

LAND AT OLDHAM ROAD, NEWTON HEATH - PHASE CONTAINING 28 HOUSES AND 6 APARTMENTS

Remediation Method Statement





GEO-ENVIRONMENTAL CONSULTING

Project Quality Assurance Information Sheet

Site	Land at Oldham Road, Newton Heath – Phase containing 28 houses and 6 apartments
Report Title	Remediation Method Statement
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PROJECT NO: 23007

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REVISION STATUS / HISTORY

Rev	Date	Issue / Comment	Prepared	Checked

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Remediation Method Statement
Land at Oldham Road, Newton Heath
Phase containing 28 houses and 6 apartments
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1. INTRODUCTION

1.1 Appointment

- 1.1.1 BEK Enviro (BEK) has been commissioned by Casey Group Limited to prepare a Remediation Method Statement required to support the remediation works required at the residential site at Land at Oldham Road, Newton Heath – Phase containing 28 houses and 6 apartments (hereafter referred to as ‘the site’).

1.2 Project Overview

- 1.2.1 The site occupies an irregular shaped piece of private land which covers an area of approximately 6130 m² within an industrialized area of Newton Heath, Manchester. The site is located to the south of Oldham Road, to the east of the former Dulverton Street. The site is currently occupied by a derelict piece of vacant land. The majority of the site is covered by made ground in the form of gravels. A large section of overgrown grasses are located in the north of the site with gravel hardstanding in the south.
- 1.2.2 Development proposals for the site include the construction of 28No. residential houses and 6No. apartments, together with associated garden areas, car parking facilities and access.
- 1.2.3 The proposed development can be seen on TP Bennett Architecture and Design drawing entitled ‘Proposed Site Plan’ (Drawing No.T8170-G-0-020-T1, dated November 2023), a copy of which is presented in Appendix B and an extract of which can be seen below.
- 1.2.4 Note the development of the site is to be completed in two phases. The remediation strategy presented herein applies to the ‘Phase containing 28 houses and 6 apartments Development Area’ only (as illustrated in Figure 1). A separate remediation strategy (BEK - Remediation Method Statement, Land at Oldham Road, Newton Heath, Report RefBEK-23007-1, February 2023) has been prepared to support the development of the Phase 1 area of the site (to residential dwellings).



Figure 1: Proposed Development Plan

1.3 Limitations

- 1.3.1 This report has been prepared to provide a summary of the remediation works required and the methodology for the validation of these works. The validation is important to confirm that the required works have been carried out in accordance with the approved remediation scheme and there are no future risks to end users of the site or the environment.
- 1.3.2 The site has been subject to previous site investigation and contamination assessment by others (see Section 2 below). These reports provide the basis for the remediation works required.
- 1.3.3 This report has been prepared in accordance with our understanding of current best practice. However, new information or legislation, or changes to best practice may necessitate revision of the report after the date of its issue.
- 1.3.4 BEK has prepared this report for the sole use and reliance of The Casey Group in accordance with our standard Conditions & Limitations. This report may not be used or relied upon by any unauthorised third party without the explicit written agreement from BEK.



2. PREVIOUS INVESTIGATION

2.1 Previous Reports

2.1.1 The Phase 1 and Phase containing 28 houses and 6 apartments areas of the site have been subjected to several phase of contamination assessment to support the re-development of the site for residential use, the details of which are provided within the following reports:

- Curtins 'Phase 1 Preliminary Risk Assessment – Oldham Road, Newton Heath, Manchester', Report Ref: 074031-CUR-00-XX-RP-GE-001, dated November 2019.
- Curtins 'Ground Investigation Report for Oldham Road, Newton Heath, Manchester' Report Ref: 074031-CUR-00-XX-RP-GE-002, dated January 2023.

2.1.2 The above assessments form the basis for the remediation works required at the site for both Phase 1 and Phase containing 28 houses and 6 apartments and should be read in conjunction with this report. This report assumes that all previous reports/assessments have been approved by the regulator.

2.1.3 The 'Ground Investigation Report for Oldham Road, Newton Heath, Manchester' by Curtins (Ref: 074031-CUR-00-XX-RP-GE-002, dated January 2023), which includes a Ground Gas Risk Assessment, forms the basis for the remediation works required at the site.

2.2 Curtins – Ground Investigation (January 2023)

2.2.1 The Curtins Ground Investigation was designed to provide indicative information for the ground conditions across the site with respect to the quantitative assessment for the potential risks associated with contamination and ground gas, as identified in the Phase 1 Preliminary Risk Assessment.

2.2.2 The Ground Investigation was undertaken in two stages. The first initial site investigation was undertaken in between 30th September and 3rd October 2019 which consisted of the drilling of 13No. window sample boreholes (WS01, WS02, WS02a, WS02b, WS02c, WS03, WS04, WS04a, WS04b, WS04c, WS05, WS06 and WS07) advancing to a maximum depth of 3.45 m bgl or refusal. In-situ testing including Standard Penetration Tests (SPTs) were undertaken at 1 m intervals within the superficial soils.

2.2.3 Supplementary ground investigation for the development site was undertaken between 27th October and 2nd November 2020. The additional works consisted of the drilling of 6No. window sample boreholes (WS021, WS202, WS203, WS204 and (WS204a) to a maximum depth of 5.45 m bgl or refusal and three Cable



Percussive Boreholes (CP101, CP102 and CP103) that were drilled to a maximum depth of 25.95 m.

2.2.3 The ground conditions at the site comprised of varying depths of made ground in the form of topsoil/asphalt or concrete overlying predominantly granular made ground material to maximum depth of 3.5 m.

2.2.4 Natural superficial deposits were encountered in all locations underlying the made ground in the form of glacial till.

2.2.5 Olfactory and visual indicators of contamination were present in the majority of the made ground strata at the site in the form of inclusions of ash and clinker. A slight hydrocarbon was noted in Borehole WS205 between 0.72 m and 2 m.

2.2.5 A summary of groundwater encountered during the site investigation is presented in Table 1 below:

Location	Depth to Water (m) bgl	Comment
WS02	0.6	Borehole wet
WS02a	0.55	Borehole wet
WS02c	0.45	Borehole wet
WS03	0.2	Borehole wet
WS04b	0.2	Borehole wet

Table 1: Summary of Groundwater Encountered During Site Investigation

2.2.6 Bedrock was not encountered within any of the exploratory locations on site.

2.2.7 Curtins selected a number of made ground samples for chemical testing. Analysis was undertaken to assess the contamination risk presented to site end users and construction works in this area of the site.

2.2.8 Curtins split the site into three zones according to the proposed-end users and assigned a specific for the generic assessment criteria screening plan to each location. These includes Zone 1 'Residential without home grown produce', Zone 2 'Residential with home grown produce' and Zone 3 'Public Open Space near residential housing'. See Figure 2 below for the generic assessment criteria screening plan.

2.2.9 The information relating to the Phase containing 28 houses and 6 apartments (Zone 1 and Zone 3) are to be included within this report.

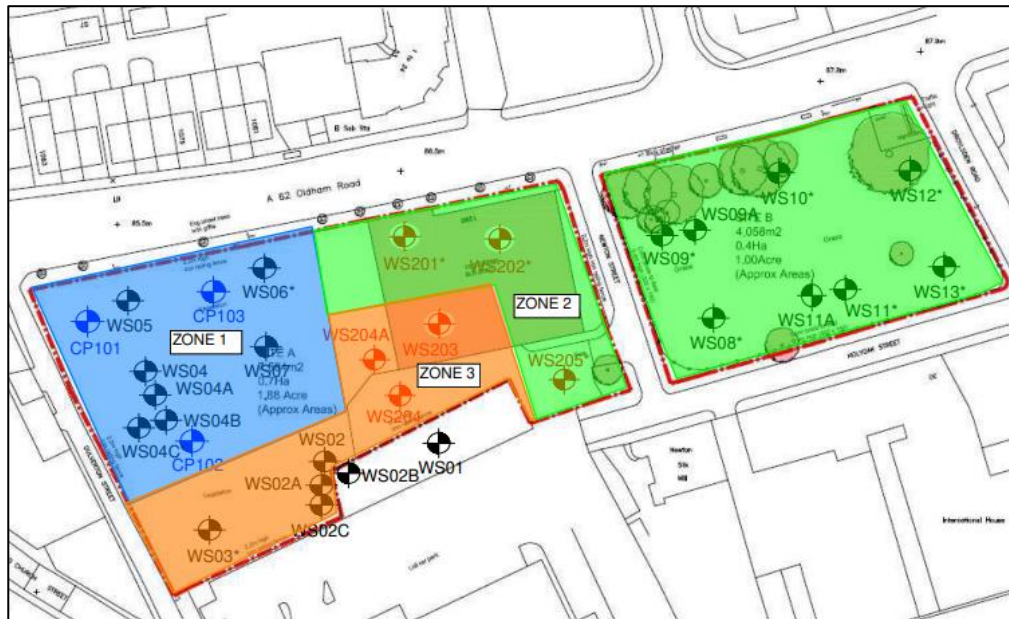


Figure 2: The generic assessment criteria screening plan for the Site.

Contamination Assessment

- 2.2.8 The chemical test results were compared to relevant generic assessment criteria to identify potential contaminants of concern. Based on the contamination assessment carried out by Curtins for the phase containing 28 houses and 6 apartments, a number of contaminant were identified when compared to the generic assessment criteria used within Zone 1 and Zone 3.
- 2.2.9 In Zone 1, with respect to the proposed end-use of the site, Tier 1 thresholds for Lead, PAHs and Aromatic TPHs were exceeded in Boreholes WS04C, WS06 and Cable Percussive Borehole CP101.
- 2.2.10 In Zone 3, with respect to the proposed end-use of the site, Tier 1 thresholds for PAHs and Aromatic TPHs were exceeded within Borehole WS01. It is likely the exceedances relate to a localised spill (likely diesel given the heavier TPH fractions encountered) in the existing car park.
- 2.2.10 Asbestos was identified within Borehole WS02b (0.45 m) located within Zone 3. Laboratory screening identified the asbestos containing material (ACM) as asbestos chrysotile cement with a percent soil composition of 0.959% w/w.

Ground Gas Risk Assessment

- 2.2.9 The ground gas risk assessment by Curtins concluded that the site is classified as Characteristic Situation 2 (CS2) and gas mitigation measures in accordance with CS2 should be installed in the apartment buildings at the site. However Curtins

concluded that no gas mitigation measures would be required in low rise residential dwellings as these were classified as NHBC Green classification.

2.3 BEK Comments

2.3.1 With regards to the contamination assessment, the Curtins Ground Investigation split Site 1 into Zones 1, 2 and 3 due to their proposed end uses with Zone 1 assessed against residential without home grown produce, Zone 2 assessed as residential with home grown produce and Zone 3 assessed against public open space near residential housing. The different zone are shown below:

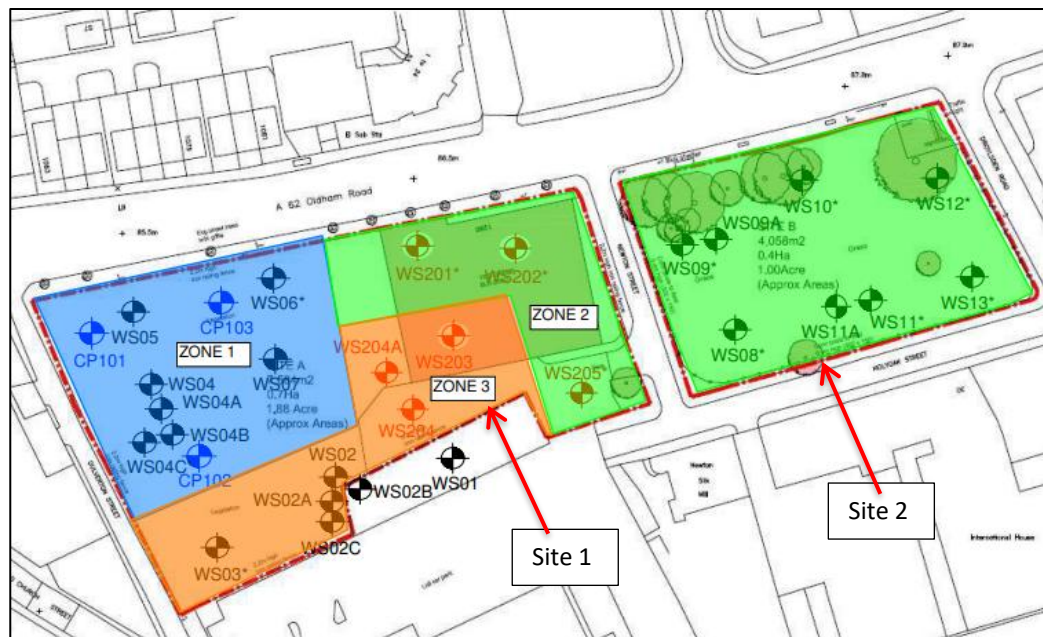


Figure 3: The generic assessment criteria screening plan for the Site.

2.3.2 Following production of the Curtins Ground Investigation report, the development proposals for the site have been amended and as such the assessment of Zone 1 and Zone 3 of Site 1 against residential without homegrown produce and against public open space near residential housing respectively is no longer applicable. Therefore BEK has undertaken further contamination assessment for Zone 1 and Zone 3 of Site 1 to reflect the amended development plans.

2.4 BEK Further Contamination Assessment

2.4.1 BEK has undertaken further contamination assessment using the previous Curtins Ground Investigation information. This has been undertaken to inform the amended proposed development plans for the site.

- 2.4.2 The amended proposed development plans for Phase containing 28 houses and 6 apartments of the site (i.e. Zone 1 and Zone 3 of Site 1) as shown on the plan below:



Figure 4: Proposed Development Plan (Zone 1 and Zone 3 of Site 1)

- 2.4.3 Due to the presence of residential housing BEK considers it necessary to re-assess the available site investigation data against residential with home grown produce assessment criteria.
- 2.5 **Previous Site Investigation within the Phase containing 28 houses and 6 apartments (Zone 1 and Zone 3)**
- 2.5.1 A review of the Curtins Ground Investigation identifies a total of 17no intrusive locations within the Phase containing 28 houses and 6 apartments (Zone 1 and Zone 3) area. These comprised of 14no window sample boreholes and 3no cable percussive boreholes. Additionally it is noted that 2no window sample boreholes (WS01 and WS02B) were drilled in close proximity to Zone 3 however correspondence with the developer indicates that these boreholes are confirmed to be outside the site boundary. A copy of the Exploratory Investigation plan undertaken by Curtins is shown in the figure below:

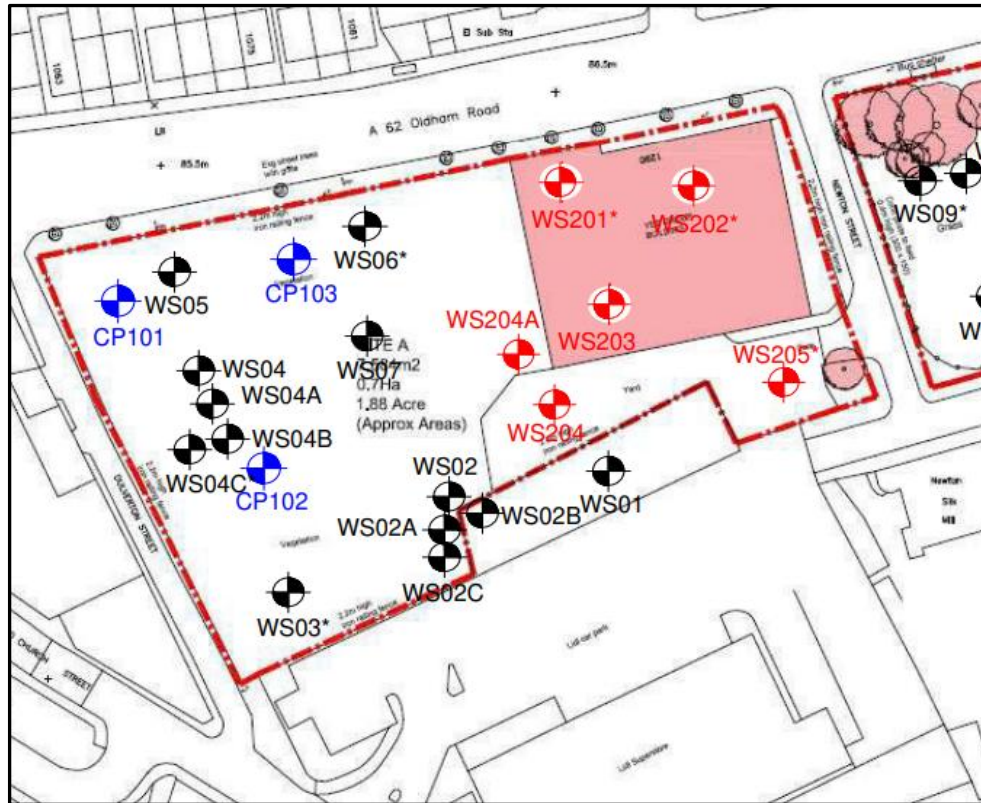


Figure 5: Exploratory Investigation Plan (from Curtins Ground Investigation Report)

2.5.2 As part of their site investigation, Curtins recovered 10no made ground samples from the Phase containing 28 houses and 6 apartments (Zone 1 and Zone 3) area for chemical testing and 2no samples from the boreholes located off-site close to Zone 3. The exploratory locations within the Phase containing 28 houses and 6 apartments (Zone 1 and Zone 3) area are WS02, WS02A, WS02C, WS03, WS04, WS04A, WS04B, WS04C, WS05, WS06, WS07, WS203, WS204, WS204A, CP101, CP102 and CP103).

2.5.3 The samples recovered by Curtins were tested for: Arsenic (Total), Cadmium (Total), Copper (Total), Lead (Total), Nickel (Total), Zinc (Total), Chromium (Total), Selenium (Total), Mercury (Total), Boron (Soluble), Hexavalent Chromium, Cyanide (Total), pH, 16 EPA Poly-Aromatic Hydrocarbons (PAH), Total Petroleum Hydrocarbon compounds (TPH-CWG), Total Phenols, Sulphate 2:1 extract, Sulphate acid extract, Soil Organic Matter and Asbestos ID.

2.6 Risk Assessment: Human Health Risks from Exposure to Contaminated Soil

2.6.1 The risks to human health have been assessed by inspection of shallow soils for the presence of elevated contaminants based on the expected contaminant findings detailed in the conceptual model and completion of a quantitative risk assessment.



- 2.6.2 The soil contamination concentrations have initially been compared to a range of generic assessment criteria. These include the use of the Land Quality Management and Chartered Institute of Environmental Health assessment criteria (S4ULs), the Contaminated Land: Applications in Real Environments assessment criteria (CL:AIRE) Category 4 Screening Levels (C4SLs) and the ATKINS ATRISK Screening Criteria.
- 2.6.3 These assessment criteria have been derived using the CLEA model and fully justified input parameters. The derivation of the assessment criteria assumes a residential end use with plant uptake. The initial assessment assumes a soil organic matter (SOM) of 1% as a conservative approach.
- 2.6.4 Table 2 summarises the chemical test results for the samples tested and lists the relevant assessment criteria and the samples with a concentration in excess of the assessment criteria. Note that only determinands with a concentration above the laboratory limit of detection are presented in the table below:

Determinand	Range of Concentrations (mg/kg)	Assessment Criteria (mg/kg)	Samples Fail
Arsenic	<1 - 35	37 ¹	---
Cadmium	<0.5 – 2.7	11 ¹	---
Chromium	5 - 29	910 ¹	---
Copper	2 – 127	2400 ¹	---
Lead	5 - 749	200 ²	WS04C (0.7 m), WS06 (0.9m), CP101 (0.25 m) and CP102 (0.60 m)
Mercury	<0.17 – 2.3	40 ¹	---
Nickel	2 - 43	180 ¹	---
Selenium	<1 – 2	250 ¹	---
Zinc	42 - 324	3700 ¹	---
Cyanide	<1 – 1	34 ³	---
Acenaphthene	<0.01 - 242	210 ¹	WS01 (0.15 m)
Acenaphthylene	<0.01 – 10	170 ¹	---
Anthracene	<0.02 – 308	2400 ¹	---
Benzo(a)anthracene	<0.04 – 554	7.2 ¹	WS01 (0.15 m) and WS04C (0.7 m)
Benzo(a)pyrene	<0.04 – 1.27	2.2 ²	WS01 (0.15 m), WS04C (0.7 m) and CP102 (0.60 m)
Benzo(b)fluoranthene	<0.05 - 586	2.6 ¹	WS01 (0.15 m), WS04C (0.7 m) and CP102 (0.60 m)
Benzo(ghi)perylene	<0.05 – 293	320 ¹	---
Benzo(k)fluoranthene	<0.07 – 195	77 ¹	WS01 (0.15 m)
Chrysene	<0.06 - 531	15 ¹	WS01 (0.15 m)
Dibenzo(ah)anthracene	<0.04 – 90.5	0.24 ¹	WS01 (0.15 m), WS04C (0.7 m) and CP102 (0.60 m)
Fluoranthene	<0.08 – 1320	280 ¹	WS01 (0.15 m)
Fluorene	<0.01 – 201	170 ¹	WS01 (0.15 m)
Indeno(123-cd)pyrene	<0.03 – 374	27 ¹	WS01 (0.15 m)
Naphthalene	<0.03 - 233	2.3 ²	WS01 (0.15 m)
Phenanthrene	<0.03 – 1110	95 ¹	WS01 (0.15 m)
Pyrene	<0.07 – 1160	620 ¹	WS01 (0.15 m)



Ali HCs >C8-C10	<1 – 1	27 ¹	---
Ali HCs >C10-C12	<1 - 316	130 ¹	WS01 (0.15 m)
Ali HCs >C12-C16	<1 - 1630	1100 ¹	WS01 (0.15 m)
Ali HCs >C16-C21	<1 – 2320	65000 ^{*1}	---
Ali HCs >C21-C35	<1 - 33100	65000 ^{*1}	---
Aro HCs >C8-C10	<1 - 368	341 ^{*1}	WS01 (0.15 m)
Aro HCs >C10-C12	1 - 684	74 ¹	WS01 (0.15 m)
Aro HCs >C12-C16	<1 - 3050	140 ¹	WS01 (0.15 m) and WS04C (0.7 m)
Aro HCs >C16-C21	<1 - 8110	260 ¹	WS01 (0.15 m) and WS04C (0.7 m)
Aro HCs >C21-C35	2 - 48500	1100 ¹	WS01 (0.15 m) and WS04C (0.7 m)
Asbestos ID	WS02B (0.45 m)		

Table 2: Summary of Elevated Contaminants of Concern in Soils

1 CIEH/LQM Derived Assessment Criteria (S4ULs based on 1% SOM)

2 Category 4 Screening Levels (C4SL)

2.6.5 It can be seen from the above table that there were elevated concentrations of lead, several PAH compounds and Aliphatic and Aromatic Hydrocarbons identified in or in close proximity to the Phase containing 28 houses and 6 apartments area of the site.

2.6.6 Additionally, one sample proved positive for the presence of asbestos.

Further Assessment – Made Ground Contamination Lead and PAH Compounds (except Naphthalene)

2.6.7 The principal human exposure pathways for heavy metals and the 16 PAH USEPA compounds tested (with the exception of naphthalene) is through dermal contact, ingestion of soil and indoor dust or consumption of home grown produce. The presence of these contaminants require similar mitigation measures, hence, BEK considers it prudent to assess heavy metals and the remaining 15 USEPA PAHs, together.

2.6.8 Further assessment of the elevated concentration of heavy metals and PAH compounds confirms that the contamination is relatively widespread across the site at various depths across various subtypes of made ground (WS01 (0.15 m), WS04C (0.7 m), WS06 (0.9m), CP101 (0.25 m) and CP102 (0.60 m)).

2.6.9 Specific mitigation measures will be required to address the heavy metal/PAH contamination (except naphthalene) at the site. This will comprise a robust capping system in soft landscaped areas to mitigate the risk to end users from the underlying lead and PAH contamination within the made ground. This will form a physical barrier between the source of contamination and the end user breaking the major pathways of dermal contact, ingestion of soil and consumption of home grown produce.



- 2.6.10 The above mentioned measures will mitigate the risks from heavy metals/PAH contamination across the site where elevated contaminant levels were generally no more than one order of magnitude more than the respective generic assessment criteria.
- 2.6.11 Notwithstanding, significantly elevated contamination was encountered within the borehole WS01 (0.15 m). A review of the Curtins Exploratory Location Plan (Figure 5) and correspondence with the developer confirms that this borehole is located off-site and therefore no further assessment with regards to Lead and PAH compounds (excluding naphthalene) associated with WS01 (0.15 m) is required. However, it is noted that if WS01 is located on site then further assessment and hotspot removal may be required.

Further Assessment – Naphthalene and Speciated Total Petroleum Hydrocarbons

- 2.6.12 Elevated naphthalene and speciated total hydrocarbons were encountered in WS01 (0.15 m) and WS04C (0.7 m). The principal pathway for naphthalene, aliphatic hydrocarbons C10-12, aliphatic hydrocarbons C12-16 and aromatic hydrocarbons C8-10 is inhalation of vapours. Elevated concentrations of naphthalene, aliphatic hydrocarbons C10-12, aliphatic hydrocarbons C12-16 and aromatic hydrocarbons C8-10 were encountered in WS01 (0.15 m).
- 2.6.13 As mentioned previously, it is understood that WS01 (0.15 m) is located off site however due to the high concentrations of volatile contaminants it is considered necessary that a watching brief during excavations is undertaken in the area in the south of site close to the location of WS01. Should any suspected contamination including hydrocarbons odours be identified during excavations in the south of the site then works should cease and professional advice should be sought.
- 2.6.14 Notwithstanding the above, elevated concentrations of aromatic hydrocarbons C12-16, aromatic hydrocarbons C16-21 and aromatic hydrocarbons C21-35 were identified in WS01 (0.15 m) and WS04C (0.7 m). The principal pathway for these contaminants is consumption of homegrown produce and ingestion of soil and indoor dust. As alluded to previously, WS01 is located off-site therefore no specific mitigation measures with regards to aromatic hydrocarbons C12-16, aromatic hydrocarbons C16-21 and aromatic hydrocarbons C21-35 and WS01 are considered necessary.
- 2.6.15 However WS04C (0.7 m) is located with the Phase containing 28 houses and 6 apartments (Zone 1 and 3) area. Further assessment indicates that the SOM of sample WS04C (0.7 m) is 35.8 % w/w therefore 6% SOM assessment criteria has been assessed for the speciated hydrocarbons for this sample as shown in the table below:



Determinand	Concentration encountered within WS04C (0.7 m)	Assessment Criteria at 6% SOM (mg/kg)	Samples Fail (Y/N)
Aro HCs >C12-C16	352	660	N
Aro HCs >C16-C21	1110	930	Y
Aro HCs >C21-C35	2760	1700	Y

Table 3: Comparison of aromatic hydrocarbons C12-16, C16-21 and C21-35 for WS04 (0.7 m) against 6% SOM assessment criteria

- 2.6.16 It can be seen from the above table that the assessment criteria is exceeded for aromatic hydrocarbons C16-C21 and aromatic hydrocarbons C21-C35 within the sample obtained from WS04C (0.7 m) with regards to residential with home grown produce end use. As such specific mitigation measures comprising of a robust capping system in soft landscaped areas to mitigate the risk to end users from the underlying contamination within the made ground.

Further Assessment – Asbestos

- 2.6.17 One sample proved positive for the presence of asbestos which was identified as Chrysotile cement (0.959% w/w) within WS02B (0.45 m). As with WS01, correspondence with the developer confirms that this location is outside of the red-line boundary.
- 2.6.18 The made ground in this location is described as ‘Blackish grey ashy clayey sandy GRAVEL. Gravel is fine to medium, sub-angular to angular of coal, ash, slate, brick and concrete. Occasional ceramic, glass and plastic’. This made ground is similar to that identified in WS02, WS02A and WS02C which are shown to be located on site however no chemical testing of the made ground in WS02, WS02A and WS02C was undertaken.
- 2.6.19 As such BEK considers it prudent to carry out all sub-surface ground works in accordance with an asbestos management plan given the significant quantities of made ground encountered at the site and its inherent variability.
- 2.6.20 Furthermore, BEK recommends that the watching brief associated with the volatile contamination in the south of the site including a vigilant assessment for the presence of asbestos contamination.

2.7 Risk Assessment: Human Health Risks from Exposure to Hazardous Gases

- 2.7.1 The ground gas risk assessment by Curtins concluded that for the apartment blocks and low-rise residential housing, a Moderate and a Low risk is identified respectively to site end-users from ground gas migration and inhalation from soils.



2.7.2 For the apartment block, this corresponds to BS8485 Characteristic Situation 2 gas regime requiring gas protection measures and for the low-rise residential housing, this corresponds with NHBC Green requiring no gas protection measures.

2.7.3 Since the production of the Curtins Ground Investigation, the NHBC Traffic Light regime for ground gas risk assessment are no longer applicable and therefore BEK considers it prudent that the site is classified as Characteristic Situation 2 and as such all proposed buildings will require gas mitigation measures.

2.8 Risk Assessment: Buildings

2.8.1 Risks to buildings include the assessment of the aggressive nature of the shallow ground with respect to concrete, the risks to the degradation of water pipes and flora due to contamination.

Risk to Concrete

2.8.2 In accordance with the Curtins Ground Investigation, laboratory test results indicate a Design Sulphate Class for concrete may be taken as DS-1 and ACEC class of AC-1s would appropriate for the made ground and glacial till deposits.

Risks to Services

2.8.3 Potable water supply pipes can be at risk from degradation if the shallow ground consists of specific organic contamination. Guidance published by UK WIR includes a methodology for the site investigation and risk assessment to determine pipe specification.

2.8.4 For brownfield sites, site investigation may be required along the intended route of the water pipeline and samples recovered from specific depths and tested for specific contaminants of concern.

2.8.5 On the basis of the ground conditions encountered, risks to water supply pipelines are considered to be moderate, however it is recommended that consultation is undertaken with the water service supplier to confirm this.

Risks to Flora

2.8.6 Copper, nickel and zinc are toxic to plants. The effects of copper, nickel and zinc are often regarded as additive.

2.8.7 The assessment criteria used for copper, nickel and zinc, are 'pseudo total concentrations' are derived from BS3882:2007 as follows:



Phytotoxic Contaminant	pH Range		
	<6.0	6.0 to 7.0	>7.0
Zinc (nitric acid extractable)	<200	<200	<300
Copper (nitric acid extractable)	<100	<135	<200
Nickel (nitric acid extractable)	<60	<75	<110

Table 4: Limits for Phytotoxic Contaminants (Units mg/kg)

- 2.8.8 By comparing the chemical test results to the concentration in the above table, it can be seen that there is one exceedance of zinc above the phytotoxic threshold criteria identified in CP101 (0.25 m).
- 2.8.9 A capping system to ensure the rhizosphere of any future flora does not come into contact with the contamination observed should be implemented at the site.
- 2.9 BEK Risk Assessment: Conclusions**
- 2.9.1 Further risk assessment has been undertaken by BEK with Phase containing 28 houses and 6 apartments (Zone 1 and 3) assessed against residential with home grown produce.
- 2.9.2 Based on the contamination assessment herein and with respect to the change of use of the site to residential with private gardens the made ground contains widespread non-volatile heavy metals, PAH compounds (excluding naphthalene). and non-volatile total petroleum hydrocarbons. Risks to flora were identified in one location within the made ground.
- 2.9.3 Moreover, a hotspot of volatile contamination is present within WS01 and asbestos was identified within WS02B which are both understood to be offsite. As such it is recommended that a watching brief is undertaken during excavations in the south of the site due to the potential presence for volatile and asbestos contamination.
- 2.9.4 The potential risks to human health and flora identified (note this table does not take into account WS01 and WS02B which are offsite) are summarised within Table 5 below:



Receptor	Contaminants of Concern	Source Strata	Significant Pathway	Secondary Pathway(s)
Human Health	Lead	WS04C (0.7 m), WS06 (0.9m), CP101 (0.25 m) and CP102 (0.60 m)	Ingestion of soil and indoor dust	Consumption of homegrown produce and attached soil
	PAH Compounds (except naphthalene)			
	Aro >C12-C16	WS04C (0.7 m)	Consumption of homegrown produce and attached soil	Ingestion of soil and indoor dust
	Aro >C16-C21			
	Aro >C21-C35			
Flora	Zinc	CP101 (0.25 m)	Assimilation by flora	

Table 5: Summary of Active Risk Pathways

- 2.9.5 Potential risk to service pipes are considered to be moderate but advice should be sought from the water supply provider. Risks to concrete are considered to be low and concrete classification of DS-1 AC1s will be suitable.
- 2.9.6 Potential risks associated with ground gas have been identified. Gas mitigation measures in accordance with CS2 of BS8584 will be required within all new buildings at the site.
- 2.9.7 Risks to controlled waters (groundwater and surface water) have been identified as low.



3. REMEDIATION STRATEGY

3.0.1 In order to remove potential risks to the development and/or human health specific remediation and mitigation measures need to be carried out.

3.1 Contamination

3.1.1 To mitigate the potential risks to human health associated with lead, PAH, and Speciated Total Petroleum Hydrocarbon (Aromatic >C12 – C16, Aromatic >C16 – C21 & Aromatic C21 – C35) contamination within the made ground, the following works will need to be undertaken:

- (i) The made ground should be either excavated and removed from all garden/landscaping areas or capped with clean, inert sub/topsoil suitable for use. Where made ground remains, a minimum of 600 mm cover thickness within rear gardens and 450 mm cover thickness within front gardens and landscaped areas should be sufficient to remove exposure to the made ground and mitigate risk where made ground is encountered. The suitability of the sub/topsoil should be independently validated.
- (ii) A watching brief should be adopted when excavating in the southern area of the site (vicinity of WS01 and WS02B) due to the presence of volatile contamination and asbestos.

3.2 Asbestos Management Plan

3.2.1 An Asbestos Management Plan (AMP) should be prepared to manage and mitigate the potential risks from asbestos inhalation. The AMP should consider the ground conditions detailed in the Curtins Ground Investigation report to implement safe working procedures and mitigate any potential risks to contractors on site or the general public adjacent to the site. All groundworks should be carried out in accordance with the recommendations presented in the AMP. The groundworkers risk assessment and method statements should reflect the information presented herein and the AMP.

3.3 Ground Gas Mitigation

3.3.1 On the basis of the assessment of the potential risks from ground gas, mitigation measures which adhere to CS2 of CIRIA C665 will be required at the site.

3.3.2 Sections 4, 5 and 6 of this report herein include a Gas Verification Plan for the site which provides details of the specific mitigation measures required at the site to ensure the proposed gas measures comply with the points system presented within BS8485:2015+A1:2019 for the appropriate building type. The gas mitigation measures should be validated in accordance with CIRIA C735.



3.4 Imported Material

- 3.4.1 There may be a requirement to import suitable topsoil/subsoil for use in the landscaped/garden areas of the development.
- 3.4.2 The suitability of the sub/topsoil and any other material imported to the site should be independently validated.
- 3.4.3 The details pertaining to the independent validation of material to be imported to the site are outlined within Section 7 of this report.

3.5 Off-Site Disposal

- 3.5.1 The chemical testing regime for off-site disposal may be different to the chemical testing required to assess the suitability of the soils for retention on site and the risks to human health. Therefore, additional assessment may be required to classify the soils for off-site disposal with testing criteria to assess whether the soil is hazardous, non-hazardous or inert waste.
- 3.5.2 However, existing laboratory test certificate will help inform the process. Any additional testing should also be used in the classification of the waste soils for off-site disposal.
- 3.5.3 The receiving landfill may require additional specialist laboratory testing to further characterise the material proposed for disposal against Waste Acceptance Criteria (WAC). We would recommend early consultation between the Contractor and the receiving landfill to determine any specific laboratory testing requirements.
- 3.5.4 Individuals/companies removing soils from the site are bound by a Duty of Care and as such this should only be undertaken by an authorised person. All waste movements should be accompanied by a waste transfer note.

3.6 Dewatering

- 3.6.1 Based on site investigation works it was determined that groundwater levels are variable and not representative of laterally continuous perched water. The water encountered is likely to be associated with pockets of perched water within more permeable layers of the made ground/superficial strata.
- 3.6.2 However, if water entering any of the excavations is visually or olfactory affected by contamination then consideration should be made for dewatering. Any impacted water should be carefully pumped from the excavation directly into a tanker for off-site disposal. Water will be pumped from the near surface of the



water and (as much as practicable) away from the sides of the excavation to avoid pumping up soils.

- 3.6.3 All pumping activities will be carefully monitored to watch for drawing in contaminated water from elsewhere on the site. Pumping will continue until visual/olfactory evidence of contamination has reduced/gone or as is considered reasonably practicable.

3.7 Construction Workers

- 3.7.1 It is recommended that construction personnel involved with direct contact with the soils at the site use appropriate PPE equipment (i.e. boots, gloves and overalls).
- 3.7.2 In addition, hygiene facilities should be made available in accordance with general health and safety guidelines. The successful remediation/site works contractor should undertake a suitable Risk Assessment to confirm the appropriate level of PPE.
- 3.7.3 A copy of all reports relating to the site should be included in the site Health & Safety File and site workers should be made fully aware of the site's setting.

3.8 Concrete Mix Design

- 3.8.1 It is recommended that a concrete classification of sulphate class DS-1 and Aggressive Chemical Environment for Concrete (ACEC) class of AC-1s is suitable for the site.
- 3.8.2 Confirmation that the correct concrete mix has been used on site is outside the BEK validation remit.

3.9 Unforeseen Circumstances

- 3.9.1 Any areas of previously unidentified potentially contaminated soils encountered during site construction works must be brought to the attention of BEK, to ensure that the recommendations herein apply. Any potentially contaminated soils should be left in-situ and subjected to further assessment, to potentially include further chemical testing and risk assessment.

3.10 Utilities

- 3.10.1 Prior to redevelopment of the site, BEK recommends that a copy of this report and the previous reports relating to the site are supplied to utility companies, and that their recommendations relating to appropriate supply pipes are adhered to.



3.11 Re-use of Waste Soils on Site

- 3.11.1 The re-use of waste soils generated at the site should be covered through environmental permit exemptions (if applicable) and/or through the preparation of a Material Management Plan as part of compliance with the Definition of Waste: Code of Practice (DoW:CoP).

3.12 Communication

- 3.12.1 We would recommend that regular communication is maintained between BEK and the Site Manager throughout the development works.

3.13 Statutory Consultation

- 3.13.1 We would recommend that a copy of this Remediation Method Statement is issued to the local authority for review/comment and approval prior to the commencement of re-development works on site.
- 3.13.2 The insurer may also require written approval of the remediation proposals from the regulators in order to satisfy their Land Quality Conditions.

3.14 Pre-Start Meeting

- 3.14.1 It is recommended that a meeting is held between the relevant parties on site, prior to commencement of validation works.

3.15 Closure

- 3.15.1 Following satisfactory completion of remediation works, BEK will produce a Validation/Completion Report to demonstrate compliance with this Remediation Method Statement.



4 DESIGN OF GROUND GAS PROTECTION MEASURES

4.1 General

4.1.1 In accordance with Table 4 of BS 8485 (2015) + A1 (2019), the proposed property is assumed to represent a **Type A** and **Type B** building. In order to protect against the CS2 ground gas risks identified, a gas protection score of **3.5 points** must be achieved.

4.1.2 A combination of two or more of the following protection measures should be used to achieve the Gas Protection Score:

- Structural barrier (floor slab)
- Ventilation measures
- Gas resistant membrane

Site Specific Assessment of Foundation Design - Gas Protection Score Assessment

4.1.3 The proposed construction elements to achieve the required points of 3.5 points are given below:

- Beam and block floor construction is to be utilised. This achieves **0 points**.
- A ground gas resistant membrane is recommended. This achieves **2 points**.
- A clear void passive venting layer with 'very good' performance is recommended. This achieves **2.5 points**.

4.2 Floor Slab

4.2.1 This floor type contains many construction joints and discontinuities and can be affected by cracking. As such, it offers little resistance to the passage of ground gas and has high permeability.

4.2.2 Based on Table 6 of BS8485:2015+A1:2019, this will achieve a gas protection score of 0 points.

4.3 Ventilation Measures

4.3.1 For the proposed development, it is intended to include a minimum 150 mm deep ventilated sub-floor void with ventilation provided via air vents around the perimeter of the property. The number of vents is to be confirmed but will meet or exceed the BS8485:2015+A1:2019 requirements of 1,500 mm²/m run of wall on at least two opposite sides. This should be sufficient to provide very good performance.



4.3.2 Where there are multiple internal obstructions to air flow (caused by beams) there should be at least four (to five) times the area of the side vents provided to the internal obstruction.

4.3.3 Based on Table 6 of BS8485:2015+A1:2019, this will achieve gas protection score of 2.5 points.

4.4 Gas Resistant Membrane

4.4.1 A low permeability methane and carbon dioxide resistant membrane (also protective against ingress of radon) which meets all of the requirements of Table 7 of BS8485:2015+A1:2019 will achieve a score of 2 points. This membrane should:

- Be made from virgin polymer and have a methane transmission rate of less than 40.0ml/day/m²/atm (average);
- Be chemically resistant to degradation by other contaminants that may be present;
- Be sufficiently impervious, both in the sheet material and in the sealing of sheets and sealing around sheet penetrations, to prevent any significant passage of methane and/or carbon dioxide through the membrane;
- Be sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions;
- Be sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc); and to withstand in-service stresses (e.g. settlement if placed below a floor slab);
- Be capable, after installation, of providing a complete barrier to the entry of the relevant gas; and
- Be verified in accordance with CIRIA C735

4.4.2 The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints. If a membrane is installed that does not meet all the criteria above then the score is zero.



5. INSTALLATION OF GROUND GAS PROTECTION MEASURES

5.1 General Comments

5.1.1 In concurrence with the NHBC guidance 'Hazardous Ground Gas - an essential for housebuilders – April 2023', BEK has advised the client that the welded solution is the preferred method for sealing gas membranes at critical junctions including laps and joints.

5.2 Components of the Membrane System

5.2.1 The manufacturer of the membrane and its associated components has yet to be confirmed by the client. The installed membrane and its associated components will need to meet the requirements of BS8485:2015+A1:2019.

5.2.2 BEK recommends two membranes which are considered suitable for use as a gas barrier and these are:

- Juta GP1 (Juta)
- Visqueen Ultra Gas Barrier

5.2.3 All membrane installation must be undertaken to the manufacturer's specification.

5.2.4 Installation accessories will also be necessary (the exact components will depend on the installation method and the exact design of the building). Components utilised to install the gas membrane system include but are not limited to:

- Jointing tape (double sided, gas resistant tape)
- Pre-formed top hats
- Pre-formed Corners and Stop Ends
- Jubilee clips
- Gas Resistant Self Adhesive Membrane (and primers if this is sealed directly to masonry, metal or concrete)
- Gas Resistant Damp Proof Course (strongly preferred in areas where internal and external walls are to be constructed)
- Liquid Gas Membrane

5.2.5 All products utilised in the gas membrane system will need to be pre-approved by BEK. Any additional products utilised will need to be re-reviewed to confirm they meet the requirements of BS8485:2015+A1:2019.



5.3 Ventilation Measures

Sub-Floor Void

- 5.3.1 The beam and block system should incorporate a void depth of a minimum 150 mm free from debris and obstructions.

Air Bricks

- 5.3.2 The number of vents will meet or exceed the BS8485:2015+A1:2019 requirements of 1,500 mm²/m run of wall on at least two opposite sides. A typical air brick provides (6,000mm² vent area).
- 5.3.3 Regardless of ground gas protection requirements, the NHBC advise for protection against moisture is that void ventilation should be provided to whichever gives the greater opening area of either (i) 1500mm² per metre run of external wall or (ii) 500 mm² per m² of floor area. Therefore, minimum NHBC requirements are likely to be appropriately protective in terms of ground gases for low rise housing. It is outside the BEK remit to confirm whether the NHBC standards/building regulations are met with regards to protection against moisture.
- 5.3.4 BEK will validate that the number of vents will meet or exceed the BS8485:2015+A1:2019 requirements of 1,500 mm²/m run of wall on at least two opposite sides.

Internal Sleeper Walls

- 5.3.5 Where there are multiple internal obstructions to air flow caused by beams and sleeper walls, cross vents will need to be installed. These need to provide a minimum of 6,000 mm²/m.
- 5.3.6 The simplest approach is to use short sections of 100 mm diameter PVC drainage pipe through the sleeper wall or construct it with gaps in the blockwork.

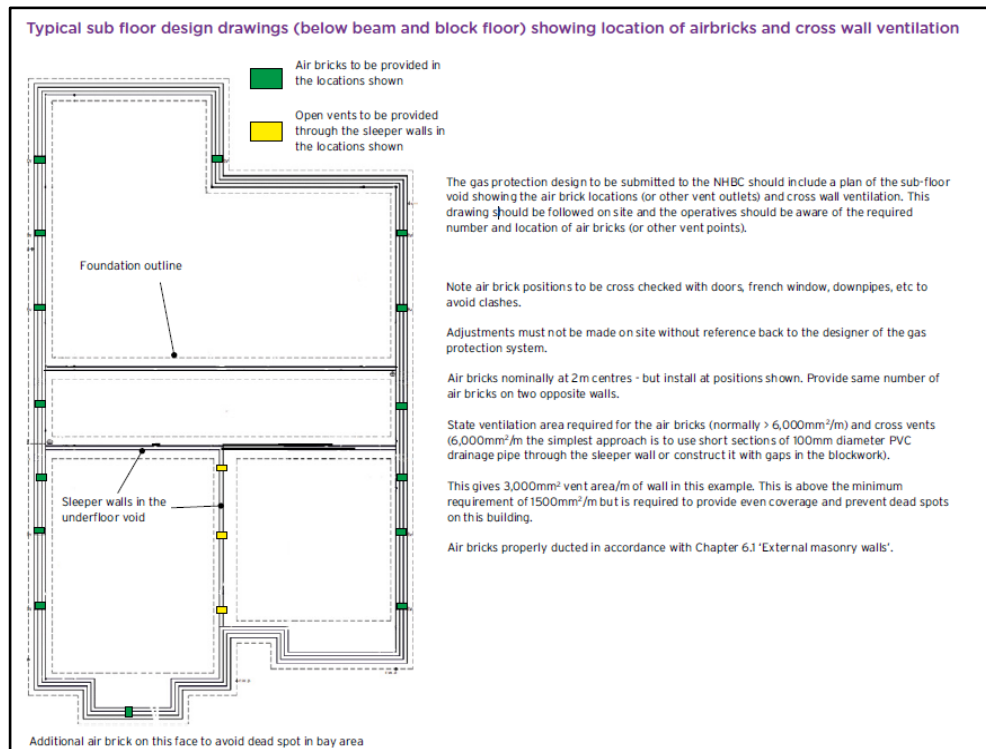


Figure 2: Example Drawing Showing Air Brick Locations

5.4 Ground Gas Membrane Installation - Outline Methodology

Preparation of the surface underlying the membrane

- 5.4.1 The surface underlying the membrane should have a smooth finish - free from voids, projections, and mortar deposits.
- 5.4.2 The gaps between the block and beams should be filled with a sand cement screed brushed into the joint. In many instances blocks are cut leaving gaps around pipe penetrations, these should be filled with expanding foam or sand and cement to ensure that the gas membrane is fully supported.
- 5.4.3 The beam and block floor should be prepared as per the manufacturer's specification (e.g. a sand blinding layer, protection fleece, or a smooth concrete float finish).

Laying of the Gas Membrane System

- 5.4.4 The membrane system shall be laid loosely extended across cavities and sealed around joints/service entries as per the manufacturers specification. This will typically require 150 mm membrane overlaps with proprietary double-sided tape within the joint and single sided proprietary tape over the top of the joint. A cross section showing the installation of membrane is illustrated in Figure 3.

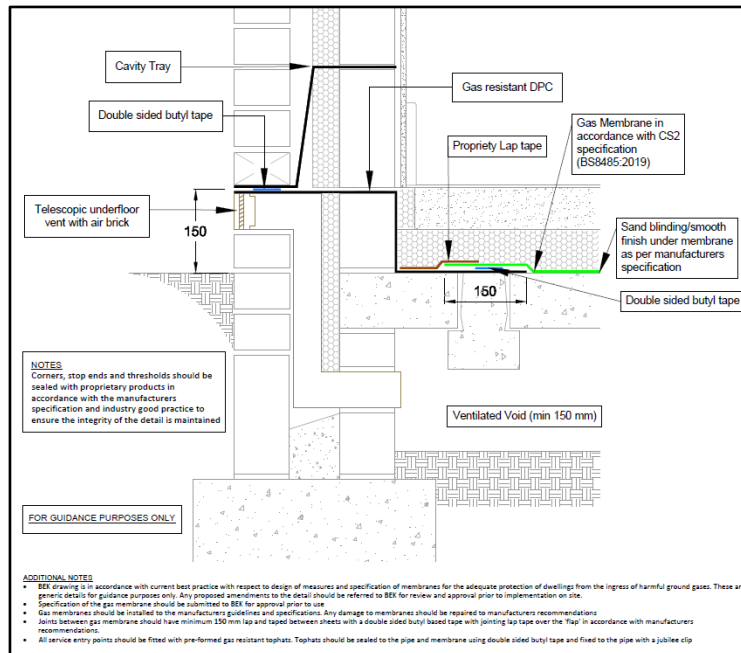


Figure 3: Typical Gas Membrane Edge Detail

- 5.4.5 Service penetrations shall be sealed with proprietary 'top hats' to the membrane and service pipe using propriety products in accordance with the manufacturer's specification. Top hats should be sealed to the pipe and gas membrane utilising double sided jointing tape and fixed with a jubilee clip. A schematic showing the installation of a top hat as per the manufacturer's specification is shown in Figure 4.

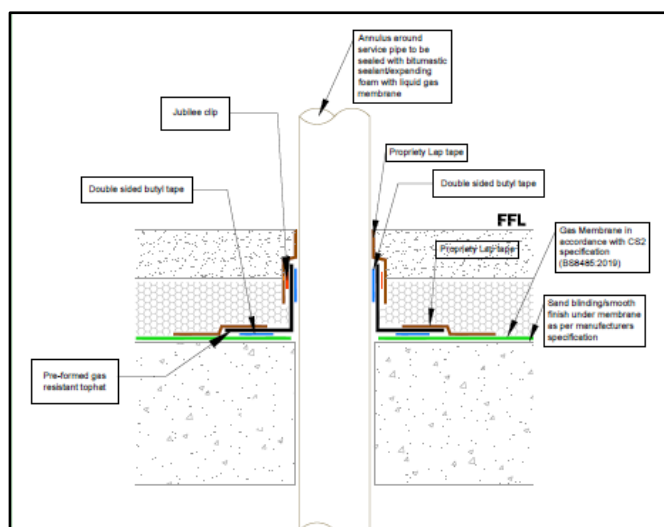


Figure 4: Typical Penetration Detail for Pre-Formed Tophats

- 5.4.6 Corners and non-standard service entries will be preferentially sealed utilising Gas Resistant Self Adhesive Membrane. Corners and block ends can also be sealed with pre-formed units.

Protection of the Gas Membrane System

- 5.4.7 BEK recommends that the gas membrane is protected through placement of the insulation and/or fleece protection above the membrane within one working day of a passed inspection (as per the manufacturers specification).

Sealing of Internal Annulus around Service Pipe

- 5.4.8 In terms of the internal annulus of the duct holding each of the service pipes and conduits (electric cables and water pipes in some areas etc.) this will be filled with expanding foam and liquid applied gas membrane. The detail for this is provided in Figure 5.

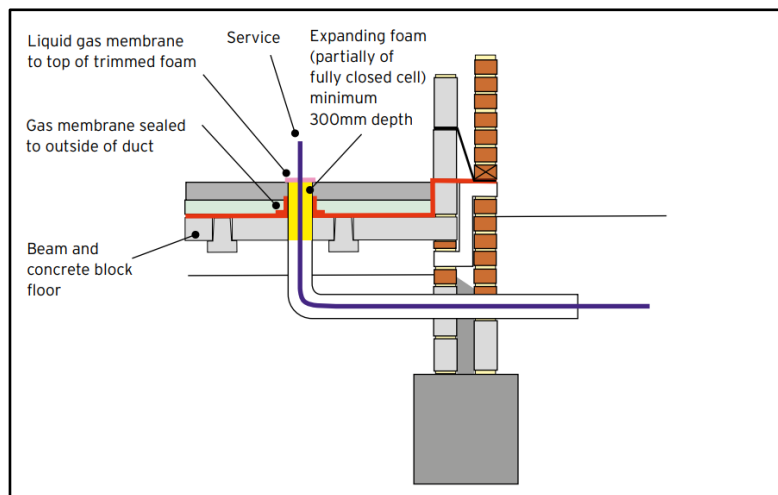


Figure 5: *Sealing of the Internal Annulus of the Service Duct (extracted from NHBC – an essential guide for house builders – April 2023)*

5.5 Installer of Ground Gas Measures

- 5.5.1 The exact construction company appointed to install the gas protection measures is unknown at the time of writing. The installers should be trained and experienced in the installation of ground gas resistant membranes.
- 5.5.2 BEK has recommended that in accordance with the NHBC 'Hazardous Ground Gas – an essential guide for housebuilders' the installation of the gas membrane system should be carried out by a specialist gas membrane installation company (specialist installer) with at least 50% of staff holding an NVQ level 2 (gas membrane installation) and/or TWI/CSWIP plastic welding accreditation with the remaining staff working towards one of those qualifications.
- 5.5.3 If non-specialist groundworkers are utilised to install the ground gas mitigation measures, BEK recommends that the general contractor doing the installation



should receive adequate training from the suppliers of materials and be suitably qualified to carry out the installation.

5.6 Verification

- 5.6.1 The installation of the membrane will be independently validated by an appointed environmental consultant from BEK. Michael Buckley (BSc (Hons) MSc MEnSci CEnv), owner and Managing Director at BEK has over 25 years' experience in the verification of ground gas mitigation measures. Michael Buckley is responsible for the appointment/training of suitably qualified staff to verify gas measures and the ultimate sign off of all verified gas mitigation measures.
- 5.6.2 All staff involved in the verification of ground gas mitigation measures are degree qualified and a number of employees at have attended the 'Verification of Gas Protection Systems Course' delivered by CL:AIRE. In house training has been delivered to all BEK employees involved the verification of ground gas mitigation measures.



6. GAS MEASURES VALIDATION PLAN

6.1 Supervision of Works

- 6.1.1 The verification as described herein follows the recommendations set out in CIRIA C735 'Good practice on the testing and verification of protection systems for buildings against hazardous ground gases'. The works will be verified in accordance with CIRIA 735 (2014) by an experienced, suitably qualified verifier.
- 6.1.2 The installation of the gas protection measures (ventilation system and gas membrane installation) will be checked and verified by the Engineer at key stages during the works.

6.2 Key Verification Responsibilities & Hold Points

- 6.2.1 Verification lines of evidence need to be collated at a number of hold points. Such lines of evidence are required to ensure that the gas mitigation measures have been installed in accordance with the methodology presented in the Gas Verification Plan report herein.
- 6.2.2 However, it will not always be possible (or practicable) for BEK to be present for every stage of the remediation works in every plot and therefore some degree of verification will need to be undertaken by the developer. However, this should only be done following communication with BEK to ensure that appropriate validation records are maintained.
- 6.2.3 In all cases, it will be the responsibility of the developer to ensure that the verifier is contacted to collate verification evidence/in house verification evidence is collated at the below mentioned hold points:



Verification Hold Points	Evidence Requirement and Party Responsible for collation of such evidence
Verify depth of sub-floor void	Verification Consultant &/or Developer (Developer can only provide these records when BEK is confident that appropriate evidence has been collated) - Provide location referenced example photos
Spacing of air bricks, inspection of underside of membrane placement and sealing of the gas membrane across the entire building footprint	Verification Consultant - is to conduct a thorough visual inspection of 100% of the membrane area prior to it being overlain by insulation and a concrete screed poured to ensure all joint/penetrations are sealed appropriately. BEK is also to verify that the air bricks have been installed at the locations specified in the design drawings.
Placement of the insulation and/or fleece protection above the membrane.	Developer - is to ensure that the membrane is insulated within 1 working day of the inspection passing on a given plot. This should be considered for periods of site closures (ie the Christmas break).
Watch brief following inspection of the membrane and prior to concrete pour to ensure gas membrane is not punctured/damaged by follow on trades	Developer - is to ensure that follow on trades are aware of the presence and purpose of the gas membrane, and who they should contact if they believe their actions have had the potential to compromise it. A watch brief should be maintained by the developer to ensure that the membrane is not damaged by follow on trades. BEK should be contacted if the developer has reason to believe the measures have been compromised.
Sealing of service ducts (prior to occupation)	Developer - is to provide confirmation that the internal annulus of any open portion of any service duct annulus has been sealed in accordance with the design drawings. Plot specific location referenced photos to be collated for all seals and to be provided to the local authority on request
Ground level checks at airbricks (prior to occupation).	Developer - is to inspect the placement of airbricks with reference to finished ground levels after completion of landscaping works to ensure theses have not been obscured.

Table 6: Summary of Key Verification Hold Points and Lines of Evidence Required at Each Hold Point.



6.3 Visual Inspection & Integrity Testing

6.3.1 A **visual inspection** method is recommended to be carried out by BEK. This should be undertaken following laying of the beam and block floor and laying of gas membrane on top, but prior to laying of insulation and poring of the screed.

6.3.2 Integrity testing is not required. However, pick testing may be carried out on site at the discretion of the BEK engineer.

6.4 Verifier Checklist

6.4.1 The BEK verifier or other suitably qualified verifier will:

- Confirm that the correct membrane has been used, including sealing/jointing tape and preformed components e.g. top hats, corners, self-adhesive gas membrane.
- Confirm that the underside of the membrane has been installed and prepared as per the manufacturer's specification with the underside of the membrane being free from voids, projections, and mortar deposits.
- Inspect the general condition of the membrane for punctures, rips and tears.
- Check that joints and laps have been sealed in accordance with manufacturers specification.
- Check that the membrane has been installed correctly across cavities, including correct jointing in these areas.
- Check that top hats have been correctly installed around service entries, including jubilee clips around the pipe and correct sealing arrangements to the membrane/pipe infrastructure as per the manufacturer's specification.
- Check that vents have been installed around the perimeter of the building in sufficient number and in the correct locations, including inspecting the condition i.e., not blocked or otherwise restricted.
- Check the presence of a passive ventilation system (clear >150mm void), including measuring that this is of a sufficient depth and the void has not been filled or otherwise compromised.
- Check that internal sleeper walls are also vented to provide adequate flow-through within the void so that none of the walls are blocking off unvented sections within the void.

6.4.2 Any sections of the gas membrane displaying a flaw, failing a visual inspection or failing integrity testing (if required) should be repaired under the supervision of the verification consultant until rectifications are considered acceptable. The verification consultant should record the type and result of the repairs on the gas proforma.

6.4.3 If the verification consultant leaves the site without rectifications being made then the plot inspection will be failed subject to re-inspection at a later date.



- 6.4.4 Photographic evidence will be recorded during all inspections and a suitable record of the validation will be included within a validation report.

- 6.4.5 A gas measures proforma sheet will be completed detailing the inspection for each inspection visit. An example of the gas pro-forma to be used is presented in Appendix A.



7. SUPERVISION AND VALIDATION OF GARDEN CAPPING

7.1 Supervision of Works

7.1.1 The works will be supervised by BEK who will ensure the following verification procedures are adopted:

- (i) Liaison with the appointed groundwork/remediation contractor
- (ii) Inspection and supervision of the works
- (iii) Collection of samples and co-ordination of laboratory testing

7.1.2 The remediation areas will be checked and verified by the Engineer at key stages during the works, including:

- (i) Installation of the telescopic vents for the passive ventilation
- (ii) Following placement and sealing the proprietary gas membrane
- (iii) Prior to/following placement of the capping soils to ensure suitability and capping thickness of suitably clean soils and placement of the geotextile membrane

7.1.3 For a sustainable approach it is recommended that the excavated soils are retained on site. However, this may not be achievable due to the requirements in meeting finished site levels.

7.2 Validation of the Works

7.2.1 Validation testing is required to ensure the remediation works have been undertaken in accordance with the methodology presented herein.

7.3 Imported Material

7.3.1 It may be necessary to import additional soil for use in the landscaped/garden areas. If possible, all imported soils should be sourced locally. The capping soils will be placed on a geotextile membrane that will help prevent mixing and act as a marker layer to mitigate any deep excavations in the future. The presence of the geotextile membrane will need to be confirmed and validated.



- 7.3.2 The methodology to validate the quality of any imported material for use in the gardens will depend on source of those materials.
- 7.3.3 To confirm the suitability of all imported sub/topsoil it will be necessary to recover representative samples for chemical testing and assessment.
- 7.3.4 For all cover system soils that are to be imported, in accordance with Manchester City Council Planning & Contaminated Land Technical Guidance, it is recommended that testing is undertaken after materials have been imported to site (minimum of three samples). Testing of imported soils can be undertaken upon import within a stockpile, or preferably upon placement within rear gardens areas. Testing will vary based on the source of the material.
- 7.3.5 A visual inspection shall also be carried out to ensure that the soil is visually acceptable for use and does not contain any deleterious material (i.e. glass, plastic, brick, concrete etc.).
- 7.3.6 The type of testing and sampling frequency will be determined by the origin of the materials. The validation of the placement of the capping soils will follow the guidance presented in the 'Manchester City Council – Planning & Contaminated Land Technical Guidance, dated February 2021). This includes a sampling frequency of at least three samples for each source used. One sample for every 200m³ of proven 'greenfield' sources and one sample every 50m³ from 'unknown', 'mixed' or 'brownfield' sources (for residential gardens). The following table summarises the recommended sampling frequencies depending on the soil source and end use.

Table 2 Sampling frequencies for imported or site-won fill materials

End-Use	Greenfield Soils	Remediated Soils	Brownfield Soils	Unknown Soil Source
Residential Gardens	1:200m ³	1:100m ³	1:50m ³	1:50m ³
Soft landscaping	1:200m ³	1:150m ³	1:150m ³	1:150m ³
Other	1:200m ³	1:200m ³	1:200m ³	1:200m ³

Table 7: Summary of Sampling Frequency (taken from MCC Technical Guidance, dated February 2021)

- 7.3.7 The sampling frequency may be varied at the discretion of the Engineer depending on the nature and variability of the imported material and its source (subject to Local Authority approval).
- 7.3.8 The verification report will need to include confirmation of the total volume of each material type imported to site to ensure representative sampling has been undertaken in accordance with the appropriate sampling frequency.



- 7.3.9 Assessment of the soil chemical analysis results against the LQM/CIEH Sutable 4 Use Levels (S4ULs), Category 4 Screening Levels (C4SL), or other similarly derived Generic Assessment Criteria for a residential with plant uptake use, are acceptable.

Further Considerations

- 7.3.10 All soils from greenfield sources will be checked to confirm the greenfield status and confirmation will be provided in the Validation Report (i.e. red line site boundary, grid reference and other checks).
- 7.3.11 If other materials will be used, re-used or imported as a component of the cover system in the top 600 mm (450 mm for POS areas) then they should be afforded the same sampling and analytical strategy as the soils in order to provide confidence that they are suitable for use.

7.4 Assessment Criteria

- 7.4.1 Taking account the proposals to redevelop the site for a residential end-use it is necessary to adopt appropriate assessment criteria which protect end-users of the site. For a conservative assumption a Soil Organic Matter (SOM) of 1 % has been used.

Imported Soils

- 7.4.2 The following table provides a list of assessment criteria for assessing suitability of material to be used within the landscaped areas of the proposed development.
- 7.4.3 The criteria have been sourced from the LQM/CIEH Sutable 4 Use Level (S4UL). In addition, the category 4 Screening Levels (C4SLs) for lead and naphthalene have been used, as well as the Atkins ATRISKSOIL screening level for cyanide.

Contaminant of Concern	Assessment Criteria (mg/kg)
Arsenic	37 ¹
Cadmium	11 ¹
Chromium (total)	910 ¹
Copper	2400 ¹
Lead	200 ²
Mercury	40 ¹
Nickel	180 ¹
Selenium	250 ¹
Zinc	3700 ¹
Cyanide	34 ³
Acenaphthene	210 ¹
Acenaphthylene	170 ¹
Anthracene	2400 ¹
Benzo(a)anthracene	7.2 ¹



Benzo(a)pyrene	2.2 ²
Benzo(b)fluoranthene	2.6 ¹
Benzo(ghi)perylene	320 ¹
Benzo(k)fluoranthene	77 ¹
Chrysene	15 ¹
Dibenzo(ah)anthracene	0.24 ¹
Fluoranthene	280 ¹
Fluorene	170 ¹
Indeno(1,2,3-cd)pyrene	27 ¹
Naphthalene	15 ²
Phenanthrene	95 ¹
Pyrene	620 ¹
Aliphatic Hydrocarbons >C5-C6	42 ¹
Aliphatic Hydrocarbons >C6-C8	100 ¹
Aliphatic Hydrocarbons >C8-C10	27 ¹
Aliphatic Hydrocarbons >C10-C12	130 ¹
Aliphatic Hydrocarbons >C12-C16	1100 ¹
Aliphatic Hydrocarbons >C16-C21	65000* ¹
Aliphatic Hydrocarbons >C21-C35	65000* ¹
Aromatic Hydrocarbons >C5-C7	70 ¹
Aromatic Hydrocarbons >C7-C8	130 ¹
Aromatic Hydrocarbons >C8-C10	34* ¹
Aromatic Hydrocarbons >C10-C12	74 ¹
Aromatic Hydrocarbons >C12-C16	140 ¹
Aromatic Hydrocarbons >C16-C21	260 ¹
Aromatic Hydrocarbons >C21-C35	1100 ¹
BTEX - Benzene	0.087 ¹
BTEX - Toluene	130 ¹
BTEX - Ethyl Benzene	47 ¹
BTEX - m & p Xylene	115 ¹
BTEX - o Xylene	60 ¹
Asbestos	None detected

Table 8: Assessment Criteria for Imported Soils

1 CIEH/LQM Derived Assessment Criteria (S4UL) (1% SOM)

2 Category 4 Screening Level (C4SL)

3 Atkins ATRISKOIL screening level

7.5 Assessment of Chemical Test Results

- 7.5.1 BEK will be responsible for the assessment of all chemical test results to determine suitability of material to be used on site.
- 7.5.2 The assessment will be undertaken in accordance with current UK policy and guidelines and any specific requirements of the local authority.
- 7.5.3 All chemical test results will be presented in the Validation Report.



7.6 Capping Thickness

- 7.6.1 The verification of the capping thickness will be completed via the excavation of a series of trial holes and the capping thickness relative to previous ground level be determined. Photographic evidence of the trial hole and capping depth will be presented in the Validation Report.
- 7.6.2 The engineer may take other measurements as required to verify the works have been carried out in accordance with the Remediation Statement.

7.7 Unexpected Areas of Ground Contamination

- 7.7.1 As stated previously within this report the site has been subject to previous site investigation and as such, indicative ground conditions are known.
- 7.7.2 However, if any area of suspect material is encountered during the development of the site (i.e. that do not conform to the anticipated ground conditions) appropriate action will be taken. This will initially include the cessation of work in the area of concern and information forwarded to BEK, who will attend site and carry out further assessment.
- 7.7.3 As a minimum BEK will notify the Local Authority and prevent any additional work in the area pending further assessment which may include sampling, testing and risk assessment.



8. REPORTING

- 8.1 On completion of the remediation and mitigation works, BEK will prepare a Validation/Completion Report.
- 8.2 The Validation/Completion Report will describe the works undertaken in order to satisfactorily demonstrate that the works have been completed successfully and will include the following:
- A description of works undertaken
 - Record of any unforeseen contamination encountered during the works
 - Confirmation of the suitability of the gas membrane and confirmation of the installation of the gas mitigation measures
 - Record of any material imported into the site for use in the residential gardens (if required)
 - Validation samples recovered and tested
 - Assessment of the chemical test results
 - Photographs showing the remediation works being undertaken and completed

APPENDIX A

Example Gas Proforma Sheet

BEK Ground Gas Validation Inspection Record

Site:				Inspected by:	
Plot No:		Date:		Inspection Method:	

	Inspected Item	Y/N	Comments/Defects/Remedials requested	Photo? Y/N
1.1	External Wall Airbricks			
1.2	Sub-Floor Void/ Pressure Relief / Passive Venting			
1.3	Any internal sleeper walls – require appropriate ventilation			
1.4	External vent trenches/ducts			
2.1	Condition of subgrade and underside of membrane			
2.2	Gas Membrane type including associated components			
2.3	Gas Membrane Condition			
2.4	Lapping Design/Seals of Laps and Joints			
2.5	Perimeter Installation/Cavities and Corners			
2.6	Service Entries			
2.7	Are there any level changes/steels/abnormals?			
Additional Notes:				

BEK Ground Gas Validation Inspection Record

	Inspected Item	Comments/Defects/Remedials requested
1.1	External Wall Airbricks	Meet or exceed the BS8485:2015+A1:2019 requirements of 1,500 mm ² /m run of wall on at least two opposite sides. A typical air brick provides (6,000mm ² vent area). Check design
1.2	Sub-Floor Void/ Pressure Relief / Passive Venting	Check the presence of a vented void / pressure relief pathway, including measuring that this is of a sufficient depth and not been filled or otherwise compromised. Subfloor Void minimum 150 mm for residential properties with beam and block construction (unless otherwise specified by design drawing)
1.3	Any internal sleeper walls	Venting of sleeper walls to provide adequate flow-through within the void (6,000 mm ² /m for low rise residential). Ventilation holes (honeycomb brickwork/pipe crossings?) – size, spacing, location in accordance with design? Check that none of the walls are blocking off unvented sections within the void
1.4	External vent trenches/ducts	Located and constructed in accordance with design drawings? If open-topped gravel – gravel type/presence of fines? If pipe or other vent, check position and construction for functionality and absence of blockages. Ability of void former to withstand bearing of the superstructure?
2.1	Condition of subgrade and underside of membrane	Check that the subgrade does not contain rough/uneven surfaces, is appropriately clean and that there are no sharp object E.g. projections, and mortar deposits. Check protective sand blinding layer or geotextile (if specified) is present and meets design specification
2.2	Gas Membrane Type including associated components	Ensure that the correct membrane have been used including components eg sealing/jointing tape, self-adhesive gas membrane, pre-formed tophats, corners, damp proof course
2.3	Gas Membrane Condition	Inspect for rips/tears/punctures/stretching of membrane. Confirm that the membrane is free from dirt, evidence of heavy foot traffic and building materials. Specify and photograph any repairs carried out during inspection
2.4	Lapping Design/Seals of Laps and Joints	Minimum lap as per manufacturers specification of 150 mm. Are joints lapped and sealed in accordance with manufacturers requirements/specification? Check double sided tape is sufficiently stuck and that lap tape isn't lifting/no fish mouths
2.5	Perimeter Installation/Cavities and Corners	Check that membrane goes across the cavity or that membrane jointed correctly to corners, stop ends and threshold (preformed corners/SAGM). Cavity should be free from debris and water.
2.6	Service Entries	Weld sealed using SAM or Tophats need to be correctly installed with no gaps between tophat and membrane and no lifting of tape. Double sided tape should be used around tophat and service entry. Jubilee clips around the pipe and correct sealing arrangements to the membrane/pipe infrastructure as per the manufacturers specification
2.7	Are there any level changes/steels/abnormals?	Changes of level are complex and should be undertaken in accordance with a site specific 3D drawing of the gas membrane detail. Steels require primer with liquid gas membrane and/or self-adhesive membrane

APPENDIX B

Drawings