

ADDITIONAL PHASE 2 SITE INVESTIGATION REPORT
FOR LAND AT
1 COMMERCIAL STREET, KNOTT MILL, MANCHESTER M15 4PZ

Prepared for:-

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June 2021

**Project Quality Assurance
Information Sheet**

***Additional Phase 2 Site Investigation Report for Land at 1 Commercial Street, Knott Mill,
Manchester M15 4PZ.***

Report Number : TLC1143

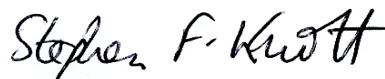
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1.0 INTRODUCTION

- 1.1 The Land Consultancy Limited (TLC) has been commissioned by Mr Andy Ince of in-*fill* Developments Ltd (e-mail dated 19th April 2021), to carry out additional Phase 2 contaminated land related site investigation work for a plot of land located at the junction of Commercial Street and Constance Street in city centre Manchester.
- 1.2 Site location and boundary plans are presented in Drawing Nos. TLC1143/01a and 02 and proposed development plans are presented in Drawing Nos. TLC1143/03a to TLC1143/03d (Appendix A). The proposed development comprises seven four-storey town houses each with a private rooftop garden. No managed ground level garden or soft landscaping areas are scheduled.
- 1.3 TLC has previously completed a combined Phase 1 and 2 Contaminated Land Report¹ for the site which drew largely on two Environmental Management Solutions Ltd (EMS) contaminated land reports^{2,3} issued in 2008; both EMS reports were completed on behalf of Bingham Davis. The TLC report reviewed the existing data, identified data gaps, provided a contemporary re-risk assessment of the available data and provided recommendations for further intrusive works. It is essential that the reader refers to the previous TLC report for background information.
- 1.4 The previous TLC report noted that *inter alia* the previous Phase 2 SI works were constrained by existing buildings and the EMS recommended post demolition Phase 2 works appeared to have not been carried out, that certain potential contaminants of concern (e.g. asbestos) had not been tested for and that further testing may help delineate potential contamination hotspots. Therefore, a further Phase 2 investigation was proposed.
- 1.5 TLC's additional Phase 2 site investigation remit included the following:
 - Sinking 5no. small diameter windowless sampling boreholes with soil sampling and in-situ testing;
 - Installing dual monitoring wells (made ground and natural strata screened separately) into 3no. of the boreholes for gas and groundwater level monitoring/sampling purposes;
 - Excavation of 7no. trial pits by mechanical means with soil sampling;
 - Logging of the strata encountered in the boreholes to BS 5930:2015⁴;
 - Undertaking a period of gas and groundwater level monitoring of the installed boreholes (6no. visits over a period of approximately six weeks); and,
 - Scheduling soil and leaching test samples for laboratory testing.
- 1.6 TLC's remit also included:
 - Factually reporting on the works undertaken; and,

¹ TLC report dated February 2021, referenced T038 SFK (TLC1143) rep AI Infill 040221 and entitled 'Combined Phase 1 Contaminated Land Desk Study and Site Investigation Report'.

² EMS report dated February 2008, referenced EMS/1240 and entitled 'Site at Commercial Street, Manchester', 'Desk Study'.

³ EMS report dated March 2008, referenced EMS/1240b and entitled 'Preliminary Contaminated Land Investigation' of 'Knott Mill, Commercial Street, Manchester'.

⁴ BSI Standards Publication BS 5930: 2015 entitled 'Code of practice for ground investigations', 'Report on Preliminary Risk Assessment'.

- Providing advice with respect to contamination and ground gases and potential remediation considerations.
- Reporting to include relevant information from the previous EMS reports.

1.7 General

- 1.7.1 It should be noted that the assessment of the factual data obtained as part of this investigation has been undertaken in accordance with generally accepted consulting practice, and in line with currently accepted national and international guidelines.
- 1.7.2 The assessment and recommendations made in this report are limited to those, which can be made based on the findings of the available site investigation data. TLC assumes all third-party data to be true and correct. No responsibility can be accepted by TLC for inaccuracies in the information supplied by any other party.
- 1.7.3 This report assumes that the ground levels intended for the redevelopment will be similar to those existing at present.
- 1.7.4 The interpretation of site investigation data presented in this report involves the interpolation of data in between exploratory holes. No responsibility can be accepted by TLC for any unexpected variations that may occur in the ground conditions between the exploratory holes.
- 1.7.5 This report is written in the context of an agreed scope of works and should not be used in a different context. Furthermore, new information, improved practices and changes in legislation may require a re-interpretation of the report in whole or in part after its original submission. TLC reserves the right to alter the conclusions and recommendations made in this report in the light of further information which may become available. This report is provided for the sole use of the client and is confidential to them and their professional advisors.

2.0 SITE LOCATION AND DESCRIPTION

- 2.1 The site is located within city centre Manchester and is surrounded by numerous multi-storey office and apartment blocks. Deansgate railway station is situated $\approx 55\text{m}$ to the north and Manchester Town Hall is located $\approx 725\text{m}$ to the north-east. The site can be centred approximately at the following coordinates: 383432E, 397436N.
- 2.2 Site location plans are presented in Drawing Nos. TLC1143/01a and 01b in Appendix A. A more detailed plan, which displays the site in its current configuration is present in Drawing No. TLC1143/02.
- 2.3 The site is triangular in shape and has an area of $\approx 475\text{m}^2$.
- 2.4 Overall, the topography of the site and immediate surrounding area is approximately level. The site is situated at an altitude of $\approx 28.6\text{m}$ AOD.
- 2.5 A site walkover survey was undertaken on 5th February 2021. The main findings of this survey are presented on Drawing No. TLC1143/02 in Appendix A and are summarised below:
- The site comprises of a gravel surfaced car park and is surrounded by an $\approx 0.3\text{m}$ high wooden fence. Vehicular access into the car park is from Commercial Street. The gravel comprised mainly of quartzite; brick, limestone and sandstone were also noted. Concrete, sandstone and tarmacadam cobbles and boulders were also noted.
 - Black gravelly sand fill appeared to underlie the surface quartzite gravel layer. This fill material may well have contained ash and cinder.
 - Several recently cut buddleia plants were present at the northern boundary.
 - An office block and a demolition rubble surfaced car park are found immediately beyond the northern site boundary. The eastern site boundary is formed with Constance Street beyond which office development is found. The south-western site boundary is formed with Commercial Street beyond which office and residential apartment development are situated.
 - No asbestos containing materials were observed during the site walkover.
 - No visible or olfactory evidence for the presence of mobile contamination (e.g. hydrocarbons/solvents) was recorded.
 - No invasive plant species (e.g. Japanese Knotweed, Himalayan Balsam, Giant Hogweed etc) were observed growing across the site.
 - No borehole well covers were observed relating to the EMS March 2008 preliminary site investigation work.
- 2.6 Selected site photographs taken during the walkover survey are presented within TLC's February 2021 report.

3.0 FIELDWORKS

3.1 Introduction

- 3.1.1 A complete record of the soils recovered in the exploratory holes providing descriptions of strata, in-situ testing results and samples obtained is given on the record sheets in Appendix B (trial pit logs and photographs) and Appendix C (windowless sampling borehole logs). The exploratory hole locations are presented on Drawing No. TLC1143/02 in Appendix A.
- 3.1.2 Prior to breaking ground, each sampling position was checked against known services runs and then scanned for services using a Cable Avoidance Tool. As a final check for services, hand pits were also excavated to $\approx 1.00\text{m bgl}$ ahead of the windowless sample boreholes.

3.2 Windowless Sampling Boreholes

- 3.2.1 5no. small diameter windowless sampling boreholes (WS1 to WS5) were sunk to depths of between 3.71m (WS2) to 4.33m (WS5) on 28th April 2021. Windowless sampling was carried out from the base of the hand pits which had been excavated at each location.
- 3.2.2 The boreholes were sunk to enable: the nature of the soils to be determined across the site; the depth to rockhead to be ascertained; samples to be obtained for chemical laboratory testing; and, to enable gas and groundwater level monitoring/sampling wells to be formed.
- 3.2.3 Soil cores were recovered from each borehole in plastic liners which were subsequently split for logging and sampling purposes; soil cores were logged by TLC to BS 5930:2015.
- 3.2.4 Standard penetration tests (SPTs) were carried out at regular depth intervals within the boreholes. No corrections have been applied to the 'N' values displayed on the borehole logs. The SPT calibration certificate is presented in Appendix C.
- 3.2.5 Photo ionisation detector (PID) headspace analyses were carried out on samples recovered from the boreholes at regular depth intervals. The PID results are presented on the borehole logs and the PID calibration certificate is presented in Appendix F.
- 3.2.6 Dual standpipe installations (19mm ID uPVC) were placed within boreholes WS1, WS2 and WS5 upon their completion, to facilitate subsequent gas and/or groundwater level monitoring and sampling. Installation details are given on the appropriate logs. The boreholes that were not installed were backfilled with bored arisings and bentonite.

3.3 Gas and Groundwater Level Monitoring and Sampling

- 3.3.1 The response zones within the installed boreholes are summarised below:

Hole ID	Response Zone (bgl)	Geology
WS1	0.50 to 1.60m	MADE GROUND.
	2.10 to 3.10m	Natural SAND
WS2	0.50 to 1.57m	MADE GROUND.
	2.10 to 3.10m	Natural CLAY and SILT
WS5	0.50 to 1.55m	MADE GROUND.
	2.10 to 3.15m	Natural SAND

- 3.3.2 'Spot' monitoring of the installations has been undertaken by TLC on 6no. occasions between 5th May 2021 and 17th June 2021. Spot monitoring was undertaken using a Geotechnical Instruments GA2000 calibrated for carbon dioxide, methane, oxygen, hydrogen sulphide,

carbon monoxide, gas flow and borehole pressure differential measurements. Borehole standing water levels and installation depths were recorded using a dip-meter.

3.3.3 The gas and groundwater level monitoring results obtained to date are presented in Appendix E. The GA2000's calibration certificates are also presented within this appendix.

3.3.4 It was not possible to obtain groundwater samples for laboratory analysis as groundwater levels are below the installation depths.

3.4 Machine Excavated Trial Pits

3.4.1 7no. trial pits were excavated using a JCB 3CX on 29th April 2021. The pits were excavated to depths of between 1.80m (TP2, TP3, TP6 & TP7) to 2.20m (TP5).

3.4.2 The trial pits were excavated to enable: the nature of the soils to be determined across the site; samples to be obtained for chemical laboratory testing; and, to enable an assessment of the stability of the made ground under shallow excavation.

3.4.3 Soils were logged at the surface from the excavation arisings by TLC to BS 5930:2015.

3.5 Laboratory Testing

3.5.1 All of the soil samples to be subjected to contamination testing were transported to the testing laboratory in cool boxes kept <4°C. The majority of the tests undertaken at the laboratory are MCERTS and UKAS accredited.

3.6 EMS Investigation

3.6.1 For completeness and to assist in this study, copies of the EMS borehole logs and laboratory certificates of analysis are provided in Appendix G. The exploratory hole locations are presented on Drawing No. TLC1143/02 in Appendix A.

4.0 GROUND CONDITIONS

4.1 The desk study indicated that the site would probably be underlain by deposits of Made Ground over Superficial Glacial Fluvial Sheet Deposits over Bedrock Triassic Chester Pebble Bed Formation sandstone.

4.2 The strata encountered during the EMS and TLC investigations are summarised below.

4.3 Made Ground

4.3.1 Deposits of Made Ground were recorded in each exploratory location at either 0.50m or 0.60m in the EMS boreholes, from 1.60m to >1.85m in TLC trial pits and from 1.60m to 2.00m in TLC windowless sample boreholes. The Made Ground comprised of a mixture of reworked gravelly sand or gravelly clay material with inclusions of ash, cinders, sandstone, coal. Occasional polythene, rusted metal, timber fragments, slag and pottery noted at shallow depths. Tarmac was noted at the surface or at shallow depth in all trial pits and boreholes WS3 to WS5.

4.3.2 The shallow granular made ground was noted as 'compact' in places, reflecting the slow rate of excavation. Cohesive Made Ground was generally noted as having a soft to firm consistency.

4.3.3 TP1, TP5, TP6 and WS1 were noted as ash rich, and the stratum in TP7 1.30m to 1.60m was noted as slightly organic rich.

4.3.4 SPT 'N' values obtained within the Made Ground are summarised in the table below:

Depth (m bgl)	SPT N Value				
	WS1	WS2	WS3	WS4	WS5
1.00-1.45m	8	0	3	0	0

4.3.5 The 'N' values indicate that the Made Ground is generally loose or of low strength. The variability is likely due to coarse gravel or presence of cobble sized inclusions.

4.4 Natural Superficial Strata

4.4.1 Generally a soft to firm consistency, very low to low strength sandy CLAY was encountered beneath the Made Ground (penetrated between 1.60m and 2.00m bgl). The EMS logs noted the upper region of this horizon (logged as clayey SAND) was intermixed with the overlying Made Ground and is therefore likely to be reworked. This accounts for the discrepancy in Made Ground depth logged between the two surveys. The CLAY was recorded in all locations where Made Ground was penetrated except for TP4 on the eastern site boundary. The CLAY was logged (where encountered) to depths of between >1.80m to 2.70m.

4.4.2 Granular strata were recorded below the CLAY with the EMS boreholes recording SAND then SAND and GRAVEL to depths of 4.00m to 4.20m. TLC also logged similar granular strata to depths of >3.55mbgl to 4.25mbgl. A layer of SILT was recorded from 2.7mbgl to 3.1mbgl in WS2 only. WS3 and WS4 refused in gravelly SAND at depths of 4.27mbgl and 4.01mbgl respectively.

4.4.3 SPT 'N' values obtained within the Superficial Deposits are summarised in the table below:

Depth (m bgl)	SPT N Value							
	WS1	WS2	WS3	WS4	WS5	BH1	BH2	BH3
1.00-1.45m	-	-	-	-	-	-	-	-
2.00-2.45m	7 (S)	0 (C)	4 (C/S)	7 (S)	4 (S)	34 (S&G)	6 (S)	16 (S)
3.00-4.00m	39 (S)	40 (S)	2 (S)	27 (S&G) 44/235mm (S&G)	4 (S)	39 (S&G)	4 (S)	32(S)
4.00-4.45m	-	-	50/265mm (S)	-	40/225mm (S&G)	-	-	-

Note: C = Clay; S = SAND; S&G = SAND and GRAVEL; REF = Refusal.

4.4.4 The 'N' values indicate a variability in the shallow CLAY strata. The granular SAND and SAND and GRAVEL strata indicate a general increase in density with depth and towards the top (weathered zone) of the SANDSTONE bedrock. However, variability in density exists with lower 'N' values of between 2 to 6 in WS3 (between 2.0mbgl to 3.45mbgl), WS5 (2.0mbgl to 3.45mbgl) and BH2 (2.2mbgl to 3.65mbgl).

4.5 Sandstone Bedrock

4.5.1 SANDSTONE bedrock was recorded by EMS at the base of each borehole beneath the superficial deposits. The sandstone was proven to depths of between 4.50-4.95m bgl. TLC boreholes recorded weathered SANDSTONE in WS1 (3.65mbgl to >3.90mbgl), WS2 (3.55mbgl to >3.71mbgl) and WS5 (4.25mbgl to >4.33mbgl). The sandstone is considered to represent the Chester Pebble Bed Sandstone Formation.

4.5.2 The SANDSTONE was recovered as a dark reddish brown slightly silty SAND.

4.5.3 SPT 'N' values undertaken wholly in this stratum comprised 50 blows for 100mm and 105mm penetration.

4.6 Groundwater

4.6.1 Groundwater was not encountered within any of the sampling locations. However, as boring operations required the use of water, it is possible that small groundwater strikes/seepages may have been masked.

4.6.3 All boreholes were recorded as being dry during the gas and groundwater level monitoring visits which were carried out between 5th May 2021 and 18th June 2021.

4.7 Contamination Observations

4.7.1 No observations of potentially mobile contamination (e.g. hydrocarbons, solvents) were recorded during the fieldworks.

4.7.2 Anthropogenic components recorded within the Made Ground included ash, cinders, brick, pottery, coal, tarmac and slag. No suspected asbestos containing materials were observed during the fieldworks.

4.7.3 PID headspace tests, which were carried out at regular intervals on soil samples recovered at regular intervals from the boreholes, all recorded at ≤3ppm. The highest reading of 4.2ppm was encountered in TP7 at 1.4mbgl in a stratum recorded with as slightly organic rich. The PID results obtained do not indicate significantly elevated by volatile contaminants.

4.8 Obstructions

- 4.8.1 Cobbles and boulders were often recorded within the Made Ground. However, these were not substantial enough to prevent progression of the windowless sampling boreholes.

5.0 CHEMICAL LABORATORY TESTING

5.1 EMS Investigation

5.1.1 EMS carried out the following analysis on selected soil samples:

BH1, BH2 and BH3 Samples taken at 0.20m depth (all Made Ground)

- Analysed for a general screening suite, speciated polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (EPH - >C10-C40) and volatile organic compounds (VOC) and sulphate (2:1 water soluble).

BH1, BH2 and BH3 Samples taken at 0.60m depth (at the Made Ground/natural drift soil intermixed zone)

- Analysed for a general screening suite, speciated polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (EPH - >C10-C40) and volatile organic compounds (VOC) and sulphate (2:1 water soluble).

BH1, BH2 and BH3 Samples taken at 2.00m depth (from the natural drift soil)

- Analysed for a general screening suite, speciated polycyclic aromatic hydrocarbons (PAH) and total petroleum hydrocarbons (EPH - >C10-C40) and sulphate (2:1 water soluble).

5.1.2 It is noted that EMS did not schedule any of the recovered samples for asbestos testing.

5.1.3 It is assumed that it was not possible to obtain samples of groundwater for analysis due to the groundwater table level being below each borehole's 4.50m bgl installation depth.

5.1.4 The soil chemical testing results obtained are presented in Appendix G.

5.2 TLC Investigation

5.2.1 TLC carried out the following analysis on selected soil samples:

Determinand	Samples		
Heavy metals, pH, total cyanide, total phenol, total sulphate.	TP3 0.30m TP4 0.25m	TP5 1.40m WS3 0.80m	WS4 0.50m WS1 0.20m (pH only)
BRE SD1 Short Suite	WS1 0.20m WS3 0.20m	WS3 1.50m WS4 0.50m	WS5 0.80m
Speciated Polyaromatic Hydrocarbons (PAHs)	TP1 0.4m TP2 0.80m TP3 0.30m TP4 0.25m TP4 0.70m TP5 0.40m TP5 0.75m TP5 1.40m	TP6 0.90m TP7 0.25m TP7 1.40m TP7 1.70m WS1 0.20m WS1 3.65-3.80m WS2 0.25m WS2 1.80m	WS3 0.20m WS3 0.80m WS3 1.50m WS4 0.50m WS4 1.80-1.90m WS5 0.30m WS5 1.60m WS5 3.50m
Speciated banded petroleum hydrocarbons (TPHCWG)	TP5 0.40m TP7 0.25m TP7 1.40m	WS3 0.20m WS4 0.50m WS5 0.30m	WS5 1.60m
Banded petroleum hydrocarbons	TP1 0.40m TP3 0.30m	TP4 0.25m	WS3 0.20m
Total Petroleum Hydrocarbons (C10-C40)	WS3 0.80m	WS4 0.50m	WS4 1.80-1.90m
Volatile Organic Compounds (VOCs)	TP1 0.40m TP1 1.25m TP2 0.80m TP2 1.80m TP4 0.70m TP5 0.40m	TP6 0.90m TP7 0.25m TP7 1.40m WS1 0.20m WS1 3.65-3.80m	WS2 0.25m WS2 1.80m WS5 0.30m WS5 1.60m WS5 3.50m
Semi-Volatile Organic Compounds (SVOCs)	TP1 0.40m TP2 0.80m TP5 0.40m	TP6 0.90m TP7 0.25m WS1 0.20m	WS2 0.25m WS5 0.30m
Polychlorinated Biphenyls (PCBs)	TP4 0.70m	TP7 0.25m	WS1 0.20m
Asbestos Screen	TP3 0.30m TP4 0.25m TP5 1.40m TP6 0.90m	TP7 0.25m WS1 0.20m WS2 0.25m	WS3 0.80m WS4 0.50m WS5 0.80m
Total Organic Carbon	TP1 0.40m TP3 0.30m TP3 0.470m TP4 0.25m TP5 0.40m	TP5 1.40m TP6 1.80m TP7 1.40m WS1 0.20m WS2 0.90m	WS3 0.20m WS3 0.80m WS4 0.50m WS4 1.10-1.20m WS5 2.3m

5.2.2 As groundwater was not present in any of the monitoring wells the following samples were subjected to leaching test analysis:

Determinand	Samples		
Heavy metals, pH, total cyanide, total phenol, total sulphate.	TP3 0.30m	TP4 0.25m	WS4 0.50m
Speciated Polyaromatic Hydrocarbons (PAHs) Speciated banded petroleum hydrocarbons (TPHCWG)	TP3 0.30m TP5 0.40m	TP7 0.25m	WS4 0.50m
Semi-Volatile Organic Compounds (SVOCs)	TP3 0.30m TP4 0.70m	TP5 0.40m TP7 0.25m	WS4 0.50m
Polychlorinated Biphenyls (PCBs) (ICES PCB7)	TP4 0.70m	TP7 0.25m	

6.0 CHEMICAL TESTING - RESULTS AND ASSESSMENT

6.1 Generic Quantitative Risk Assessment

6.1.1 Human Health Assessment

6.1.1.1 In line with CLR11⁵, a Generic Quantitative Risk Assessment (GQRA) has been undertaken to determine the significance of the measured concentrations of contaminants from the chemical analysis.

6.1.1.2 The GQRA comprises the comparison of the measured concentrations with Generic Assessment Criteria (GAC). The GAC used for the assessment of soil concentrations comprise Soil Guideline Values (SGVs) and values that have been derived using the CLEA⁶ model (v 1.06) adopting the appropriate assumptions and input parameters provided in the Environment Agency SR series of reports⁷ and with reference to the LQM/CIEH⁸ and EIC/AGS/CL:AIRE reports⁹. If exceeded, measured concentrations have been compared to the recently produced C4SLs¹⁰ where available, with the exception of lead where the C4SL value has been adopted due to the withdrawal of the SGV, as it was not considered to be sufficiently health protective. With respect to soil risk assessment, TLC has adopted the following hierarchy:

- C4SLs
- LQM/CEH S4ULs
- EIC/AGS/CL:AIRE screening levels

6.1.1.3 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) as shown below:

- 1- and 2-methylnaphthalene: compared to naphthalene S4UL (5.6mg/kg 2.5% SOM). This is considered appropriate given that the guidance provided on the ATSDR website¹¹ indicates that the oral toxicity of 2-methylnaphthalene is within an order of magnitude to that of naphthalene, although it was unknown what an appropriate inhalation reference dose is.
- Dibenzofuran and Carbazole: compared to commercial C4SL for benzo(a)pyrene (77mg/kg 6% SOM). These contaminants are a biproducts of organic combustion but can be naturally occurring. The Material Safety Sheets indicates these compounds are not volatile and considering there is no toxicological information available¹², the analytical results are compared to the most toxic PAH as a precaution.

⁵ Environment Agency/Department for Environment, Food and Rural Affairs, 2004, Model Procedures for the Management of Land Contamination, CLR11

⁶ <https://www.gov.uk/government/publications/contaminated-land-exposure-assessment-clea-tool>

⁷ Environment Agency, 2009, Human health toxicological assessment of contaminants in soil (SR2) & updated technical background to the CLEA model (SR3)

⁸ Nathanail, C.P., McCaffrey, C., Gillet, A.G, Ogden, R.C. and Nathanail, J.F. 2015. The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, Nottingham.

⁹ The EIC/AGS/CL:AIRE Soil Generic Assessment Criteria for Human Health Risk Assessment. December 2009.

¹⁰ Defra (2014a & b). SP1010 – Development of Category 4 Screening Levels for assessment of land affected by contamination.

¹¹ ATSDR (2005). Public Health for naphthalene, 1-methylnaphthalene and 2-methylnaphthalene.

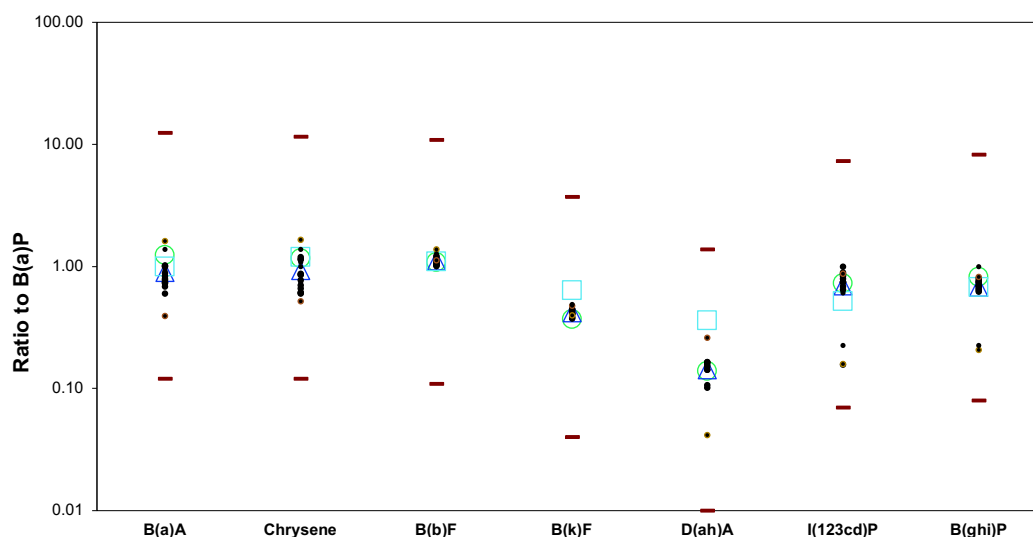
¹² IRIS Database (USEPA). <http://www.epa.gov/iris/subst/0429.htm>. Last updated 20th December 2010.

- 2-methylphenol and 4-nitrophenol: results were combined with phenol concentrations and compared to the phenol S4UL (1,300mg/kg, 2.5% SOM) as a conservative screening value. This is considered appropriate due to similar toxicity to phenol, with the primary risk from direct contact. These contaminants are a primary constituent of creosols¹³.

6.1.1.4 15no. Made Ground samples were analysed for Total Organic Carbon (TOC) content. The SOM contents which have been derived from the TOC results are summarised in the table below; appropriate GAC for the SOM contents indicated have been used to carry out the human health risk assessment.

Soil Type	No. of Samples	Average	Std Dev	Max	Min	GAC used for SOM Content
		Sample SOM Concentration				
Made Ground (ash and cinder rich)	2	9.3	ND	11.1	7.6	6.0
Made Ground (other)	13	4.0	2.81	10.8	0.8	2.5

6.1.1.5 The Made Ground PAH congener results (from both investigations) were analysed using the LQM PAH profiling tool to determine whether using benzo(a)pyrene as a surrogate marker for PAH contamination derived from coal tar was appropriate. The graph below presents the results of this assessment. Although the assessment was affected by several non-detects, as almost all of the results plot within $\pm 2.5x$ the mean of the Culp PAH data, the use of benzo(a)pyrene as a surrogate marker for PAH contamination was considered to be justified. It should be noted that non-detect concentrations were treated as being equal to the laboratory detection limit.



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).

¹³ ATSDR (2008). "Toxicological profiles for Cresols." <http://www.atsdr.cdc.gov/toxprofiles/tp34.pdf>.

- 6.1.1.6 The site is proposed to be developed out with seven four storey town houses; there will be no garden or soft landscaping areas at ground level. The chemical testing results obtained have therefore been compared to screening concentrations derived for the residential without plant uptake scenario.
- 6.1.1.7 The soil determinand concentrations obtained were compared to the GAC screening concentrations presented in Appendix D. The GQRA has identified a number of contaminants of concern (CoC) beneath the property. The samples equaling or exceeding GAC concentrations are listed in the table below.

Contaminant of Concern (CoC)	GAC (mg/kg)	Measured Concentration (mg/kg)	Location & Depth (bgl)	Notes
Lead	310	411	BH1 @ 0.20m	Made Ground
		1184	BH2 @ 0.20m	Made Ground
		524	BH2 @ 0.60m	Intermixed drift & Made ground
		910	TP4 @ 0.25m	Made Ground Ash Rich
		598	WS4 @ 0.50m	Made Ground
Naphthalene	5.6 / 13	6.9	BH2 @ 0.20m	Made Ground
		114	TP5 @ 0.25m	Made Ground
		40.62	TP7 @ 0.25m	Made Ground
		6.39	WS1 @ 0.25m	Made Ground Ash Rich
		20.06	WS3 @ 0.20m	Made Ground
		42.54	WS4 @ 0.50m	Made Ground
		22.29	WS5 @ 0.30m	Made Ground
Benzo(a)pyrene	5.3	14.4	BH2 @ 0.20m	Made Ground
		58.33	TP3 @ 0.30m	Made Ground
		17.03	TP4 @ 0.25m	Made Ground
		43.51	TP5 @ 0.40m	Made Ground
		152.44	TP7 @ 0.25m	Made Ground
		13.96	WS1 @ 0.20m	Made Ground Ash Rich
		24.04	WS2 @ 0.25m	Made Ground
		40.76	WS3 @ 0.20m	Made Ground
		71.43	WS4 @ 0.50m	Made Ground
1,1,1-trichloroethane	18	41	BH3 @ 0.20m	Made Ground
1-Methylnaphthalene	5.6 / 13	28.87	TP4 @ 0.25m	Made Ground
		30.17	TP7 @ 0.25m	Made Ground
2-Methylnaphthalene	5.6 / 13	28.87	TP4 @ 0.25m	Made Ground
		30.17	TP7 @ 0.25m	Made Ground
Dibenzofuran	5.3	16.9	TP5 @ 0.40m	Made Ground
		45.7	TP7 @ 0.25m	Made Ground
Carbazole	5.3	10.76	TP5 @ 0.40m	Made Ground
		41.91	TP7 @ 0.25m	Made Ground

6.1.1.8 In addition, detectable levels of non-dioxin like PCBs (Congener 28) were recorded in TP4 @ 0.70m and TP7 @ 1.40m (maximum concentration 0.23mg/kg). The UK does not have an assessment criterion for the PCB7 result; however, the Dutch Intervention Value is 1mg/kg.

6.1.1.9 10no. Made Ground samples were screened for asbestos fibres. No asbestos fibres were detected in any of the samples analysed.

6.2 Human Health Results Discussion

6.2.1 The analytical results indicate the presence of lead in the shallow made ground across the site. The presence may be related to the ash and cinders and pottery.

- 6.2.2 For PAHs (using benzo(a)pyrene as a surrogate marker and including carbazole and dibenzofuran), a number of elevations were noted site wide. The elevations ranged between 14.4mg/kg and 152.44mg/kg and were present in samples collected from the 0.5m. The source is considered to be the ash and cinder inclusions and possible intermixing with the overlying tarmac.
- 6.2.3 For naphthalene (and 1- and 2- methylnaphthalene), a number of elevations were noted site wide. The elevations ranged between 6.9mg/kg and 42.54mg/kg and were present in the upper 0.5m. The source is considered to be the ash and cinder inclusions and possible intermixing with the overlying tarmac. A single elevated concentration of 1,1,1-trichloroethane was recorded on the northwest corner of the site.
- 6.2.4 In summary, with respect to end users of the site, the shallow made ground (inclusive of ash and cinders and ash and immediately below the tarmac is:
- Contaminated with hotspots of lead;
 - Contains site wide elevated benzo(a)pyrene contamination;
 - Contains site wide elevated naphthalene contamination; and,
 - Contains very localised 1,1,1-trichloroethane.
- 6.2.5 Samples below the shallow made ground layer i.e. TP4 @ 0.7m, TP5 @ 0.75m, TP7 @ 1.4m, WS2 @ 1.8m, WS3 @ 0.8m, WS3 @ 1.5m, WS4 @ 1.1-1.2m, and WS5 @ 1.6m were all below the generic assessment criteria. This suggests the impacted strata comprises the upper c. 0.7m.

6.3 Leaching Tests / Groundwater

- 6.3.1 It was not possible to obtain samples of groundwater from installed boreholes as the groundwater table was below the installation depths.
- 6.3.2 No evidence of significant mobile contamination was identified on the site. Although elevated metals and PAHs were identified within the soils, the source is anticipated to be ash, cinders and shallow tarmac noted within the made ground. Contamination associated with ash, cinders and tarmac is not anticipated to be mobile due to the residual crystalline nature of the matrix.
- 6.3.3 The leaching test is aggressive (de-ionised water) and is not in aqueous equilibrium (steady state) with the solid sample which may cause overestimation of the concentrations compared to groundwater in contact with contaminated soils. Traditionally the leaching test was developed for inorganic constituents and the leaching of organics is poorly understood¹⁴.
- 6.3.4 TLC have compared results above Limits of Detection (LOD). Where relevant the review of priority substances takes precedence considering threshold values for groundwater cannot be used '*as part of site-specific investigations*'. The hierarchy is as follows:
- River Basin District Standards¹⁵ and updated Water Framework Directive¹⁶ for Annual Average / Maximum Allowable Concentration Environmental Quality Standards (AA-MAC-EQS) for priority substances (surface water risk).
 - 2016 private water supply standards (UKDWS potable)¹⁷.

¹⁴ EA (2009). "Petroleum Hydrocarbons in Groundwater: Supplementary Guidance for Hydrological Risk Assessment."

¹⁵ Defra (2010). "The River Basin Districts Typology, Standards and Groundwater Threshold Values". Water Framework Directive (England and Wales) Directions 2010.

¹⁶ Defra (2015). "Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015".

¹⁷ Statutory Instruments (2016). "The Private Water Supplies Regulation 2016." No. 614

- 2001 Environment Agency Values for Environmental Quality Standards (EQS) and UK Drinking Water Standard (UKDWS)¹⁸.
- Surface Water Abstraction Directive (SWAD)¹⁹ based on A2 treatment (TPH only).

6.3.4 The results indicate elevated concentrations of PAHs congeners in TP3 @ 0.3m and TP7 @ 0.25m and aliphatic TPH in TP7 @ 0.25m and WS4 @ 0.50m.

6.3.5 Notwithstanding the above exceedances, TLC note the limitations of the leaching test for organic determinands. The site will also be fully hardstood post development and therefore it is considered unlikely that rainwater will percolate through the made ground and leach contaminants from the site made ground.

6.4 Buried Concrete

6.4.1 The Made Ground and Superficial deposits chemical testing results obtained have been contrasted with guidance given in BRE SD1²⁰ assuming a brownfield land use and static groundwater.

6.4.2 The natural strata and made ground may generally be classified as DS1 AC1s. The exceptions are WS1 @ 0.20m, WS4 1.80-1.90m, BH2 0.2m and BH3 0.2m which may be classified as DS2 AC1s.

6.4.3 The percentage of oxidisable sulphides is >0.3% in WS1 @ 0.20m, indicating the possibility of pyrite. Pyrite is unlikely to be present within any of the other samples analysed.

6.5 Gas and Groundwater Level Monitoring Results

6.5.1 The atmospheric pressure and weather conditions at the time each gas and groundwater monitoring visit was undertaken, and pressure trends for the previous 24 hours, are summarised in the table below:

Visit No.	Date	Atmospheric Pressure (mb)	Atmospheric Pressure Trend*	Weather/External Ground Conditions
1	05/05/2021	1004	Rising slowly	Sunny spells, dry, calm, T=9°C / Dry
2	17/05/2021	NR	Rising	Dry, overcast, calm. Heavy showers around. T=11°C / Saturated
3	27/05/2021	1018	Rising	Mainly sunny, calm, T=20°C / Dry
4	31/05/2021	1019	Falling	Sunny, dry, light wind, T=18°C / Dry
5	10/06/2021	1015	Steady	Overcast, dry, calm, T=19°C / Dry
6	17/06/2021	1007	Steady and falling slowly	Overcast, dry, calm, T=17°C / Dry

* - Pressure trends recorded with a Davis Vantage PRO 2 Weather Station, Whitestake, Nr Preston.

6.5.2 The peak gas concentrations (lowest Oxygen), peak flow rates, pressure differentials, PID readings and standing water levels recorded are summarized below:

¹⁸ EA (2002). "Environment Agency technical advice to third parties on Pollution of Controlled Waters for Part IIA of the Environment Protection Act 1990."

¹⁹ Surface Water Directive (EC 75/440/EEC); Water Supply (Water Quality) Regulations 1989, as modified.

²⁰ BRE Special Digest 1:2005 *Third edition* entitled 'Concrete in aggressive ground'.

Monitoring Point	CH ₄ (% v/v)	CO ₂ (% v/v)	O ₂ (% v/v)	H ₂ S (ppm)	CO (ppm)	Flow* (l/hr)	PD (mb)	PID (ppm)	SWL (bgl)
WS1 (S)	BD	1.6	18.6	BD	1	BD	BD	0.8	>1.60m
WS1 (D)	BD	2.8	18.2	BD	7	BD	0.1	0.7	>3.16m
WS2 (S)	BD	0.3	20.7	BD	1	BD	BD	0.7	>1.55m
WS2 (D)	BD	4.3	16.0	BD	26	BD	BD	0.5	>3.09m
WS5 (S)	BD	2.6	16.8	BD	2	BD	BD to -0.4	0.9	>1.57m
WS5 (D)	BD	4.6	16.5	BD	18	BD to -0.1	BD to -0.5	0.7	>3.10m

BD - below detection limit of instrument (<0.1%v/v; <1ppm; 0.1l/hr; <0.01mb)

SWL - standing water level; PD = Pressure Differential

(S) - Shallow monitoring well (made ground)

(D) - Deep monitoring well (superficial deposits)

- 6.5.3 The PID readings generally mirror the soil headspace readings obtained during the site investigation works and confirm olfactory evidence of the absence of volatile hydrocarbon or solvent contamination.
- 6.5.4 No elevated flow rates were recorded and the pressure differentials were negligible. This is typical of the type of made ground encountered and the underlying superficial deposits. The highest concentrations of carbon dioxide (and highest carbon monoxide and lowest oxygen) were encountered in the deeper wells which were instrumented fully within the natural superficial deposits. TLC have recorded similar results within sites in the city centre.
- 6.5.5 Carbon monoxide was detected in all boreholes and ranged between 1 and 2ppm in the shallow monitoring wells and between 4 and 26ppm in the deeper monitoring wells. Only workplace exposure limits defined by the HSE are available for carbon monoxide and are not fully applicable to a residential setting. A Short-Term Exposure Limit of 200ppm (15-minute period) and Long-Term Exposure Limit of 30ppm have been defined (8-hour period). Based on the above exposure limits, carbon monoxide is not expected to pose a significant risk to the proposed site receptors.
- 6.5.6 In accordance with CIRIA C665²¹, a Gas Screening Value (GSV) may be calculated. Assuming worst-case scenario maximum gas concentrations and flow for each borehole have been used to calculate the GSV. The GSV can be used to determine the characteristic situation (CS). The maximum GSV for carbon dioxide is 4.6×10^{-3} l/hr. This places the site within CS1. The highest carbon dioxide reading is less than 5% v/v, therefore in accordance with CIRIA C665, due consideration to upgrading the CS designation need not be given.

6.6 Potable Water Pipes

- 6.6.1 Concentrations of organic contaminants in the shallow made ground (typical pipe depth is 0.75-1.35mbgl) are above United Utilities criteria for standard PE pipe. Therefore, it is likely that barrier pipe is required.

6.7 Risk Assessment

- 6.7.1 Risks to the potential receptors identified for site derived contamination (see the following table) have been classified with reference to CIRIA guidance C552²² using the following risk classifications:

²¹ CIRIA (2007). "Assessing Risks Posed by Hazardous Ground Gases to Buildings." CIRIA C665.

²² CIRIA, 2001, Contaminated Land Risk Assessment – A Guide to Good Practice, C552

- High Risk – There is a high probability that severe harm could arise or is occurring to the designated receptor from an identified hazard.
- Moderate Risk – It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild.
- Low Risk – It is possible that harm could arise to a designated receptor from an identified hazard, but it is unlikely that this harm, if realised, would at worst be normally mild.

6.7.2 Where the pollutant linkage is considered to not be viable, then a negligible risk rating has been adopted. As such the conceptual site model from the desk study has been updated to take into account observed fieldwork ground conditions and the generic screening criteria assessment and is tabulated overleaf.

Source	Pathway	Receptor	Comment	Risk	Mitigation Measures	Residual Risk
<u>Made Ground</u> Lead, benzo(a)pyrene, naphthalene, 1,1,1-trichloroethane.	– Dermal contact. – Inhalation of contaminated soil dust. – Ingestion of soil.	– Future site residents	The site will be completely covered with buildings. Therefore, it will not be possible for end users to come into contact with the soils beneath the site.	Negligible	None required	Negligible
<u>Made Ground</u> Naphthalene, 1,1,1-trichloroethane and potentially volatile petroleum hydrocarbon contamination	– Inhalation of volatiles	– Future site residents	Volatile contamination has the potential to enter the proposed town houses through cracks in house floorslabs, cavity walls and service penetrations. Site wide contamination appears to be restricted in the upper 0.75m.	Moderate to High	To protect end users against vapours either 1) Remove impacted shallow made ground (approx. 0.75mbgl) off site. OR 2) Incorporate a vapour resistant gas membrane into the houses' floorslab design and keep service penetrations of the floorslab to a minimum.	Very Low
<u>Made Ground</u> Asbestos Containing Materials (ACMs)	– Inhalation of fibres.	– Future site residents	No visual evidence of ACM has been observed within the Made Ground soils across the site. Laboratory testing has not identified any fibres in the soil samples tested. The site will be completely covered with buildings. Therefore, it will not be possible for asbestos fibres contained within the Made ground to come into contact with end users.	Negligible	No specific mitigation measures considered necessary.	Negligible
<u>Made Ground</u> Lead, benzo(a)pyrene, naphthalene, 1,1,1-trichloroethane.	– Dermal contact. – Inhalation of contaminated soil dust. – Ingestion of soil. – Inhalation of volatiles	– Construction and future site maintenance workers.	These receptors will potentially be coming into direct contact with the Made Ground beneath the site.	Moderate to High	Wear appropriate PPE, eating/smoking prohibited away from designated areas, wash hands before eating/smoking. Keep exposed soils damp in dry weather to reduce dust/fibre risk.	Very Low
<u>Made Ground</u> Asbestos Containing Materials (ACMs)	– Inhalation of fibres.	– Construction and future site maintenance workers.	No evidence of ACMs noted on site or present in the laboratory samples. However, localised "cache" of ACMs could still be present on site.	Low	Wear appropriate PPE, eating/smoking prohibited away from designated areas, wash hands before eating/smoking. Keep exposed soils damp in dry weather to reduce dust/fibre risk. Maintain watching brief for possible ACMs.	Very Low
<u>Made Ground</u> Lead, benzo(a)pyrene, naphthalene, 1,1,1-trichloroethane.	– Dermal contact. – Inhalation of contaminated soil dust. – Ingestion of soil.	– Neighbouring residents & office workers.	Made Ground soils could be tracked off site during the construction period. Contaminated soil dust could be blown off site during earth movements in dry weather. However, it is unlikely that these receptors will come into direct contact with significant quantities of contaminated soil during the construction period. There is no risk to these receptors post construction as the site will be complete covered with buildings.	Low	During the construction period keep exposed soils damp in dry/windy weather and use a wheel wash if necessary. Use a road sweeper to remove soils tracked off site from the roads adjacent to the site.	Very Low
<u>Made Ground</u> Naphthalene, 1,1,1-trichloroethane	– Inhalation of volatiles	– Neighbouring residents & office workers.	Volatile contamination of the source terms encountered is unlikely to migrate off site in significant concentrations. CLEA model assumes the contaminant sits at shallow depth directly below the building and that vapour velocities decrease rapidly with increasing distance from the building ²³ .	Very Low	No further action.	Very Low

²³ EA (2004). "Update on Estimating Vapour Intrusion into Buildings." Briefing Note 2.

Source	Pathway	Receptor	Comment	Risk	Mitigation Measures	Residual Risk
<u>Made Ground</u> Asbestos Containing Materials (ACMs)	– Inhalation of fibres.	– Neighbouring residents & office workers.	No evidence of ACMs noted on site or present in the laboratory samples. However, localised “cache” of ACMs could still be present on site. Made Ground soils could be tracked off site during the construction period. Fibres could be blown off site during earth movements in dry weather.	Low	During the construction period keep exposed soils damp in dry/windy weather and use a wheel wash if necessary. Use a road sweeper to remove soils tracked off site from the roads adjacent to the site.	Very Low
<u>Made Ground</u> Lead, benzo(a)pyrene, naphthalene, 1,1,1-trichloroethane.	– Leaching with vertical migration – Vertical migration of free product	– Principal Aquifer	The site will be completely covered with buildings and the groundwater table is likely to be at depths of >4.5m below the site – well below the base of the Made Ground. Therefore, post development it is unlikely that significant amounts of contaminated leachate could be derived from the Made Ground which could impact on the aquifer. Leaching tests show no elevated inorganic contaminants. Analysis likely to overestimate the risk from hydrocarbons and PAHs as contaminants likely held in a crystalline matrix. The nearest EA defined groundwater source protection zone to the site (Zone III) is located 154m E. The nearest EA licensed groundwater abstraction point is located 600m E.	Very Low	No further action.	Very Low
<u>Made Ground</u> Lead, benzo(a)pyrene, naphthalene, 1,1,1-trichloroethane	– Leaching from the Made ground followed by vertical migration to the groundwater table and then lateral migration to the potential receptors identified. – Vertical migration of free product to the groundwater table and then lateral migration to the potential receptors identified.	– River Medlock (33m W) – Bridgewater Canal (65m W) – Rochdale Canal (115m N)	The site will be completely covered with buildings and the groundwater table is likely to be at depths of >4.5m below the site – well below the base of the Made Ground. Therefore, post development it is unlikely that significant amounts of contaminated leachate could be derived from the Made Ground which could impact on the aquifer. Leaching tests show no elevated inorganic contaminants. Analysis likely to overestimate the risk from hydrocarbons and PAHs as contaminants likely held in a crystalline matrix.	Very Low	No further action.	Very Low
<u>Made Ground</u> Landfill type ground gases (carbon dioxide, methane, carbon monoxide, hydrogen sulphide)	– Inhalation of hazardous gas concentrations. – Migration through permeable strata. – Build-up in confined areas.	– users – Residents/office workers within adjacent property – Construction and Future maintenance workers.	The desk study did not identify any credible sources of landfill type gases within at least 250m of the site. No significantly elevated concentrations of gas encountered during gas monitoring survey.	Low Very Low Very Low	None required. None required. Take appropriate precautions in deep excavations.	Negligible Very Low Negligible
Soil/Groundwater	– Reaction	– Buried concrete	Low pH and high sulphate concentrations can cause buried concrete to severely degrade and weaken.	Very Low	Use a specification of concrete suited to the ground conditions as per BRE Digest SD1:2005 <i>Third edition</i> .	Negligible

Source	Pathway	Receptor	Comment	Risk	Mitigation Measures	Residual Risk
Made Ground/Groundwater	– Ingestion of tainted water supply. – Degradation of plastic water supply pipes and seals.	– Future site residents – Pipe work	Organic contamination has been identified within the Made Ground.	High	Use barrier pipe to supply the site's water supply or lay standard PE pipe in sterile trenches.	Very Low
Made Ground	– Root uptake of phytotoxic contaminants.	– Flora	The site will be completely covered by buildings.	No Hazard	None required	No Hazard
Invasive plant species.	– Movement of affected soils during building works.	– Structures/services – Ecology	No invasive plant species have been identified growing on or in close proximity to the site.	No Hazard	None required	No Hazard

7.0 GEOTECHNICAL REVIEW

- 7.1 Given the variability of composition and strength of the Made Ground and the underlying superficial clay strata these materials are not considered to be a suitable founding stratum.
- 7.2 The underlying granular superficial deposits (SAND and SAND and GRAVEL) are generally medium dense to dense (density increasing with depth); however, they are also similarly afflicted by localised areas of lower density and strength – in places possibly down to 3.5mbgl. The area of lower strength covers the central and southern part of the site encompassed by WS3, WS5 and BH2. The inherent variability indicates this material is not a suitable founding stratum unless in-situ consolidation and improvement is carried.
- 7.3 TLC are not aware of the required foundation loading; however, given the scale of the development and shallow depth to bedrock it would be prudent to consider a piled foundation solution into the SANDSTONE bedrock. The types of piles may be CFA or driven / cast insitu with high slump concrete used to reduce the risk of any downward migration of contamination.
- 7.4 The type of piling selected may require a hydrogeological risk assessment for the approval of the Environment Agency.
- 7.5 The existing information suggests a vapour risk from naphthalene and made ground up to 2m depth. On this basis a suspended passively ventilated floor void may be required.

8.0 CONTAMINATION AND GROUND GASES – CONCLUSIONS AND RECOMMENDATIONS

8.1 Contamination

- 8.1.1 The additional Phase 2 site investigation works has identified the presence of localised elevated lead and site wide PAHs (benzo(a)pyrene). The lead and PAHs are likely due to the presence of ash, cinders and pottery fragments.
- 8.1.2 The elevated naphthalene is likely due to the ash and cinders and also the presence of shallow tarmac. No elevated naphthalene was noted in the made ground below 0.75mbgl. This suggests the impact is restricted to the shallow layers.
- 8.1.3 With respect to end users, the risk of direct contact from lead and PAHs is not viable as the site will be fully hardstood. However, a viable risk from vapour ingress remains and remedial works are required.
- 8.1.4 The remedial works may comprise source removal (i.e. shallow made ground <0.75mbgl and subsequent validation testing, or the provision of a hydrocarbon membrane and passively ventilated subfloor void.
- 8.1.5 Given the presence of organic contaminants throughout the full depth of made ground, a risk to PE potable pipes remains in the full depth of made ground and remedial works are required. United Utilities may require that a pipeline risk assessment for potable water supply is completed.
- 8.1.6 It is advised that a design sulphate class of DS-1 is adopted for buried concrete; the ACEC classification of the site is AC-1s. The exceptions are DS-2 around WS1 @ 0.20m WS4 1.80-1.90m BH2 0.2m BH3 0.2m.
- 8.1.7 The elevated concentrations of organic contaminants in the leaching tests are not considered realistic or significant because the contamination is likely held in a crystalline form and the testing will over estimate the risk. The proposed development will be fully hardstood and restrict the infiltration of rainwater, which in turn will restrict the potential for leaching of contaminants.
- 8.1.8 Risks to construction workers from the Made Ground have been identified. These risks should be managed through health and safety procedures including the CDM regulations. Standard health and safety precautions (as per HSE guidance²⁴) should be adopted by all workers involved with site enabling and construction works, and future maintenance works. These should include as a minimum:
- Ensuring wind blow is minimised by dampening down exposed surfaces.
 - Ensuring that all vehicles leaving the site are clean and if necessary have used a wheel wash.
 - Wearing appropriate PPE (including dust masks which prevent the inhalation of asbestos fibres).
 - Limiting unauthorised access to the site to prevent exposure to contaminated materials.
 - The provision and use of washing facilities for site staff, requirement for high standards of personal hygiene to be adopted by all site staff, particularly before and during meals.

²⁴ HSE (1991). 'Protection of workers and the general public during the development of contaminated land'. London HMSO.

- Restrict smoking to designated areas.

8.2 Ground Gas

- 8.2.1 The gas monitoring has not identified any elevated concentrations of methane and carbon dioxide. Detectable carbon monoxide was encountered; however, the risk assessment indicates remedial works are not required.
- 8.2.2 Construction workers should be made aware that concentrations of ground gas (especially carbon dioxide and carbon monoxide on this site) could be present in any deep excavations. Risks to construction workers are considered to be managed through health and safety procedures including the CDM regulations.
- 8.2.3 Risks to neighbouring residents from migrating site derived gases are considered to be very low.

8.3 Remedial Strategy Report

- 8.3.1 This will be required by Manchester City Council prior to any remedial related works being undertaken at this site.
- 8.3.2 It is advised that no on-site works are carried out until the remedial strategy report has been agreed with the council's contaminated land officer.
- 8.3.3 The Remediation Strategy should give due recourse to the options present in this report to mitigate against potential vapour ingress i.e. provision of vapour resistant membrane and passively ventilated subfloor void OR removal of upper 0.75mbgl of made ground and validation testing to demonstrate the vapour risk has been removed.
- 8.3.4 Should the subfloor void and vapour resistant membrane be the chosen option then the foundation design should be prior approved by Manchester City Council.

8.4 Remediation, Verification and Site Completion Report

- 8.4.1 It is recommended that all remediation related works which are carried out on site are validated by a third party, and suitable documentary evidence is subsequently provided in a Site Completion Report; documentary evidence could comprise of photographs, consignment documents and analytical results. The Site Completion Report should include as a minimum:
- Details of the areas of the site from where Made Ground has been removed.
 - Either a) Validation of naphthalene source removal OR b) Provision of vapour protective membrane and subfloor void.
 - Verification of any imported soils materials.
 - Information on the installation of protective pipes and /or sterile trenches.
- 8.4.2 The Site Completion Report will assist the Council in the discharge of the contaminated land planning condition and will be of use to solicitors acting on behalf of any prospective conveyancer who may have concerns over the site.

8.5 Other Recommendations

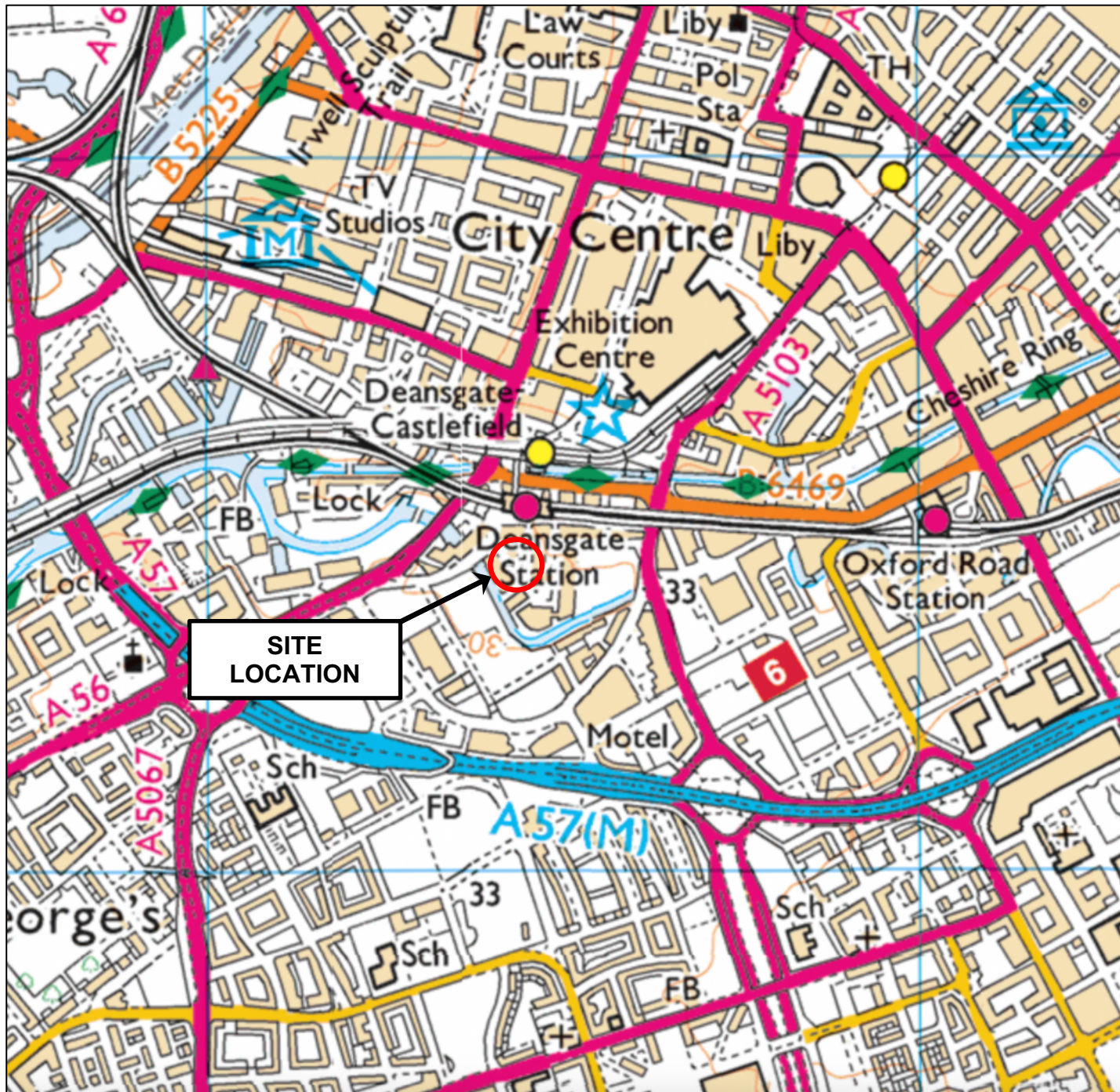
- 8.5.1 Items that were highlighted by the desk study which would further work include:

- An Unexploded Ordnance (UXO) pre-desk study assessment of has been completed for the site by Zetica. Zetica have indicated that the site is at medium risk of being affected by UXO dropped during WWII and they advise that a detailed desk study is commissioned to further assess the UXO hazard level on the site.
- The EA indicate that the site is at moderate risk from flooding related to the River Medlock. It is therefore advised that a detailed flood risk assessment of the site is completed by a specialist.

APPENDICES

APPENDIX A

DRAWINGS



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Project:

1 Commercial Street, Knott Mill, Manchester M15 4PZ

Title:

Site Location Plan

Scale:

Km Grid Squares

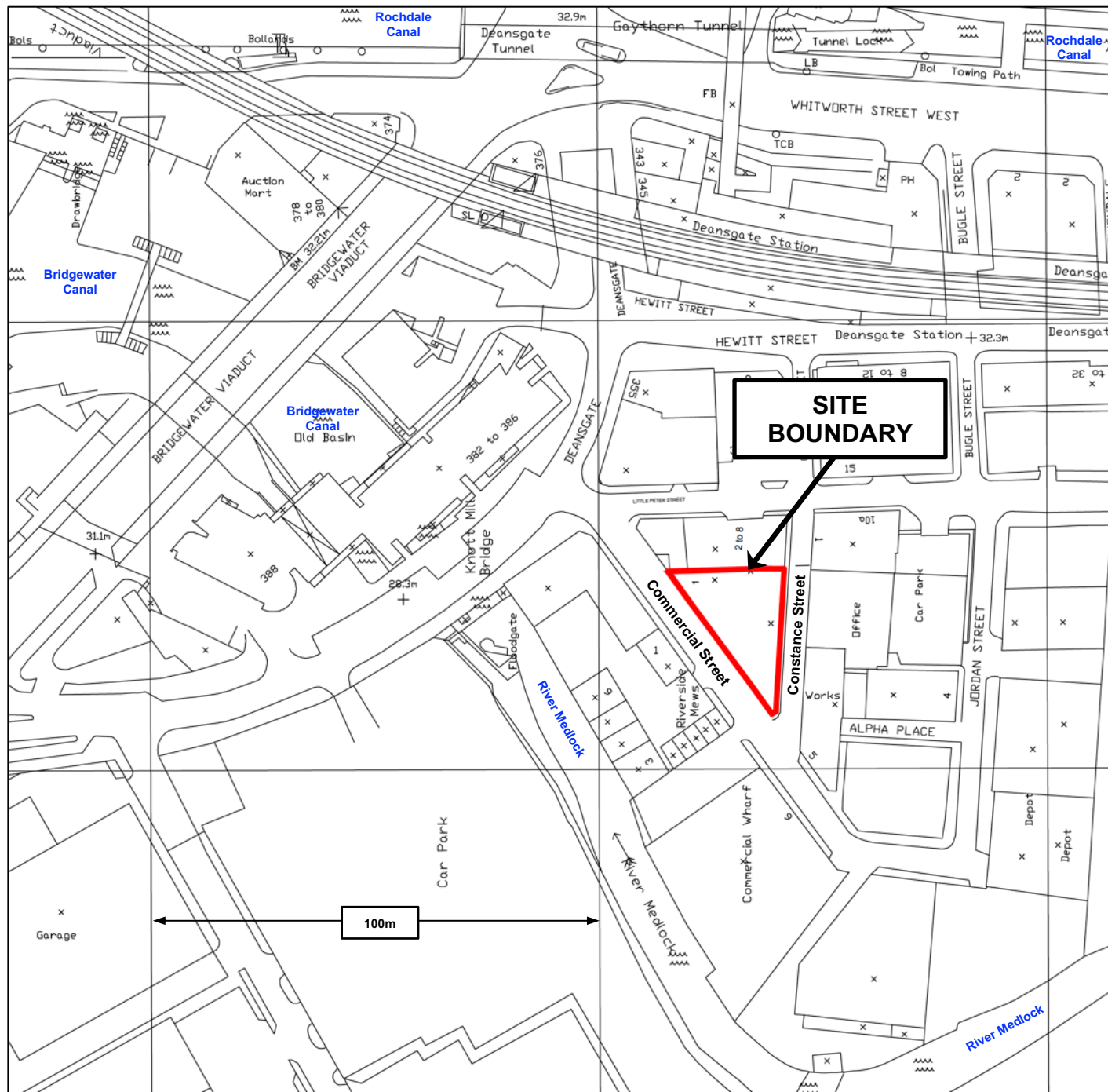
Drawn by:

SFK

Date:

04/02/2021

Drawing No.: TLC1143/01a



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Project:

1 Commercial Street, Knott Mill, Manchester M15 4PZ

Title:

Site Location Plan

Scale:

100m Grid Squares

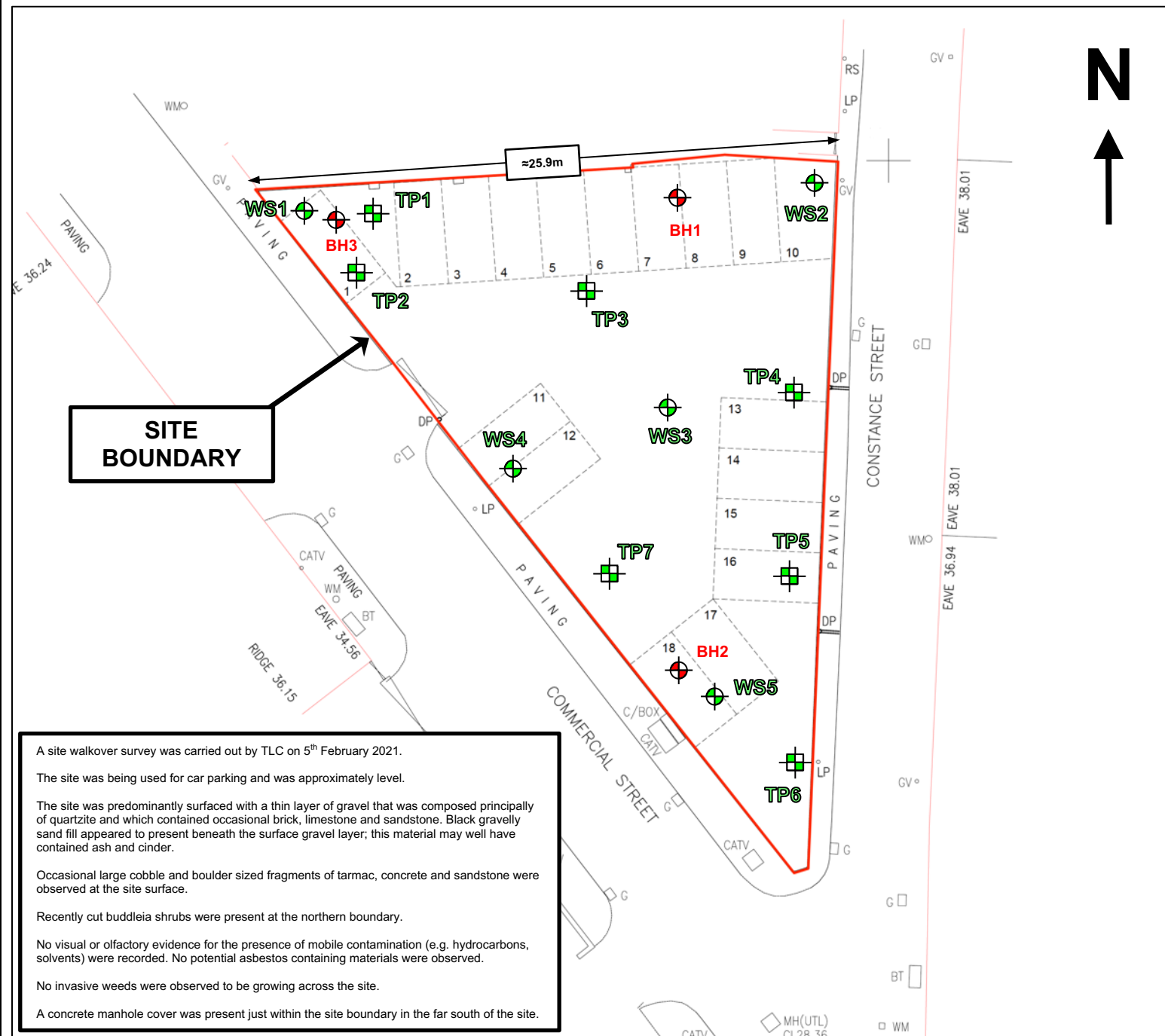
Drawn by:

SFK

Date:

05/02/2021

Drawing No.: TLC1143/01b



A site walkover survey was carried out by TLC on 5th February 2021.

The site was being used for car parking and was approximately level.

The site was predominantly surfaced with a thin layer of gravel that was composed principally of quartzite and which contained occasional brick, limestone and sandstone. Black gravelly sand fill appeared to present beneath the surface gravel layer; this material may well have contained ash and cinder.

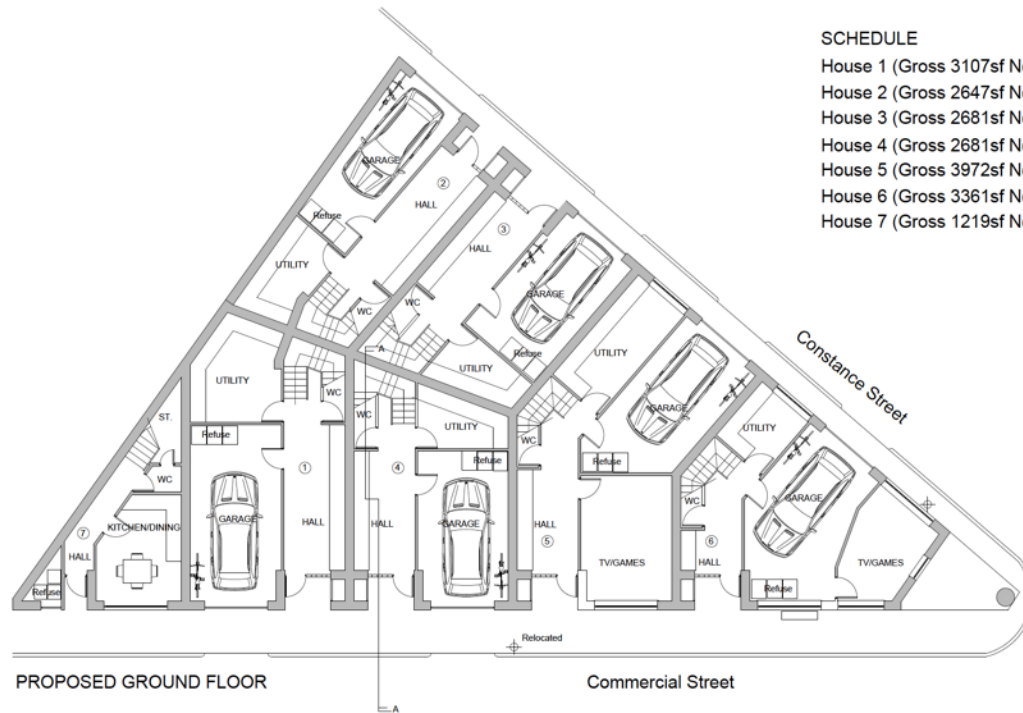
Occasional large cobble and boulder sized fragments of tarmac, concrete and sandstone were observed at the site surface.

Recently cut buddleia shrubs were present at the northern boundary.

No visual or olfactory evidence for the presence of mobile contamination (e.g. hydrocarbons, solvents) were recorded. No potential asbestos containing materials were observed.

No invasive weeds were observed to be growing across the site.

A concrete manhole cover was present just within the site boundary in the far south of the site.



SCHEDULE

- House 1 (Gross 3107sf Net 2391sf - inc 258sf garage plus 452sf terrace)
- House 2 (Gross 2647sf Net 1987sf - inc 205sf garage plus 398sf terrace)
- House 3 (Gross 2681sf Net 2035sf - inc 226sf garage plus 387sf terrace)
- House 4 (Gross 2681sf Net 2035sf - inc 226sf garage plus 387sf terrace)
- House 5 (Gross 3972sf Net 3100sf - inc 248sf garage plus 612sf terrace)
- House 6 (Gross 3361sf Net 2528sf - inc 248sf garage plus 549sf terrace)
- House 7 (Gross 1219sf Net 1162sf inc terrace)



Adapted from Harrison Ince Architects Drawing No. AL01 dated October 2020

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Project:

1 Commercial Street, Knott Mill, Manchester M15 4PZ

Title:

Proposed Development Plans

Scale:

As Shown

Drawn by:

SFK

Date:

05/02/2021

Drawing No.: TLC1143/03a



PROPOSED SECOND FLOOR



PROPOSED THIRD FLOOR

Adapted from Harrison Ince Architects Drawing No. AL02 dated October 2020

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Project:

1 Commercial Street, Knott Mill, Manchester M15 4PZ

Title:

Proposed Development Plans

Scale:

As Shown

Drawn by:

SFK

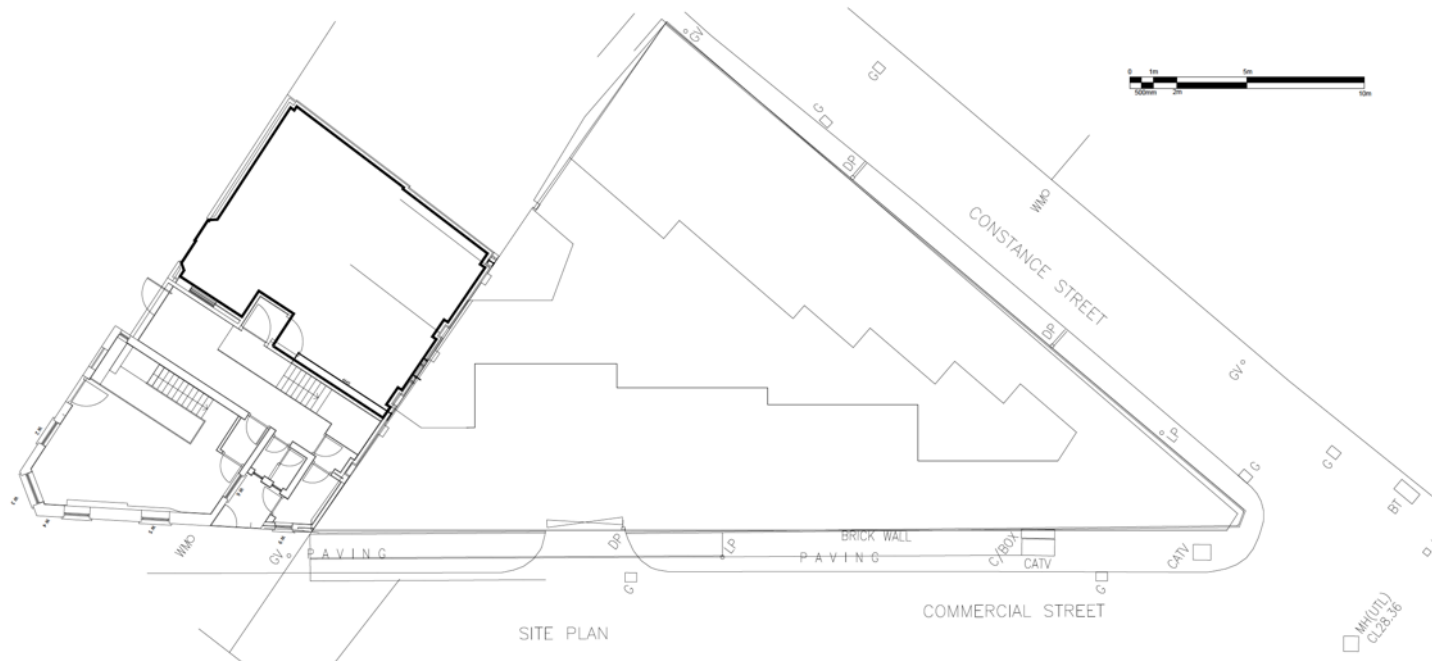
Date:

05/02/2021

Drawing No.: TLC1143/03b



PROPOSED FOURTH FLOOR



Adapted from Harrison Ince Architects Drawing No. AL03 dated October 2020

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Project:

1 Commercial Street, Knott Mill, Manchester M15 4PZ

Title:

Proposed Development Plans

Scale:

As Shown

Drawn by:

SFK

Date:

05/02/2021

Drawing No.: TLC1143/03c



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Project:

1 Commercial Street, Knott Mill, Manchester M15 4PZ

Title:

Artist's Rendering of the Finished Development –
View Down Commercial Street

Scale:
NTS

Drawn by:
SFK

Date:
05/02/2021

Drawing No.: TLC1143/03d

APPENDIX B

TRIAL PIT LOGS AND PHOTOGRAPHS

THE LAND CONSULTANCY LIMITED				The Land Consultancy Limited T: 01772 610609; M: 07771 800859 email: sfknott@thelandconsultancy.co.uk web: www.thelandconsultancy.co.uk		Trial Pit No TP1 Sheet 1 of 1	
Project Name Commercial Street, Manchester M15 4PZ			Project No. TLC1143		Coords: E: N: Level (m AOD):		Date 29/04/2021
Location: Commercial Street, Manchester M15 4PZ				Dimensions (m) Depth 1.85 2.80			Scale 1:10
Client: Infill Developments Ltd							Logged By S.F.Knott
Samples and In-Situ Tests			Depth (m)	Level (m OD)	Legend	Stratum Description	
Depth (m)	Type	Results (kPa)					
0.40	ES		0.08			3cm of quartzite gravel over rotten black TARMAC. (MADE GROUND)	
						Moderately compact black gravelly SAND with low to medium cobble content. Sand is ash rich. Gravel is fine to coarse angular of cinder, brick, sandstone with occasional coal, pottery and iron rich slag. Occasional fragments of polythene and rusted iron recovered. Cobbles are of brick and sandstone. (MADE GROUND)	
						0.40m - PID test carried out = 0.1ppm.	
0.90	ES		0.80			Soft orangish brown and dark brown sandy gravelly CLAY with low cobble content. Gravel is fine to coarse angular of brick and occasional coal. Cobbles are of brick. (MADE GROUND)	
						0.90m - PID test carried out = 1.1ppm.	
1.25	ES		1.35			Dark brown clayey gravelly SAND. Gravel is fine to coarse angular of brick and coal. (MADE GROUND)	
1.80	ES		1.85			1.80m - PID test carried out = 1.4ppm.	
						Trial Pit Complete at 1.850m	
2							
Remarks: Good stability. Excavated using a JCB 3CX Sitemaster. Trial pit was backfilled with compacted excavated arisings on completion. Recovered soils were logged by Dr Stephen Knott of The Land Consultancy Ltd to BS5930 2015							
Groundwater: No groundwater encountered.							

SITE NAME/CONTRACT: 1 Commercial Street, Knott Mill, Manchester M15 4PZ

SCALE: NTS

TITLE: TP1 Photograph

DATE: April 2021



THE LAND CONSULTANCY LIMITED

Fairweather House, 4 Parker Lane, Whitestake, Preston PR4 4JX

Tel: 01772 610609; M: 07771 800859

email: sfknott@thelandconsultancy.co.uk; web: www.thelandconsultancy.co.uk

**TP1
PHOTOGRAPH**

SITE NAME/CONTRACT: 1 Commercial Street, Knott Mill, Manchester M15 4PZ

SCALE: NTS

TITLE: TP1 Photographs

DATE: April 2021



THE LAND CONSULTANCY LIMITED

Fairweather House, 4 Parker Lane, Whitestake, Preston PR4 4JX

Tel: 01772 610609; M: 07771 800859

email: sfknott@thelandconsultancy.co.uk; web: www.thelandconsultancy.co.uk

**TP1
PHOTOGRAPHS**

THE LAND CONSULTANCY LIMITED				The Land Consultancy Limited T: 01772 610609; M: 07771 800859 email: sfknott@thelandconsultancy.co.uk web: www.thelandconsultancy.co.uk		Trial Pit No TP2 Sheet 1 of 1		
Project Name Commercial Street, Manchester M15 4PZ			Project No. TLC1143		Coords: E: N: Level (m AOD):		Date 29/04/2021	
Location: Commercial Street, Manchester M15 4PZ				Dimensions (m) Depth 1.80 0.60 2.70			Scale 1:10	
Client: Infill Developments Ltd							Logged By S.F.Knott	
Samples and In-Situ Tests			Depth (m)	Level (m OD)	Legend	Stratum Description		
Depth (m)	Type	Results (kPa)						
0.30	ES		0.05			Quartzite GRAVEL. (MADE GROUND)		
			0.10			TARMAC. (MADE GROUND)		
0.80	ES		0.90			Moderately compact black silty gravelly to very gravelly SAND with high cobble and boulder content. Sand contains some ash. Gravel is fine to coarse angular of sandstone, brick, cinder and occasional pottery. Occasional iron and rare timber fragments recovered. Cobbles and boulders are of sandstone and brick. (MADE GROUND)	1	
						0.30m - PID test carried out = 0.2ppm.		
1.45	ES		1.40			Soft to firm pale yellowish brown sandy gravelly CLAY with low cobble content. Gravel is fine to coarse angular of brick, coal and occasional sandstone. (MADE GROUND)		
						0.80m - PID test carried out = 1.3ppm		
						1.20m - PID test carried out = 1.7ppm.		
						1.45m - PID test carried out = 1.9ppm.		
1.80			1.50			Black clayey gravelly SAND with high cobble content. Sand is coal rich. Gravel is fine to coarse angular. Gravel and cobbles are of brick and sandstone. (MADE GROUND)		
						Dark brown clayey gravelly SAND. Gravel is fine to coarse angular of brick and occasional coal. (MADE GROUND)		
			1.80			Trial Pit Complete at 1.800m	2	
Remarks: Good stability. Excavated using a JCB 3CX Sitemaster. Trial pit was backfilled with compacted excavated arisings on completion. Recovered soils were logged by Dr Stephen Knott of The Land Consultancy Ltd to BS5930 2015								
Groundwater: No groundwater encountered.								

SITE NAME/CONTRACT: 1 Commercial Street, Knott Mill, Manchester M15 4PZ

SCALE: NTS

TITLE: TP2 Photograph

DATE: April 2021



THE LAND CONSULTANCY LIMITED

Fairweather House, 4 Parker Lane, Whitestake, Preston PR4 4JX

Tel: 01772 610609; M: 07771 800859

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**TP2
PHOTOGRAPH**

SITE NAME/CONTRACT: 1 Commercial Street, Knott Mill, Manchester M15 4PZ

SCALE: NTS

TITLE: TP2 Photographs

DATE: April 2021



THE LAND CONSULTANCY LIMITED

Fairweather House, 4 Parker Lane, Whitestake, Preston PR4 4JX

Tel: 01772 610609; M: 07771 800859

email: sfknott@thelandconsultancy.co.uk; web: www.thelandconsultancy.co.uk

**TP2
PHOTOGRAPHS**

THE LAND CONSULTANCY LIMITED				The Land Consultancy Limited T: 01772 610609; M: 07771 800859 email: sfknott@thelandconsultancy.co.uk web: www.thelandconsultancy.co.uk		Trial Pit No TP3 Sheet 1 of 1	
Project Name Commercial Street, Manchester M15 4PZ			Project No. TLC1143		Coords: E: N: Level (m AOD):		Date 29/04/2021
Location: Commercial Street, Manchester M15 4PZ				Dimensions (m) Depth 1.80 0.70			Scale 1:10
Client: Infill Developments Ltd							Logged By S.F.Knott
Samples and In-Situ Tests			Depth (m)	Level (m OD)	Legend	Stratum Description	
Depth (m)	Type	Results (kPa)					
0.30	ES		0.07			2cm of quartzite gravel over TARMAC. (MADE GROUND)	
						Compact dark brownish grey and dark grey very gravelly SAND with high cobble and boulder content. Sand is locally ashy. Gravel is fine to coarse angular of sandstone, brick, pot drainage pipe, occasional cinder and pottery. Cobbles and boulders are of sandstone and brick. Deposit contains some clay pockets. (MADE GROUND)	
						0.30m - PID test carried out = 1.5ppm.	
0.70	ES		0.50			Firm to stiff brown, dark brown, yellow and yellowish brown sandy gravelly CLAY with low cobble content. Gravel is fine to coarse of brick and occasional sandstone. Cobbles are of sandstone. (MADE GROUND)	
						>0.70m - Soft.0.70m - PID test carried out = 2.2ppm.	
1.30	ES						
						1.30m - PID test carried out = 1.7ppm.	
			1.50			Dark greyish brown clayey slightly gravelly SAND. Gravel is of sandstone, brick and occasional coal. (MADE GROUND)	
						1.70m - PID test carried out = 0.8ppm.	
			1.80			Trial Pit Complete at 1.800m	
1							
2							
Remarks: Good stability. Excavated using a JCB 3CX Sitemaster. Trial pit was backfilled with compacted excavated arisings on completion. Recovered soils were logged by Dr Stephen Knott of The Land Consultancy Ltd to BS5930 2015							
Groundwater: No groundwater encountered.							