed as bulk fill at depth and capped and hydraulically sealed to mitigate any risk to human health and controlled waters.

The presence of ACMs and deleterious material in its current state would render any earthworks processing (such as screening) and re-deposition and compaction unviable.

Regulatory

The findings of this report should be provided to the Environment Agency for comment and a disposal or re-use route for the material agreed.

Asbestos in Soil

Asbestos was noted across the site surface and is present within the soil.

Therefore, additional precautions shall be taken when working with the material. The presence of asbestos in the site soils presents a potential risk of generation of airborne fibres if this material is disturbed, such as for excavations to construct new foundations.

This risk can be managed by careful procedures and site monitoring to reduce the risk of airborne fibres, and it is recommended that an appropriate 'Asbestos Management Strategy' is developed and adopted for all intrusive ground works which disturb the made ground in the area of concern. This should be carried out in line with CIRIA C733⁴⁴.

This may include asbestos awareness training for all site staff, provision of suitable personal and respiratory protective equipment and air monitoring.

With regards to cement bound asbestos, this can be handpicked, doubled bagged and disposed of appropriately to a licenced landfill. Guidance on removing asbestos cement is described in HSE (2012)⁴⁵.

⁴⁴ CIRIA (2014). "Asbestos in Soil and Made Ground: A Guide to Understanding and Managing Risks". C733.

⁴⁵ HSE (2012). "Removing Asbestos Cement (AC) Debris." A11 Asbestos Essential – Non-licenced Tasks.

Updated Build Phase Remediation Strategy

If the material is to remain on site then LKC recommend that further boreholes are drilled and gas monitoring is carried out to identify if the proposed CS2 / Amber 1 protection measures remain applicable for the development.

The existing Remediation Strategy should be updated and remedial requirements for the build phase *inter alia* specification and validation requirements for garden capping layers, gas protection measures and potable water pipes provided for regulatory approval.

The appointed Structural Engineer should determine the specification of any subsurface concrete to be laid in contact with the materials.

Site Completion Report

All the remediation and validation work should be documented in a Site Completion Report. The following Completion Reports will be provided to satisfy the outstanding contaminated land planning conditions:

- » **Pre-construction Phase Completion Report:** Material placement, validation testing, ACM management details, post placement gas monitoring survey and revised build phase Remediation Strategy.
- » **Build-phase Construction Completion Report:** garden capping layer depth, validation testing of any imported topsoil, gas protection measures validation, completion of UU potable water supply document and/or discussion with UU.

The aim of the completion reports will be to demonstrate to the Local Authority that the site has been suitably remediated to the extent that construction works may commence and, in accordance with the National Planning Policy Framework (NPPF)⁴⁶:

- » The site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation;
- » After remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990⁴⁷; and,
- » Adequate site investigation information, prepared by a competent person, is presented.

Once the above is satisfied the Local Authority should be able to discharge all the relevant contaminated land conditions.

⁴⁶ DCL (2018). "National Planning Policy Framework." Department of Communities and Local Government.

⁴⁷ Defra (2006). "Environmental Protection Act 1990: Part 2A Contaminated land." Defra Circular 01/2006.

Figures

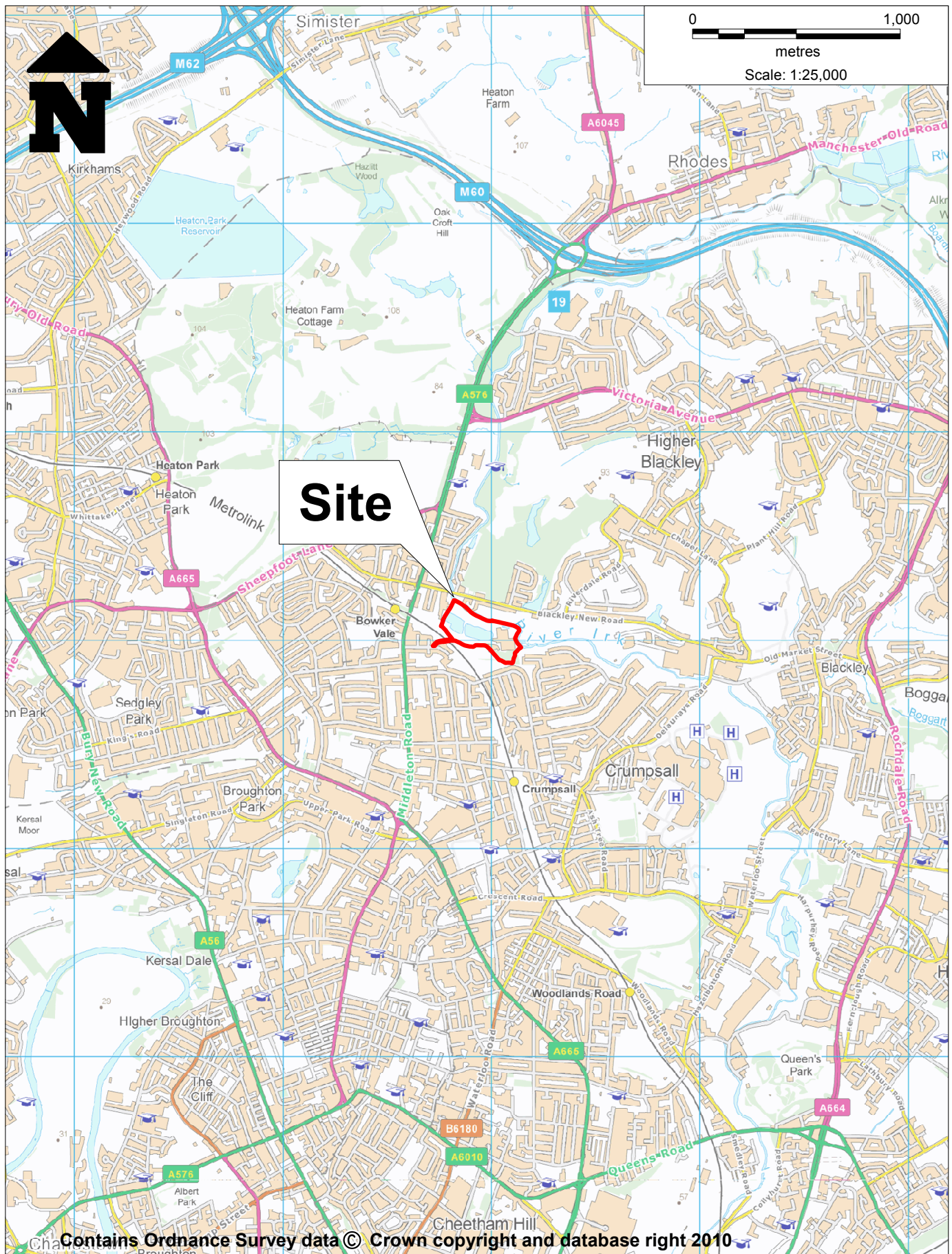
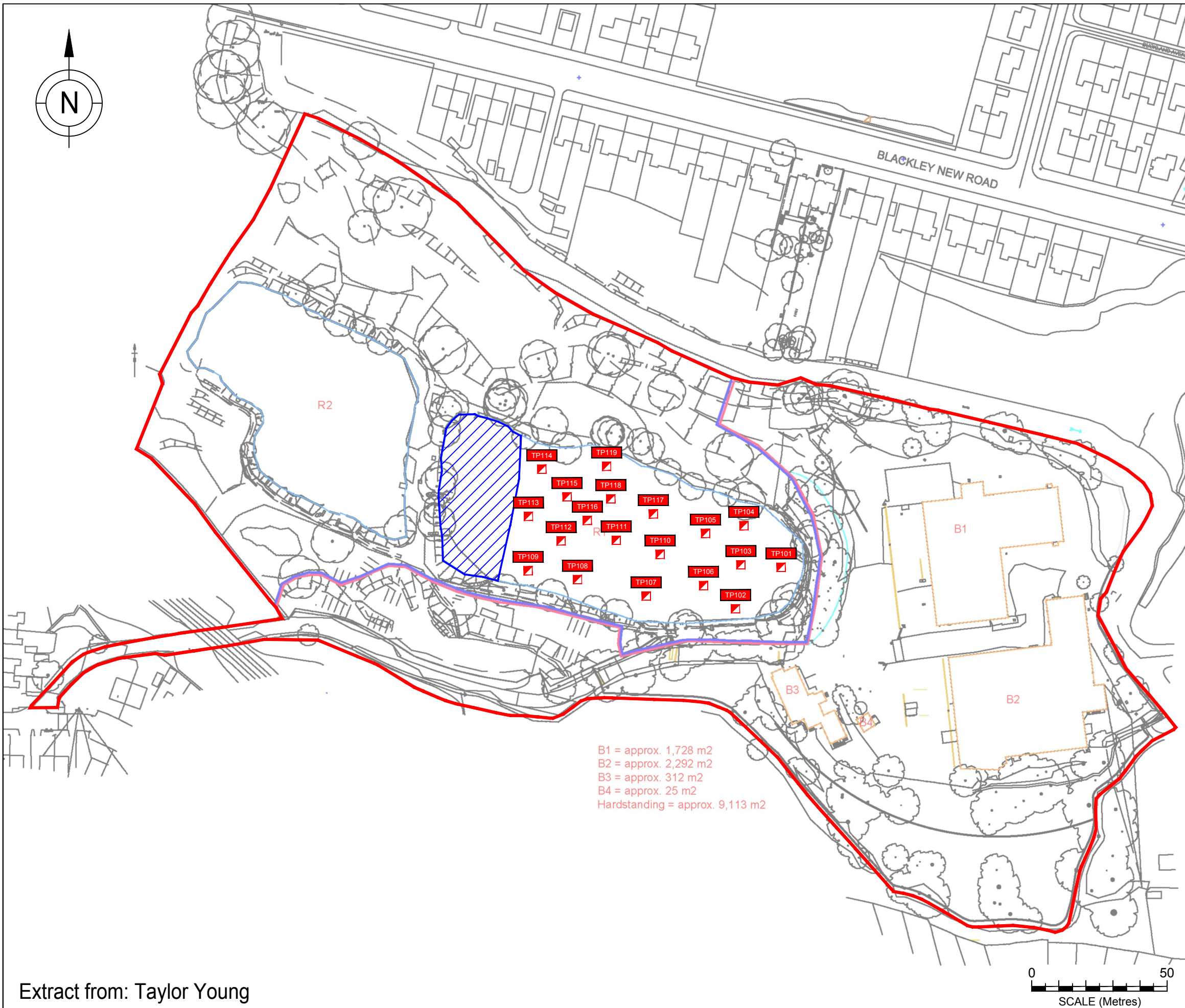


Figure 1: Site Location Plan, Blackley Mere Lower Reservoir, Manchester

Drawn: April 2019 Scale: 1:25,000 @ A4 (see scale bar)



Extract from: Taylor Young
Drawing Ref: Site Boundary & Location, No.SP(90)105, Rev:C (23/10/2012)

KEY

- Site Boundary
- Trial Pit (TP)
- Water

Sampling Locations and features annotated by LK Consult Ltd are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.



Client: Blackley Developments Ltd			
Site: Blackley Mere Lower Reservoir, Manchester			
Title: Site Investigation Location Plan			
Job No.: LKC 19 1139	Scale (See Scale Bar): See Scale Bar	Figure: 2	Revision:
Drawn By: AC	Checked By: KW	Drawn: Apr 2019	