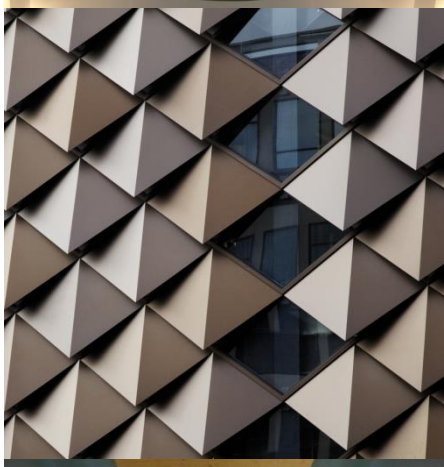








Gorton Lane

Remediation Strategy

Curtins Ref: 067694-CUR-00-XX-RP-GE-001

Revision: V03

Issue Date: 05 November 2021

Client Name: One Manchester

Client Address: Quattro House, Redgate Lane, Longsight, Manchester, M12 4RZ

Site Address: Gorton Lane Sites, Manchester, M12 5WF

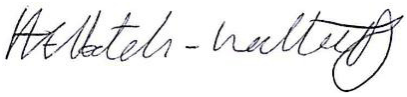
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Rev	Description	Issued by	Checked	Date
V01	Issue of report	SH	JJ	18 02 2021
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V03	Updated Front Garden Capping Thickness	MH	NF	05 11 2021

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Appendices

Appendix A **Drawings**

Appendix B **Delineation Investigation Chemical Results**

Appendix C **Chemical Acceptability Thresholds; Topsoil and Subsoil**

Appendix D **Detailed UXO Risk Assessment Report**

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1.0 Introduction

This Remediation Strategy has been prepared by Curtins for One Manchester (the Client) to provide guidance with respect to land remediation requirements for a site known as Gorton Lane, Manchester located just off Gorton Lane, Manchester, M12 5WF.

The site is centred on NGR 387260, 396950 in West Gorton and comprises two plots of land which are separated by Wenlock Way / Gorton Lane which is aligned east-west. Site 1 (north of Wenlock Way/Gorton Lane) is vacant urban green space with a mix of low-lying shrubs and evergreen trees. Site 2 (to the south of Wenlock Way/Gorton Lane) is a mix of segregated green space with vegetated, built earth mounds, areas of mature trees and grassland, and areas of road and gravel hardstanding. The two sites are within residential areas, with Site 1 bounded by residential and commercial properties along with three roadways. Site 2 is bounded by residential properties and four different roadways.



Figure 2.1 *– Site 1 and Site 2 Location Plan taken from Google Maps*

This report has been revised with respect to **Site 1 only**, produced in support of an associated planning application Ref: 1219876/FO/2021, with proposals comprising 8 x 2 storey and 4 x 3 storey semi-detached

residential properties, with areas of car parking, private gardens and soft landscaping. Development plans can be referred to within *Appendix A* of this report.

This report has been compiled following a Phase 2 Intrusive Investigation undertaken by Curtins in July 2018 and updated in 2021 (Ref.1) and an additional delineation investigation undertaken in November and December 2019 (reported herein, *Section 3.0*).

1.1 Requirements of the Remediation Strategy

The Remediation Strategy is to account for the following;

- A description of the materials likely to be encountered by the developer and their sub-contractors;
- Proposals for excavations with respect to the materials likely to be encountered;
- Any action required to reduce the risk from contaminants from within site soils on the development site;
- Advice on the thickness and quality of any cover to areas of soft landscaping as a part of the development; and
- Advice on the verification and if required, validation of the cover layer, including a regime for sampling and chemical analysis of sub-soil material.

Reference should also be made to Curtins Phase 2 Site Investigation Report, dated 2018 (Ref. 1).

1.2 Definitions

In this document the following definitions apply,

Contractor Refers to the appointed contractor responsible for undertaking the remediation works.

Site Manager Refers to a representative of the appointed contractor resident on site.

Engineer Refers to a suitably qualified representative from Curtins, who would not normally be resident on site.

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2.0 Phase 2 Ground Conditions

Ground conditions have been summarised based on the Curtins 2018 Site Investigation report, updated in 2021 (Ref.1). Borehole locations are shown on the borehole plans contained within *Appendix A*. The investigation generally revealed the following:

2.1 Previous Site Use

Earliest records (1848) depict the site as predominantly agricultural fields with a road along the northeast boundary of Site 1 and a pond in the southwest of Site 2. From the late 19th Century, terraced properties occupy the sites, with a hotel in the north of Site 2, and multiple industries such as an engineering, iron, starch and pottery works surround within 100m. In the early 20th Century, there is a tramway on the eastern boundary.

By the mid-20th Century, buildings disappear in the east of Site 2 and immediately southeast which is potentially due to bombing during WWII. In the 1970s there is large scale redevelopment involving the removal of terraced properties, with Site 1 becoming part of the neighbouring Openshaw Technical College to the west. During the late 20th Century, Pottery Lane is constructed to the west, the site layout now resembles the present day.

2.2 Made Ground

The Made Ground across Site 1 and Site 2 was encountered from ground level to depths of between 0.40m and 5.00m bgl within all exploratory boreholes. Generally, the Made Ground on Site 1 was encountered to depths of between 0.40m to 2.00m bgl. The Made Ground on Site 2 was encountered to depths of between 0.60m to 2.60m bgl. However, 5.00m of Made Ground was encountered within one exploratory borehole (CP2). Grass covered the Made Ground in all exploratory borehole locations.

The Made Ground can be sub-divided into the following principal soil horizons:

- Cohesive Made Ground – sandy silty Clay with frequent rootlets. Rare cobbles of brick and concrete and rare to frequent fragments of brick, coal, concrete, clay pipe, slate, clinker, glass, ceramic, sandstone, wood, cloth, asphalt, ash, plastic, metal, aggregate, tile and cables.
- Granular Made Ground (brick/ash fill) – sand and gravel, with cobbles and whole bricks/concrete, gravel of ash, clinker, coal, concrete, brick, glass, metal, ceramic, sandstone, asphalt, coal, wires, wood, aggregate, slate, ash, plastic and clay pipe rare pockets of clay within the ash fill.

Generally, across Site 1 and 2, the cohesive Made Ground is recorded to overlie the granular Made Ground. In three exploratory borehole locations on Site 2 (TP11, WS5 and CP4) and one on Site 1 (CP1) the granular Made Ground was found to be interbedded between cohesive Made Ground layers.

Within WS2 on Site 1 and CP2 on Site 2, the cohesive Made Ground was recorded to directly overlie the superficial deposits.

Asphalt was encountered within CP1 (Site 1) at 0.20m to 0.25m bgl. Asbestos containing materials (ACMs) of Asbestos Insulation Board (AIB) were encountered at 0.60m bgl within WS6.(Site 2).

2.3 Superficial Deposits

The natural superficial deposits comprised Glacial Till from depths of 0.40m to 5.00m bgl to proven depths of 11.70m to 13.00m bgl. The Glacial Till was recorded directly below the Made Ground within all exploratory hole positions where advancement past Made Ground was made.

It generally comprised firm to very stiff Clay with rare cobbles. Gravel of various lithologies including sandstone, mudstone, coal and quartzite was recorded.

CP01 was terminated within the Glacial Till at 10.00m bgl and no bedrock was encountered in Site 1 during the ground investigation.

2.4 Obstructions Encountered

The following obstructions were encountered during site works.

Table 2.4 – *Encountered Obstructions*

Borehole Ref.	Depth (m bgl)	Obstruction encountered	Action taken
TP2	0.40	Concrete	Drilled through

2.5 Groundwater

There were no groundwater strikes in Site 1 during the intrusive investigation, with groundwater levels recorded during subsequent monitoring visits detailed in *Table 2.5* below.

Table 2.5 – *Groundwater Noted During Site Investigation*

Site ref	Borehole Ref.	Monitored Water Levels	
		Installation Strata	Depth m bgl (m AOD)
Site 1	CP1	Clay	7.58 – 9.30 (45.30 – 47.02)
	WS1	Made Ground and Clay	DRY >1.50 (<50.40)
	WS2	Clay	*
	WS3	Clay	2.72 – DRY (>4.00) (<49.50 – 50.78)

* Unable to remove bung to monitor groundwater levels.

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During monitoring visits, groundwater was recorded at 2.72m to 9.30m bgl. However, it should be noted this was during dry summer months, therefore groundwater may be encountered at shallower depths during winter or wetter periods.

2.6 Contamination Concentrations

When compared to '*Residential with home grown produce'* thresholds, the Site Investigation recorded several elevated concentrations of Lead, PAHs and TPHs above GAC thresholds in nine exploratory borehole locations across Site 1, as detailed in *Table 2.6*:

Table 2.6 – *Soil GAC exceedances for a residential with home grown produce end-use for Site 1*

Determinand	Sample Ref. (Depth to Top of Sample m bgl)	GAC mg/kg	Concentration (mg/kg)
Lead	CP1 WS1 TP3 TP4	200	230 230 230 620
Benzo(a)anthracene	CP1 TP5	7.2	30 13
Chrysene	CP1	15	29
Benzo(a)pyrene	CP1 WS1 TP2 TP5	2.2	25 6.0 2.5 10
Dibenzo(ah)anthracene	CP1 WS1 TP2 TP5	0.24	5.9 1.4 0.6 2.2
Benzo(b)fluoranthene	CP1 WS1 TP5	2.6	28 5.3 13
Naphthalene	CP1	2.3	15
TPH aromatic C12-C16	CP1	140	210
TPH aromatic C16-C35	CP1 WS1	1100	2050 1260

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Chrysotile asbestos fibres were identified by laboratory testing within CP1 0.30-0.40m bgl at <0.001%. No asbestos containing materials (ACMs) were identified during the intrusive investigation works across Site 1.

2.7 Water Supply Pipe Assessment

With reference to the UKWIR Report no. 10/WM/03/21 (Ref. 2) advice is given on the appropriate materials for these ground conditions. The exact requirements are to be confirmed with the relevant utility supplier.

2.8 Ground Gases

2.8.1 Ground Gas Assessment

Given proposed site layouts, it is understood that the development site has been categorised as NHBC Green for the low-rise housing. Ground gas risk has therefore not been considered as part of this remediation strategy.

2.8.2 Radon

UK Radon Mapping confirms the site is situated in an intermediate probability radon area (1% to 3% of homes are estimated to be at or above the action level). On this basis no radon protection measures are considered necessary in the construction of new dwellings or extensions.

Where the new development incorporates a basement the advice of a specialist Radon assessor must be obtained.

2.9 Unexploded Ordnance

Risk mapping for UXO places the site in a moderate-risk area and it is noted that the surrounding area was subject to bomb strikes in the vicinity during WWII from the analysis of historical mapping from the University of Manchester records bomb strikes; The area around the site was damaged during the bombings. Historical mapping records ruins located 100-200m to the northeast and 200m to the northwest.

Due to the potential risk from UXO, a Detailed Unexploded Ordnance (UXO) Risk Assessment report was obtained. It concluded that the majority of the site was **Low** risk, but the southeast of Site 2 was **Medium** risk. This report is included in *Appendix D* for reference.

It is recommended that construction contractors carry out their own risk assessment and put relevant measures in place.

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3.0 Additional Delineation Investigation

3.1 Introduction

The Phase 2 report identified exceedances of the semi-volatile PAH Naphthalene within CP1 on Site 1.

A delineation investigation was undertaken as per recommendations within the Phase 2 report (Ref.1) to assess vapour risks posed to site end users from Naphthalene. Works were split between two days and carried out on 11th of December 2019.

3.2 Scope of Works

Machine excavated trial pits were carried out three locations (V07-V09) around CP1. The depth of these ranged from 1.10m to 2.80m bgl.

Curtins drawing ref. 068244-CUR-00-XX-DR-GE-001-V02 records the locations of the delineation exploratory holes, copies of which are contained within *Appendix A*.

3.3 Ground Conditions

3.3.1 Made Ground

The Made Ground across Site 1 during the delineation investigation was encountered from ground level to depths of 0.90m to 2.50m bg. Grass covered the Made Ground in all exploratory borehole locations.

V07 and V08 recorded Made Ground to 0.90m and 0.95m bgl respectively, while the base of the Made Ground was not encountered in V09 which ws terminated at 2.80m bgl.

The Made Ground consisted of a topsoil layer from ground level to depths of 0.30m to 0.40m bgl within all delineation pit locations. It consisted of dark brown slightly clayey gravelly silty fine to coarse SAND with occasional fine to medium, sub-rounded to angular gravel of brick and slate, with frequent rootlets.

Granular Made Ground consisted of sand and gravel, with paving slabs of stone, cobbles and whole bricks/concrete, fine to coarse gravel of slate, concrete, tarmac, ash, coal, clinker and brick. Occasional fragments of slate, glass, ceramic and metal.

A narrow void was noted in the northern side of the V09 excavation, which extended to 2.80m bgl. This may be a possible basement or cellar feature but was not further investigated at the time of the delineation works.

3.3.2 Superficial Deposits

The natural superficial deposits comprised Glacial Till from depths of 0.90m to 2.00m bgl with the total depth of the Glacial Till unknown. The Glacial Till was recorded directly below the Made Ground within all exploratory hole positions where advancement past Made Ground was made.

It generally comprised firm Clay with fine to medium, rounded to sub-rounded gravel of various lithologies including, siltstone, sandstone and mudstone.

3.4 Obstructions Encountered

No obstructions were recorded in V07, V08 and V09 advanced around CP1.

3.5 Contamination

In total, three Made Ground soil samples were tested for Naphthalene from the three delineation trial pits around BH01. With respect to the proposed end-use of the site, no exceedances are noted within the tested soil samples. Chemical testing certificates for the Naphthalene can be referred to within *Appendix B.*

This therefore confirms that the Naphthalene exceedance is a concentrated hotspot within CP1 and does not extend laterally into the surrounding Made Ground soils. The hotspot should be remediated/removed as per *Section 5.1* of this report in order to remove the vapour intrusion risk to site end-users.

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4.0 Revised Conceptual Site Model

A revised conceptual site model (CSM) for the site has been developed based on the Ground Investigation works undertaken and the additional delineation works carried out.

The potential pollutant linkages (PPL) listed in *Table 4.0* have been identified as requiring remediation to enable the safe re-development of the site.

Table 4.0 *Potential Pollutant Linkages (Existing)*

PPL	Sources	Receptor	Potential Pathway	Remediation Recommended
1	**Made Ground** soils centred around CP1 with elevated Naphthalene (Semi-volatile)	Residential Site end-users	Inhalation, ingestion and dermal contact with PAHs including Naphthalene contaminants in soil within CP1 and soil-derived dust from on-site Made Ground.	**Moderate Risk** Elevated concentrations of Naphthalene have been further investigated with no additional exceedances of Naphthalene detected. It is recommended that the hotspot at CP1 is removed via a 2x2m square of the location during the redevelopment of the site due to the vapour risk posed to site end-users.
2	**Made Ground** soils containing elevated concentrations of heavy metals, PAHs and TPHs	Residential Site end-users	Inhalation, ingestion and dermal contact with PAH, TPH and Lead contaminants in soil and soil-derived dust from on-site Made Ground.	**Moderate Risk** Engineered capping and geotextile membrane to serve as physical barrier between original site soils and site surface in areas of soft landscaping. The building footprint and areas of hard standing will break the source-pathway-receptor linkage across the remainder of the site.

5.0 Remedial Works

With reference to the Conceptual Site Model and the potential contaminant linkages detailed in *Table 4.0* remedial actions are recommended, in order for the site to be brought up to a condition that is deemed 'suitable for use';

- **Remedial Action 1**: Removal of 2x2m square around hotspots containing Naphthalene on Sites 1 and 2; and
- **Remedial Action 2**: Engineered capping and geotextile membrane to serve as physical barrier between original site soils and site surface in areas of soft landscaping

5.1 Remedial Action 1 – Removal of Naphthalene Hotspots

The first PPL identified at the site relates to the inhalation exposure to site end users from elevated concentrations of the semi-volatile contaminant Naphthalene in soil and soil derived dust (*PPL 1, Table 4.0*). During the intrusive investigation Naphthalene was recorded above 'Residential' thresholds in CP1. All three samples collected during the delineation exercise recorded Naphthalene below the GAC.

PPL 1 identified at the site relates to inhalation of Naphthalene in Made Ground soils within CP1 and soil-derived dust on site to site-end users (residents).

Remedial measures for the Naphthalene-impacted soils are detailed in *Table 5.1.*

Table 5.1 *Remedial Measures for Naphthalene-Impacted Soils*

Naphthalene impacted soils	Further Remedial Measures Required	Rationale
CP1 (0.30-0.40m)	The material centred around CP1 is excavated (approximately 2.00m x 2.00m) to 1.50m depth and the material removed from site to a suitably licensed facility.	Remove potential for exposure of receptors via direct contact with and volatilisation and inhalation of Naphthalene in shallow Made Ground soils.

The excavation of the Naphthalene-impacted soils is to be supervised and validated by a qualified Engineer.

5.2 Remedial Action 2 – Engineered Capping

PPL 2 identified at the site relates to exposure to concentrations of heavy metals, PAHs and heavy fraction TPHs in soil and soil derived dust to site end users (*Table 4.0*).

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Hardstanding, including vehicular asphalt, pedestrian asphalt and concrete block paving are considered sufficient to break the potential contaminant linkage, PPL 2, detailed in *Table 4.0* and therefore no specific remediation measures, above activities required for construction, are considered necessary.

However, a risk remains in landscaped areas of exposure to contaminated Made Ground. Therefore, as part of future developments, areas of private gardens and soft landscaping are anticipated to be required to be covered in a minimum depth of verified clean capping, comprising a thickness of imported subsoil and topsoil.

Recommended remedial measures are detailed in *Table 5.2* below.

Table 5.2 *Engineered Capping Details for Areas of Soft Landscaping and Private Gardens*

Location	Further Remedial Measures Required	Rationale
General Landscape Areas across the site	Provision of a minimum 300 mm clean capping comprising a minimum of 150mm topsoil over resultant depth of subsoil. Clean and inert capping layer to be underlain by demarcation membrane.	Remove potential for exposure of receptors via contact with contaminants in shallow site soils. Demarcation membrane to minimise cross contamination.
Private Gardens Front	Provision of a minimum 600 mm clean capping comprising a minimum of 150mm topsoil over resultant depth of subsoil. Clean and inert capping layer to be underlain by demarcation membrane.	Remove potential for exposure of receptors via contact with contaminants in shallow site soils. Demarcation membrane to minimise cross contamination.
Private Gardens Rear	Provision of a minimum 600 mm clean capping comprising a minimum of 150mm topsoil over resultant depth of subsoil. Clean and inert capping layer to be underlain by demarcation membrane	Remove potential for exposure of receptors via contact with contaminants in shallow site soils. Demarcation membrane to minimise cross contamination.

Drawings have been provided by the Architect for the development site, showing the proposed area(s) of soft landscaping. These drawings can be referred to within *Appendix A*.

6.0 Topsoil/Subsoil Specification

6.1 Sourcing of Materials

6.1.1 Off-Site Sources

It is anticipated that materials are to be imported to the site for use in constructing the growing medium in soft landscaping areas. It is strongly recommended that materials are sourced from reputable suppliers and comprise materials that have been suitably processed to produce standardised materials. It is not recommended that materials are imported directly from 'donor' development sites without appropriate material management strategies complying with Waste Management regulations being in place. Imported material will also require verification testing to ensure suitability for reuse, and it is strongly advised that the Contractor undertake their own independent verification testing if accepting material from a third party, rather than relying on supplier reports.

6.1.2 On-Site Sources

Site won topsoil and subsoil may be considered as 'uncontaminated' or 'clean' material for reuse subject to verification as detailed below, however Topsoil on site is described as Made Ground, including fragments of glass and brick, and therefore should be subject to visual inspection prior to re-use, to ensure it is compliant with the requirements of the landscape architect, architect or client as a growing media.

6.2 Imported Topsoil

Imported topsoil will invariably be required and should be supplied and placed in accordance with the Landscape Architects' specification but generally, all topsoil will be a minimum of 150mm thick in soft landscaped areas and private gardens front and rear as a part of the overall thickness as detailed in *Section 5.3*).

Where topsoil is imported, it is to be 'Multipurpose' in accordance with BS 3882:2015 'Specification for Topsoil and Requirements for Use'.

The topsoil should also be confirmed to be 'suitable for use' as per the analysis outlined in *Section 6.4.*

6.3 Imported Subsoil

Where imported subsoil is required as part of the growing medium this can be cohesive or granular but should be free-draining and confirmed to be 'suitable for use' as per the analysis outlined in *Section 6.4* and compliant with the British Standard for Subsoil BS 8601:2013.

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6.4 Chemical Composition of Soils

Site won and imported subsoil and topsoil should not contain concentrations of contaminants that present an unacceptable risk to the health of future site occupants.

The Contractor shall be responsible for demonstrating that both site-won and imported material is 'clean' and therefore suitable for use in soft landscaping areas. This will include the recovery of samples for laboratory testing from both the material source and verification testing of material following delivery to site.

The required testing frequencies for material source types are detailed below. Other sources may be applicable, however testing frequencies shall be confirmed with the Engineer prior to acceptance.

Table 6.4a *Environmental chemistry testing frequency for imported and re-used soils*

Source	Testing Frequency
Imported Topsoil (Greenfield)	**At Source:** One sample for every 250m^3 imported is to be tested by the supplier in accordance with Clause 5 of BS 3882:2015 or to the landscape architect's / architect's / client's specification. **On-site Verification:** one sample every 250m^3 used (or a minimum of 3 No. samples, whichever is greater).
Imported Subsoil (Greenfield)	**On-site Verification:** one sample every 250m^3 used (or a minimum of 3 No. samples, whichever is greater).
Re-used / Site Won Inert constituents of Made Ground	**On-site Verification:** one sample every 100m^3 used (or a minimum of 6 No. samples, whichever is greater).
Re-used / Site Won Natural Soils	**On-site Verification:** one sample every 100m^3 used (or a minimum of 3 No. samples, whichever is greater).

The environmental chemistry testing requirements are as *Table 6.4b*. Additions to the suite and frequency of sampling maybe required based on the source of the imported materials. For example, if the imported topsoil is not naturally sourced, e.g. recycled soil, further chemical determinants may be added to the chemical analysis suite at the discretion of the Engineer. In these instances, chemical analysis of the topsoil is to be undertaken at a frequency of one sample every 100m^3 used

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Table 6.4b *Environmental chemistry analysis suite for imported soils.*

Suite Reference	Environmental Chemistry Analysis
Greenfield or Manufactured Soils Imported to Site and Site Won Soils for Use as Clean Capping	Total metals: Arsenic, cadmium, chromium, chromium VI, lead, mercury, selenium, copper, nickel, zinc, water soluble boron; pH Soil Organic Matter Asbestos Screening Polycyclic Aromatic Hydrocarbons by GC-MS (Detection Limit 0.1mg/kg for each compound - 16 USEPA speciation) Total Petrol Hydrocarbons (Full TPHCWG analysis – aromatic/aliphatic split, Detection Limit 0.01mg/kg for each banding C5 to C10 and 1mg/kg for bandings above C10)

Assessment criteria: Concentrations of the above determinants shall not exceed the '*Residential with Home Grown Produce'* screening criteria; refer to *Appendix C*.

Definition of 'clean': Where ALL concentrations are less than these values the soils shall be defined as 'clean'. 'Clean' soils are also subject to visual inspection prior to re-use, where deemed appropriate, with particular attention to the re-use of site-won topsoil.

Soil organic matter (SOM): A review of the thresholds contained within *Appendix C* may be made for specific soil sources whereby the Soil Organic Matter is proving to be routinely above 6%.

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7.0 Earthworks

The following section provides general guidance with respect to infrastructure works specifically, excavations and the materials arising from them.

7.1 General

Method statements and risk assessments: It is the contractor's responsibility to provide and carry out their own appropriate risk assessments and mitigation to protect themselves and their employees, other human receptors and the environment from potential contamination, including but not limited to heavy metals, PAHs, TPHs and asbestos. Such risks must be adequately mitigated by law, specifically the Construction Design Management (CDM) Regulations, 2015, which require that potential risks to human health and the environment from construction activities are appropriately identified and all necessary steps taken to eliminate / manage that risk. Before excavation works commence, appropriate risk assessments and method statements should therefore be undertaken by all subcontractors. A strategy for handling contaminated or potentially contaminated soils is provided within Section 8.0 of this report.

Personal protective equipment and site sanitary facilities: are to be provided to a standard that adequately accounts for the nature of the materials likely to be encountered during excavations. Reference is to be made to HSE document HS (G) 66 'PROTECTION OF WORKERS AND THE GENERAL PUBLIC DURING THE DEVELOPMENT OF CONTAMINATED LAND'.

Proposed Levels: It is recommended that the development levels of the site are designed to allow minimal off-site disposal of site material so as not to incur a significant expense in disposal costs.

The construction of the development will result in the generation of excavation arisings, principally Made Ground and natural clay. These materials may be used as a cut-and-fill exercise in order to raise levels where required provided they are geotechnically and chemically suitable.

Based on the geochemical testing results presented as part of the site investigation it is considered that generally there is not a requirement to remove soils from site as they do not present an unacceptable risk to human health or the environment. However, where the Naphthalene hotspots were recorded at TP11, CP1 and CP2, these areas are to be excavated (2x2m wide excavation, 1.5m deep) and removed from site as detailed in *Section 5.1.*

The re-use of site-won soils across the remainder of the site may therefore be undertaken if the following principles are met:

i) the geotechnical suitability of the material needs to be confirmed;

ii) the re-use of the material needs to be covered as part of the planning approval, e.g. site levels maintained within agreed limits;

iii) the volume of the material being re-used needs to be confirmed and traceable; and

iv) regulatory approval from the relevant authorities has been sought.

Movement and reuse of Made Ground materials must be undertaken in compliance with the CL:AIRE publication The Definition of Waste: Development Industry Code of Practice (Ref: 3) which requires the compilation of a Materials Management Plan with declaration to the Environment Agency by a 'Qualified Person'.

7.2 Excavations

Identification of excavation areas: The Site Manager is to identify the area of the site in which the excavation is to be undertaken and accurately locate and mark out on site the length and the width of the proposed excavation.

Expected ground conditions: The Site Manager is to familiarise himself/herself with the expected ground conditions in order that the type of Made Ground and the natural strata can be correctly identified.

Obstructions: Underground obstructions in the form of relic foundations are likely to be encountered across Site 1 due to previous uses including a college on Site 1.

Excavation of Made Ground: Excavate (providing suitable trench support where required) the required depth of underlying existing (historical) Made Ground to excavation formation.

Removal or re-use of excavated Made Ground: As detailed in *Section 4.1*, removal of naphthalene-impacted soils from site to a suitably licensed disposal facility soils surrounding CP1 (Site 1).

Remove from site to a suitably licensed disposal facility all other surplus existing (historical) Made Ground, unless deemed environmentally and geo-technically suitable whereby the soils can be used as selected backfill in the works approved under the granted Planning Permission. Such works should be detailed within a Materials Management Plan.

Excavation of natural soils: If natural soils are likely to be encountered, due to the depth of excavation required, the Made Ground is to be excavated taking care not to over excavate in order to minimise cross contamination of the natural soils.

Re-use of excavated natural soils: If environmentally and geo-technically suitable for reuse as selected backfill, place and store the excavated 'clean' natural soils in a suitable location on the site on top of the clean natural imported fill. Provide a polythene membrane under the stored natural soils to protect the capping layer and also to allow easy identification of the reclamation level.

Removal of excavated natural soils: If the 'clean' natural soils are not suitable as selected back-fill, remove from site to a suitably licensed disposal facility. Alternatively, if suitable, use the natural soils as part of the required additional capping thickness in the managed soft landscaped areas.

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Service Trenches: Install/construct foundations, pipes, ductwork, cables etc. and backfill the excavation up to the reclamation level with suitable engineering materials in accordance with the relevant utility/engineer's specification utilising the excavated soils where suitable.

Groundwater: The ground investigation indicates groundwater may be encountered in shallow excavations. Therefore, it is considered prudent to allow for temporary groundwater control measures to mitigate groundwater and, during heavy rainfall events, surface water ingress such as dewatering but generally removal of water within trenches should be possible with conventional sump pumping.

7.3 Waste Classification of Surplus Excavation Arisings for Disposal

Where any site soils are to be disposed of off-site guidance on the disposal of contaminated soils is provided within the following document published by the Environment Agency, the Guidance on the classification and Assessment of Waste Technical Guidance WM3 (1st Edition 2015) (Ref: 4).

Guidance states that the principal contractor (or any other sub-contractor undertaking excavations) should, in conjunction with the proposed disposal facility, use where possible the relevant environmental chemistry analyses results to classify any surplus material identified for off-site disposal. However, further testing of excavated material identified for disposal may need to be tested and assessed in accordance with WM3 to enable classification during the works.

Where natural soils are being considered for offsite disposal as inert waste, Waste Acceptance Criteria (WAC) testing will be required with confirmation of acceptability from the receiving landfill.

With regard to the intention to dispose of waste soils from the development site it is the waste producers responsibility to ensure that the waste soils are a) correctly classified and described, b) appropriately managed and contained prior to transfer, c) transferred to appropriately registered carriers and a waste management operator who has an environmental permit or registered exemption to accept such waste.

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8.0 Strategy for Handling Potentially Contaminated Soils and Contaminative Incidents on Site

8.1 Unexpected Contamination

In the event that material is revealed on the site of a nature that does not accord with the previously observed and recorded descriptions the following procedure is to be complied with:

a) Cease and make safe all excavations in this location and report observations to the Site Manager;

b) The Site Manager is to notify the Engineer;

c) Under guidance of the Engineer take representative samples of the suspect materials and forward to a suitably accredited laboratory for analysis;

d) Await Engineers instructions with respect to re-commencement of the works and or remediation or removal of suspect material to a suitably licensed disposal facility (following guidance outlined in *Section 7.3*); and

e) Local Authority and if relevant, the Environment Agency, are to be kept fully informed of any site such occurrences.

If such visual and/or olfactory evidence of contamination is encountered, excavation at the location shall cease until the results of the analytical testing have been received. Only in exceptional circumstances, if it is unavoidable that excavation continues, the removed soils shall be placed separately from other materials on an impermeable membrane that is securely covered at the end of each working day to prevent rain entering the soils and leachate migrating from the material.

8.2 Contaminative Incidents

It is possible that some below ground features / structures exist that have not been recorded on plans and have not been encountered during the ground investigation works or demolition works. It is possible that unknown/unrecorded substructures may exist which if ruptured may release materials that could contaminate the surrounding soils and groundwater. In the unlikely event that this occurs an outline strategy is detailed below.

Where a subsurface structure (e.g. tank/pipework) is damaged during excavation and the contents are released into the surrounding soil, the structure should be immediately pumped dry into another suitable container and a trench with a low permeability base formed around the structure to prevent seepage laterally and to collect the contaminant. Where groundwater is encountered in the trench, it should be

pumped into a suitable container and tested for the contaminant/potential contaminants of concern. All soils affected shall then be tested and removed from site as appropriate.

Where the damage is caused to the underside of a structure and seepage is vertical, the contaminants may present a risk of polluting the groundwater. In this instance, and subject to the findings of a risk assessment, boreholes may be required to prove and intercept the contaminant. The contaminant will then be pumped into suitable containers.

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9.0 Verification, Validation and Reporting

Validation visits shall be undertaken by an appropriately qualified and experienced person throughout the construction phase to ensure that the requirements of this Remediation Strategy have been implemented at the site. It is anticipated records will be taken during the work as identified below:

- Excavation of the Made Ground generally to inspect for unexpected contamination;
- Supervision and validation of the Naphthalene hotspot removal, in the area of CP1 by a qualified engineer;
- Placement and depth validation of clean capping material in areas of soft landscaping;
- Verification of capping materials via chemical laboratory analysis; and
- Documentation of asbestos management procedures during the works.

All documentation, including photographic evidence, pertaining to the above will be supplied to the Engineer and incorporated within a completion report. The Completion Report will be required on completion of the works confirming that the remedial works have been completed satisfactorily.

9.1 Verification of Clean Capping/Growing Media

Confirmatory analysis outlined previously is required to verify the suitability of any imported and site won topsoil, and where required, subsoil. Evidence that the specified depth of capping/growing media has been provided will be required**.**

On completion of the 300mm thick capping layer within soft landscaping areas; and 600mm thick layer within front and rear private gardens (with minimum 150mm thick topsoil), a program of hand dug exploratory pits will be undertaken by an independent third party/Curtins to clearly identify the combined thickness of the topsoil and sub soil layer provided.

The pits shall be excavated to the base of the imported material to prove the existence of the demarcation membrane.

A photographic record of the hand excavated trial pits would also be required, clearly showing the recorded depth of the clean and inert capping. A number of trial pits would be required across the development site, with as a minimum every rear garden and every 1 in 3 front garden validated.

10.0 Completion Report

A Remediation Completion Report will be required on completion of the works confirming that the remedial works have been completed satisfactorily.

The following shall be provided to the Engineer to be verified and included in the Completion Report:

- Evidence of 2x2m square removal to minimum 1.50m depth of Naphthalene hotspots in location of CP1 (through evidence of photographs and copies of the waste consignment notes).
- Environmental test results of top and sub soils used to confirm the suitability of the soils, in line with *Section 6.4*;
- Evidence of verification (through either hand excavated trial pits or comparison of reduced and final level surveys) of the depth of clean capping/growth medium, within soft landscaped areas and private gardens, in line with *Table 5.3*;
- Confirmation that the remediation has been undertaken satisfactorily and in accordance within this Remediation Statement;
- Confirmation that the remediation objectives have been achieved (see *Section 5.0*); and
- Details of any unexpected contamination encountered on site and appropriate measures taken to respond.

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11.0 References

1. Curtins, *Phase 2 Site Investigation for Gorton Lane, Manchester;* ref: 068244-CUR-00-XX-RP-GE-001-V03; 9 September 2021
2. UK Water Industry Research (2010) Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites (report no. 10/WM/03/21).
3. Contaminated Land: Applications in Real Environments (CL:AIRE) *The Definition of Waste: Development Industry Code of Practice. Version 2*; March 2011
4. Environment Agency (2015) Guidance on the Classification and Assessment of Waste Technical Guidance WM3 (1st edition).

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Appendix A Drawings

- OMi Architects, Site Layout Plan – Second, drawing ref. L0152 Rev A (dated July 2021).
- Curtins, Site 1 Exploratory Hole Location Plan drawing ref. 068244-CUR-00-XX-DR-GE-001-V02 (dated Jan 2020).

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POTTERY LANE

GORTON LANE

GORTON LANE

KEY

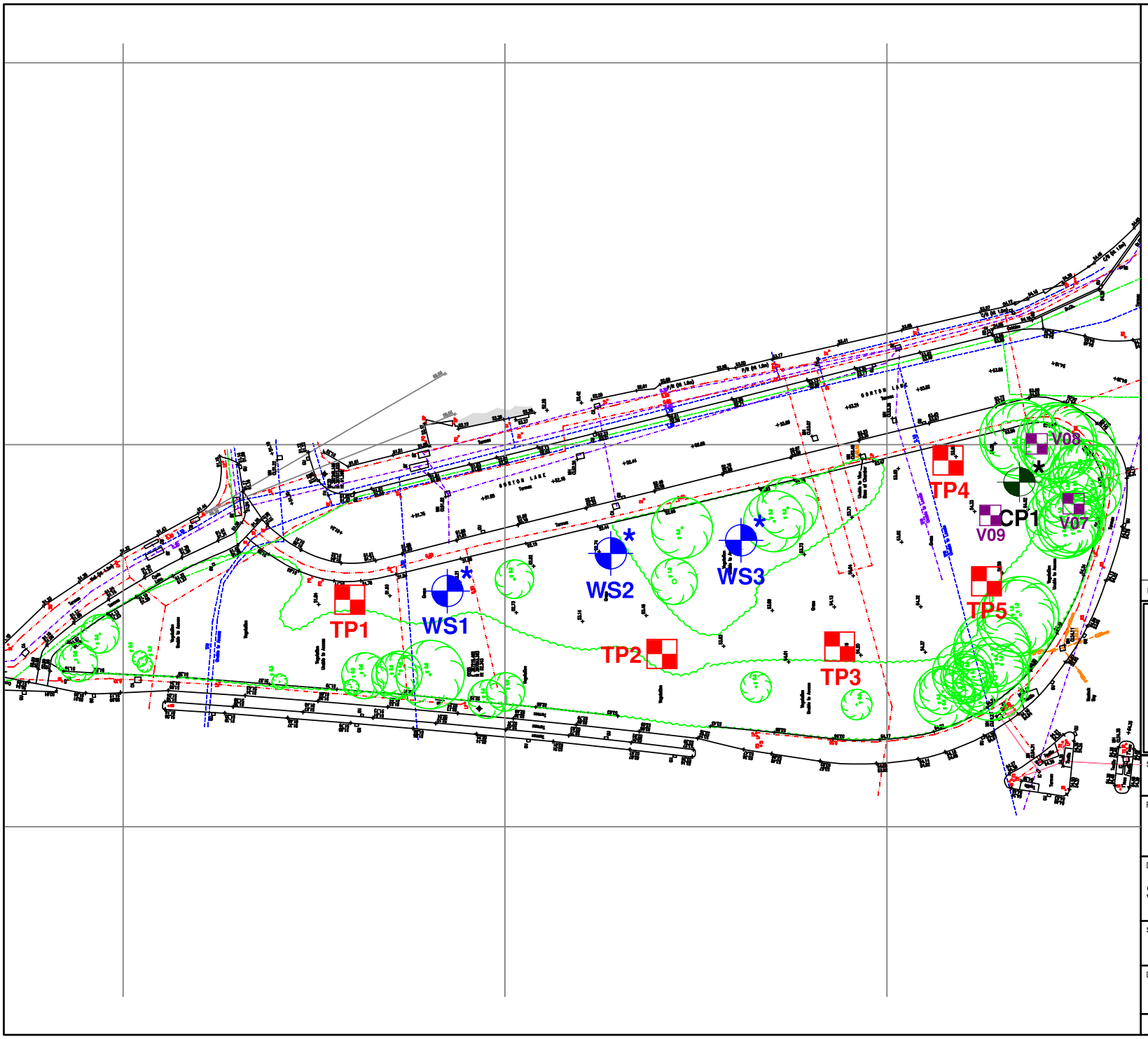
- 3 BED 4 PERSON HOUSE
- 4 BED 6 PERSON HOUSE
- PAVING TO PRIVATE EXTERNAL AREAS
- RESIDENTS' PARKING COURT
- DENSE PLANTING
- PRIVATE GARDEN
- SITE BOUNDARY
- NEW TREE
- EXISTING TREE

One Manchester
Gorton Lane, Manchester

Site Layout Plan - Second

1:200 @ A1 JUL 2021
1405 DWG: L0152 A

OMI Architects



2018 Curtins Investigation

- Phase 2 Machine Excavated Trial Pit
- Phase 2 Window Sample Borehole Location
- Phase 2 Cable Percussive Borehole Location
- * Denotes borehole is installed

2019 Curtins Delineation

- Delineation Machine Excavated Trial Pit

Rev:	Description:	Date:	By:	Chkd:

curtins

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Structures - Civils - Environmental - Infrastructure - Transport Planning - Sustainability - Expert Advisory Services
Birmingham - Bristol - Cardiff - Douglas - Edinburgh - Kendal - Leeds - Liverpool - London - Manchester - Nottingham

Status: INFORMATION

Project: Gorton Lane

Drg Title: Site 1 Exploratory Hole Location Plan

Scale:	Size:	First Issue:	Drawn:	Checked:
NTS	A3	15/01/20	MH	JJ

Drg No: 068244-CUR-00-XX-DR-GE-001-V02 | Rev: /

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Appendix B Delineation Investigation Chemical Results

- Envirolab Environmental Chemistry Analysis Results (Soil)
  - Final Analytical Test Report 19/11836

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Trial Pit Log

Trialpit No **V07**

Sheet 1 of 1

Project Name: Gorton Lane Remediation	Project No. B067694.300	Co-ords: - Level:	Date 11/12/2019
Location: Gorton Lane, Machester, M12 5HD		Dimensions (m): Depth 1.10	Scale 1:20
Client: Bardsley Construction Ltd			Logged MH

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
							Grass over TOPSOIL: Dark brown slightly silty fine and medium sand. Frequent rootlets. Occasional twigs and branches.
				0.30			MADE GROUND: Dark grey and dark brown gravelly fine to coarse sand. Gravel is fine to coarse angular to subrounded including ash, brick, concrete, sandstone and rare clinker.
				0.50			MADE GROUND: Dark grey and dark brown gravelly fine to coarse sand. Gravel is fine to coarse angular to subrounded including brick, concrete and ash. Frequent cobbles of brick. Rare concrete boulders.
	0.70	ES					*Firm light brown with grey mottling sandy CLAY encountered at south side of trial pit from 0.60m bgl. Made ground recorded to 0.90m at northern side of excavation.*
				0.90			Firm light brown with grey mottling sandy CLAY.
				1.10			End of pit at 1.10 m

Remarks: No Groundwater encountered. Machine excavated trial pit.

Stability: Stable

Trial Pit Log

Trialpit No **V08**

Sheet 1 of 1

Project Name: Gorton Lane Remediation	Project No. B067694.300	Co-ords: - Level:	Date 11/12/2019
Location: Gorton Lane, Machester, M12 5HD		Dimensions (m): Depth 1.10	Scale 1:20
Client: Bardsley Construction Ltd			Logged MH

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
							Grass over TOPSOIL: Dark brown slightly silty fine and medium sand. Frequent rootlets. Occasional twigs and branches.
				0.30			
				0.40			MADE GROUND: Grey slightly silty gravelly fine to coarse sand. Gravel is fine and medium angular to subangular including concrete, tarmac and rare ceramic fragments.
	0.50	ES					MADE GROUND: Brown gravelly fine to coarse sand. Rare roots and rootlets. Gravel is fine to coarse angular to subrounded including brick, concrete, slate, wood fragments and rare ash. Occasional cobbles of brick. Frequent slate cobbles at base.
				0.95			Firm light brown with grey mottling sandy CLAY. Rare fine, angular and subangular gravel of coal.
				1.10			End of pit at 1.10 m

1 2 3 4

Remarks: No Groundwater encountered. Machine excavated trial pit.

Stability: Stable

AGS

Trial Pit Log

Trialpit No **V09**

Sheet 1 of 1

Project Name: Gorton Lane Remediation	Project No. B067694.300	Co-ords: - Level:	Date 11/12/2019
Location: Gorton Lane, Machester, M12 5HD		Dimensions (m): Depth 2.80	Scale 1:20
Client: Bardsley Construction Ltd			Logged MH

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
							Grass over TOPSOIL: Dark brown slightly silty fine and medium sand.
				0.40			MADE GROUND: Brown gravelly fine to coarse sand. Gravel is fine to coarse angular to subrounded including brick, concrete, slate, sandstone, rare glass and rare tarmac.
	0.60	ES					*Narrow void noted at northern side of excavation. Extends to 2.80m bgl. Possible basement or cellar feature.*
							Firm light brown with grey mottling sandy CLAY at southern side of excavation from 1.10m bgl.
				1.30			MADE GROUND: Brown gravelly fine to coarse sand. Gravel is fine to coarse angular to subrounded including brick, concrete, slate, sandstone, rare glass and rare tarmac. Occasional to frequent cobbles of brick.
				2.80			End of pit at 2.80 m

1 2 3 4

Remarks: No Groundwater encountered. Machine excavated trial pit.

Stability: Stable

AGS

envirolab
Units 7 & 8 Sandpits Business Park
Mottram Road, Hyde, Cheshire, SK14 3AR

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 19/11836
Issue Number: 1 **Date:** 18 December, 2019

Client:
Curtins Consulting
Merchant Exchange
17-19 Whitworth Street
Manchester
UK
M1 5WG

Project Manager: Joe James/Matthew Holroyd
Project Name: Gorton Delineation
Project Ref: B067694
Order No: EBMA2209
Date Samples Received: 12/12/19
Date Instructions Received: 13/12/19
Date Analysis Completed: 18/12/19

Prepared by:

Melanie Marshall
Laboratory Coordinator

Approved by:

Danielle Brierley
Client Manager

Envirolab Job Number: 19/11836

Client Project Name: Gorton Delineation

Client Project Ref: B067694

Lab Sample ID	19/11836/1	19/11836/2	19/11836/3	19/11836/5	19/11836/6	19/11836/7		Units	Limit of Detection	Method ref
Client Sample No	1	1	1	2	3	1				
Client Sample ID	V07	V08	V09	V10	V10	V11				
Depth to Top	0.70	0.50	0.60	0.60	1.00	0.60				
Depth To Bottom										
Date Sampled	11-Dec-19	11-Dec-19	11-Dec-19	11-Dec-19	11-Dec-19	11-Dec-19				
Sample Type	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES	Soil - ES				
Sample Matrix Code	4AB	4AB	4A	5A	4A	5A				
% Stones >10mm$_A$	11.5	<0.1	<0.1	<0.1	9.0	4.7		% w/w	0.1	A-T-044
Naphthalene $_A^{M\#}$	0.04	<0.03	0.05	<0.03	0.07	0.15		mg/kg	0.03	A-T-019s

REPORT NOTES

General
This report shall not be reproduced, except in full, without written approval from Envirolab.
The results reported herein relate only to the material supplied to the laboratory.
The residue of any samples contained within this report, and any received with the same delivery, will be disposed of six weeks after initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of six months after the initial Asbestos testing is completed.
Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and interpretations expressed are outside the scope of our accreditation.
If results are in italic font they are associated with an AQC failure, these are not accredited and are unreliable.
A deviating samples report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.
The Client Sample No, Client Sample ID, Depth to Top, Depth to Bottom and Date Sampled were all provided by the client.

Soil chemical analysis:
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any “A” subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH analysis of water by method A-T-007:
Free and visible oils are excluded from the sample used for analysis so that the reported result represents the dissolved phase only.

Electrical Conductivity of water by Method A-T-037:
Results greater than 12900µS/cm @ 25°C / 11550µS/cm @ 20°C fall outside the calibration range and as such are unaccredited.

Asbestos:
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis.
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Predominant Matrix Codes:
1 = SAND, 2 = LOAM, 3 = CLAY, 4 = LOAM/SAND, 5 = SAND/CLAY, 6 = CLAY/LOAM, 7 = OTHER, 8 = Asbestos bulk ID sample.
Samples with Matrix Code 7 & 8 are not predominantly a SAND/LOAM/CLAY mix and are not covered by our BSEN 17025 or MCERTS accreditations, with the exception of bulk asbestos which are BSEN 17025 accredited.
Secondary Matrix Codes:
A = contains stones, B = contains construction rubble, C = contains visible hydrocarbons, D = contains glass/metal, E = contains roots/twigs.

Key:
IS indicates Insufficient Sample for analysis.
US indicates Unsuitable Sample for analysis.
NDP indicates No Determination Possible.
NAD indicates No Asbestos Detected.
N/A indicates Not Applicable.
Superscript # indicates method accredited to ISO 17025.
Superscript "M" indicates method accredited to MCERTS.
Subscript "A" indicates analysis performed on the sample as received.
Subscript "D" indicates analysis performed on the dried sample, crushed to pass a 2mm sieve

Please contact us if you need any further information.

Envirolab Deviating Samples Report

Units 7&8 Sandpits Business Park, Mottram Road, Hyde, SK14 3AR
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: Curtins Consulting, Merchant Exchange, 17-19 Whitworth Street , Manchester, UK, M1 5WG

Project: Gorton Delineation

Clients Project No: B067694

Project No: 19/11836

Date Received: 13/12/2019 (am)

Cool Box Temperatures (°C): 12.0

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

Appendix C Chemical Acceptability Thresholds

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Adopted Soil Generic Assessment Criteria
Sandy loam with 6% SOM

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Contaminants	Residential with home grown produce	Residential without home grown produce	Allotments	Commercial	Public open space near residential housing POS_{resi}	Public park POS_{park}
Metals						
Beryllium	*1.7*	*1.7*	*35*	*12*	*2.2*	*63*
Boron	*290*	*11,000*	*45*	*240,000*	*21,000*	*46,000*
Cadmium	**10**[13] 22	**85**[13] 150	**1.8** 3.9	**230** 410	*120* 220	*560* 880
Chromium III	*910*	*910*	*18,000*	*8,600*	*1,500*	*33,000*
Chromium VI	*6* 21	*6* 21	*1.8* 170	*33* 49	*7.7* 21	*220* 250
Lead	200	310	80	2,300	630	1,300
Mercury *(elemental)*	**1**	**1**	**26**	**26**	*16*	**26**[8] [*30*]
Mercury (inorganic)	**170**	**240**	**80**	**3600**	*120*	*240*
Nickel	*130*[10]	*180*[10]	*53*[11]	*980*[10]	*230*	*800*
Vanadium	*410*	*1200*	*91*	*9000*	*2000*	*5000*
Copper	*2400*	*7100*	*520*	*68000*	*12000*	*44000*
Zinc	*3700*	*40000*	*620*	*730000*	*81000*	*170000*
Semi-Metals and non-metals						
Arsenic	**32**[12] 37	**35**[12] 40	**43**[12] 49	**640**[12] 640	*79* 79	*170* 170
Antimony		***550***		***7500***	***1500***	***3300***
Selenium	**350**	**600**	**120**	**13000**	*1100*	*1800*
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
$EC_{>5}$ - EC_6	*160*	*160*	*3900*	*12000*	*600000*	*180000*
$EC_{>6}$ - EC_8	*530*	*530*	*13000*	*40000*	*620000*	*320000*
$EC_{>8}$ - EC_{10}	*150*	*150*	*1700*	*11000*	*13000*	*21000*
EC_{10}-EC_{12}	*760*	*770*	*7300*	*47000*	*13000*	*24000*
EC_{12}-EC_{16}	*4300*	*4400*	*13000*	*90000*	*13000*	*26000*
$EC_{>16}$ - EC_{35}	*110000*	*110000*	*270000*	*1800000*	*250000*	*490000*
$EC>_{35}$ - EC_{44}	*110000*	*110000*	*270000*	*1800000*	*250000*	*490000*
Aromatic risk banded hydrocarbons - TPHCWG method						
$EC>_5$ - EC_7	*300*	*1400*	*57*	*86000*	*56000*	*92000*
$EC>_7$ - EC_8	*660*	*3900*	*120*	*180000*	*56000*	*100000*
$EC_{>8}$ - EC_{10}	*190*	*270*	*51*	*17000*	*5000*	*9300*
EC_{10} - EC_{12}	*380*	*1200*	*74*	*34000*	*5000*	*10000*
EC_{12} - EC_{16}	*660*	*2500*	*130*	*38000*	*5000*	*10000*
$EC_{>16}$ - EC_{21}	*930*	*1900*	*260*	*28000*	*3800*	*7800*
$EC_{>21}$ - EC_{35}	*1700*	*1900*	*1600*	*28000*	*3800*	*7900*
$EC>_{35}$ - EC_{44}	*1700*	*1900*	*1600*	*28000*	*3800*	*7900*
Aliph + Arom EC >44-70	*1900*	*1900*	*3000*	*28000*	3800	7900
Aromatic						
Benzene	**0.33** 0.87	**1.0** 3.3	**0.07** 0.18	**95** 98	*73* 140	*110* 230
Ethyl benzene	**350**	**840**	**90**	**2800**[8] [66000]	**2800**[8] [*25000*]	**2800**[8] [*27000*]
Toluene	**610**	**2700**	**120**	**4400**[8] [190000]	**4400**[8] [*56000*]	**4400**[8] [*100000*]
Xylene[9]	**230**	**290**	**160**	**2600**[8] [32000]	**2600**[8] [*43000*]	**2600**[8] [*31000*]
Phenol	**420**	**520**	**280**	**3200**[14] (38000)	**3200**[14] (*10000*)	**3200**[14] (*9300*)
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	*13*	*13*	*24*	*1100*	*4900*	*3000*
Acenaphthylene	*920*	*6000*	*160*	*100000*	*15000*	*30000*
Acenaphthene	*1100*	*6000*	*200*	*100000*	*15000*	*30000*
Fluorene	*860*	*4500*	*160*	*71000*	*9900*	*20000*
Phenanthrene	*440*	*1500*	*90*	*23000*	*3100*	*6300*
Anthracene	*11000*	*37000*	*2200*	*540000*	*74000*	*150000*
Fluoranthene	*890*	*1600*	*290*	*23000*	*3100*	*6400*
Pyrene	*2000*	*3800*	*620*	*54000*	*7400*	*15000*
Benz(a)anthracene	*13*	*15*	*13*	*180*	*29*	*62*
Chrysene	*27*	*32*	*19*	*350*	*57*	*120*
Benzo(b)fluoranthene	*3.7*	*4.0*	*3.9*	*45*	*7.2*	*16.0*
Benzo(k)fluoranthene	*100*	*110*	*130*	*1200*	*190*	*440*
Benzo(a)pyrene	*3.0* 5.0	*3.2* 5.3	*3.5* 5.7	*36* 77	*5.7* 10	*13* 21
Indeno(123cd)pyrene	*41*	*46*	*39*	*510*	*82*	*180*
Dibenzo(ah)anthracene	*0.3*	*0.32*	*0.43*	*3.6*	*0.58*	*1.4*
Benzo(ghi)perylene	*350*	*360*	*640*	*4000*	*640*	*1600*
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	*0.0014*	*0.0015*	*0.0018*	*0.12*	*3.5*	*5.4*
Trichloroethene (TCE)	*0.075*	*0.08*	*0.21*	*5.7*	*120*	*120*
1,1,1,2 Tetrachlorethane	*6.4*	*8.2*	*4.4*	*560*	*1400*	*2100*
Tetrachlorethene (PCE)	*0.90*	*0.92*	*3.6*	*95*	*1400*	*1500*
1,1,1 Trichlorethane	*39*	*40*	*240*	*3000*	*140000*	*100000*

Notes

1. All values above are in mg/kg
2. **Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters**, *numbers in italics are S4ULs*, ***numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters*** and underlined numbers are C4SLs
3. Soil organic matter (SOM) is assumed to be 6% - DEFAULT VALUE
4. Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
5. For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
6. For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
7. For classrooms consider increasing the dust loading fator in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m^{-3}
8. Based on vapour saturation limt as suggested by EA / [ ] model value
9. Lowest of o-, m- and p-xylene
10. Based on comparison of inhalation exposure with inhalation TDI
11. Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
12. Based on a comparison of oral and dermal soil exposure with oral Index Dose only
13. Averaged over and based on lifetime exposure
14. Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
15. NA: Not applicable

Adopted Soil Generic Assessment Criteria
Sandy loam with 2.5% SOM

curtins

Contaminants	Residential with home grown produce	Residential without home grown produce	Allotments	Commercial	Public open space near residential housing POS_{resi}	Public park POS_{park}
Metals						
Beryllium	*1.7*	*1.7*	*35*	*12*	*2.2*	*63*
Boron	*290*	*11,000*	*45*	*240,000*	*21,000*	*46,000*
Cadmium	**10**[13] 22	**85**[13] 150	**1.8** 3.9	**230** 410	*120* 220	*560* 880
Chromium III	*910*	*910*	*18,000*	*8,600*	*1,500*	*33,000*
Chromium VI	*6* 21	*6* 21	*1.8* 170	*33* 49	*7.7* 21	*220* 250
Lead	200	310	80	2,300	630	1,300
Mercury *(elemental)*	**1**	**1**	**26**	**26**	*16*	**26**[8] [*30*]
Mercury (inorganic)	**170**	**240**	**80**	**3600**	*120*	*240*
Nickel	*130*[10]	*180*[10]	*53*[11]	*980*[10]	*230*	*800*
Vanadium	*410*	*1200*	*91*	*9000*	*2000*	*5000*
Copper	*2400*	*7100*	*520*	*68000*	*12000*	*44000*
Zinc	*3700*	*40000*	*620*	*730000*	*81000*	*170000*
Semi-Metals and non-metals						
Arsenic	**32**[12] 37	**35**[12] 40	**43**[12] 49	**640**[12] 640	*79* 79	*170* 170
Antimony		***550***		***7500***	***1500***	***3300***
Selenium	**350**	**600**	**120**	**13000**	*1100*	*1800*
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
$EC_{>5}$ - EC_6	*78*	*78*	*1700*	*5900*	*590000*	*130000*
$EC_{>6}$ - EC_8	*230*	*230*	*5600*	*17000*	*610000*	*220000*
$EC_{>8}$ - EC_{10}	*65*	*65*	*770*	*4800*	*13000*	*18000*
EC_{10}-EC_{12}	*330*	*330*	*4400*	*23000*	*13000*	*23000*
EC_{12}-EC_{16}	*2400*	*2400*	*13000*	*82000*	*13000*	*25000*
$EC_{>16}$ - EC_{35}	*92000*	*92000*	*270000*	*1700000*	*250000*	*480000*
$EC>_{35}$ - EC_{44}	*92000*	*92000*	*270000*	*1700000*	*250000*	*480000*
Aromatic risk banded hydrocarbons - TPHCWG method						
$EC>_5$ - EC_7	*140*	*690*	*27*	*46000*	*56000*	*84000*
$EC>_7$ - EC_8	*290*	*1800*	*51*	*110000*	*56000*	*95000*
$EC_{>8}$ - EC_{10}	*83*	*110*	*21*	*8100*	*5000*	*8500*
EC_{10} - EC_{12}	*180*	*590*	*31*	*28000*	*5000*	*9700*
EC_{12} - EC_{16}	*330*	*2300*	*57*	*37000*	*5100*	*10000*
$EC_{>16}$ - EC_{21}	*540*	*1900*	*110*	*28000*	*3800*	*7700*
$EC_{>21}$ - EC_{35}	*1500*	*1900*	*820*	*28000*	*3800*	*7800*
$EC>_{35}$ - EC_{44}	*1500*	*1900*	*820*	*28000*	*3800*	*7800*
Aliph + Arom EC >44-70	*1800*	*1900*	*2100*	*28000*	3800	7800
Aromatic						
Benzene	**0.16**	**0.49**	**0.035**	**50**	*72*	*100*
Ethyl benzene	**150**	**380**	**39**	**1200**[8] [35000]	**1200**[8] [*24000*]	**1200**[8] [*22000*]
Toluene	**270**	**1300**	**51**	**1900**[8] [110000]	**1900**[8] [*56000*]	**1900**[8] [*95000*]
Xylene[9]	**98**	**120**	**70**	**1200**[8] [14000]	**1200**[8] [*42000*]	**1200**[8] [*23000*]
Phenol	**290**	**420**	**140**	**1500**[14] (35000)	**1500**[14] (*10000*)	**1500**[14] (*8300*)
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	*5.6*	*5.6*	*10*	*460*	*4900*	*1900*
Acenaphthylene	*420*	*4600*	*69*	*97000*	*15000*	*30000*
Acenaphthene	*510*	*4700*	*85*	*97000*	*15000*	*30000*
Fluorene	*400*	*3800*	*67*	*68000*	*9900*	*20000*
Phenanthrene	*220*	*1500*	*38*	*22000*	*3100*	*6200*
Anthracene	*5400*	*35000*	*950*	*540000*	*74000*	*150000*
Fluoranthene	*560*	*1600*	*130*	*23000*	*3100*	*6300*
Pyrene	*1200*	*3800*	*270*	*54000*	*7400*	*15000*
Benz(a)anthracene	*11*	*14*	*6.5*	*170*	*29*	*56*
Chrysene	*22*	*31*	*9.4*	*350*	*57*	*110*
Benzo(b)fluoranthene	*3.3*	*4.0*	*2.1*	*44*	*7.2*	*15*
Benzo(k)fluoranthene	*93*	*110*	*75*	*1200*	*190*	*410*
Benzo(a)pyrene	*2.7*	*3.2*	*2*	*35*	*5.7*	*12*
Indeno(123cd)pyrene	*36*	*46*	*21*	*510*	*82*	*170*
Dibenzo(ah)anthracene	*0.28*	*0.32*	*0.27*	*3.6*	*0.57*	*1.3*
Benzo(ghi)perylene	*340*	*360*	*470*	*4000*	*640*	*1500*
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	*0.00087*	*0.001*	*0.001*	*0.077*	*3.5*	*5*
Trichloroethene (TCE)	*0.034*	*0.036*	*0.091*	*2.6*	*120*	*91*
1,1,1,2 Tetrachlorethane	*2.8*	*3.5*	*1.9*	*250*	*1400*	*1800*
Tetrachlorethene (PCE)	*0.39*	*0.4*	*1.5*	*42*	*1400*	*1100*
1,1,1 Trichlorethane	*18*	*18*	*110*	*1300*	*140000*	*76000*

Notes

1. All values above are in mg/kg
2. **Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters**, *numbers in italics are S4ULs*, ***numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters*** and underlined numbers are C4SLs
3. Soil organic matter (SOM) is assumed to be 2.5% - DEFAULT VALUE
4. Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
5. For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
6. For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
7. For classrooms consider increasing the dust loading fator in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m^{-3}
8. Based on vapour saturation limt as suggested by EA / [ ] model value
9. Lowest of o-, m- and p-xylene
10. Based on comparison of inhalation exposure with inhalation TDI
11. Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
12. Based on a comparison of oral and dermal soil exposure with oral Index Dose only
13. Averaged over and based on lifetime exposure
14. Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
15. NA: Not applicable

Adopted Soil Generic Assessment Criteria
Sandy loam with 1% SOM

curtins

Contaminants	Residential with home grown produce	Residential without home grown produce	Allotments	Commercial	Public open space near residential housing POS_{resi}	Public park POS_{park}
Metals						
Beryllium	*1.7*	*1.7*	*35*	*12*	*2.2*	*63*
Boron	*290*	*11,000*	*45*	*240,000*	*21,000*	*46,000*
Cadmium	**10**[13] 22	**85**[13] 150	**1.8** 3.9	**230** 410	*120* 220	*560* 880
Chromium III	*910*	*910*	*18,000*	*8,600*	*1,500*	*33,000*
Chromium VI	*6* 21	*6* 21	*1.8* 170	*33* 49	*7.7* 21	*220* 250
Lead	200	310	80	2,300	630	1,300
Mercury *(elemental)*	**1**	**1**	**26**	**26**	*16*	**26**[8] *[30]*
Mercury (inorganic)	**170**	**240**	**80**	**3600**	*120*	*240*
Nickel	*130*[10]	*180*[10]	*53*[11]	*980*[10]	*230*	*800*
Vanadium	*410*	*1200*	*91*	*9000*	*2000*	*5000*
Copper	*2400*	*7100*	*520*	*68000*	*12000*	*44000*
Zinc	*3700*	*40000*	*620*	*730000*	*81000*	*170000*
Semi-Metals and non-metals						
Arsenic	**32**[12] 37	**35**[12] 40	**43**[12] 49	**640**[12] 640	*79* 79	*170* 170
Antimony		***550***		***7500***	***1500***	***3300***
Selenium	**350**	**600**	**120**	**13000**	*1100*	*1800*
Inorganic chemicals						
Cyanide	34	34	34	34	34	34
Organic contaminants						
Aliphatic risk banded hydrocarbons - TPHCWG method						
$EC_{>5}$ - EC_6	*42*	*42*	*730*	*3200*	*570000*	*95000*
$EC_{>6}$ - EC_8	*100*	*100*	*2300*	*7800*	*600000*	*150000*
$EC_{>8}$ - EC_{10}	*27*	*27*	*320*	*2000*	*13000*	*14000*
EC_{10}-EC_{12}	*130*	*130*	*2200*	*9700*	*13000*	*21000*
EC_{12}-EC_{16}	*1100*	*1100*	*11000*	*59000*	*13000*	*25000*
$EC_{>16}$ - EC_{35}	*65000*	*65000*	*260000*	*1600000*	*250000*	*450000*
$EC_{>35}$ - EC_{44}	*65000*	*65000*	*260000*	*1600000*	*250000*	*450000*
Aromatic risk banded hydrocarbons - TPHCWG method						
$EC_{>5}$ - EC_7	*70*	*370*	*13*	*26000*	*56000*	*76000*
$EC_{>7}$ - EC_8	*130*	*860*	*22*	*56000*	*56000*	*87000*
$EC_{>8}$ - EC_{10}	*34*	*47*	*8.6*	*3500*	*5000*	*7200*
EC_{10} - EC_{12}	*74*	*250*	*13*	*16000*	*5000*	*9200*
EC_{12} - EC_{16}	*140*	*1800*	*23*	*36000*	*5100*	*10000*
$EC_{>16}$ - EC_{21}	*260*	*1900*	*46*	*28000*	*3800*	*7600*
$EC_{>21}$ - EC_{35}	*1100*	*1900*	*370*	*28000*	*3800*	*7800*
$EC_{>35}$ - EC_{44}	*1100*	*1900*	*370*	*28000*	*3800*	*7800*
Aliph + Arom EC >44-70	*1600*	*1900*	*1200*	*28000*	3800	7800
Aromatic						
Benzene	**0.08**	**0.3**	**0.017**	**28**	*72*	*90*
Ethyl benzene	**65**	**170**	**16**	**520**[8] [17000]	**520**[8] *[24000]*	**520**[8] *[17000]*
Toluene	**120**	**610**	**22**	**860**[8] [59000]	**860**[8] *[56000]*	**860**[8] *[87000]*
Xylene[9]	**41**	**53**	**28**	**480**[8] [69000]	**480**[8] *[41000]*	**480**[8] *[17000]*
Phenol	**180**	**310**	**66**	**760**[14] (31000)	**760**[14] *(10000)*	**760**[14] *(7600)*
Polycyclic Aromatic Hydrocarbons (PAH)						
Naphthalene	*2.3*	*2.3*	*4.1*	*190*	*4900*	*1200*
Acenaphthylene	*170*	*2900*	*28*	*83000*	*15000*	*29000*
Acenaphthene	*210*	*3000*	*34*	*84000*	*15000*	*29000*
Fluorene	*170*	*2800*	*27*	*63000*	*9900*	*20000*
Phenanthrene	*95*	*1300*	*15*	*22000*	*3100*	*6200*
Anthracene	*2400*	*31000*	*380*	*520000*	*74000*	*150000*
Fluoranthene	*280*	*1500*	*52*	*23000*	*3100*	*6300*
Pyrene	*620*	*3700*	*110*	*54000*	*7400*	*15000*
Benz(a)anthracene	*7.2*	*11*	*2.9*	*170*	*29*	*49*
Chrysene	*15*	*30*	*4.1*	*350*	*57*	*93*
Benzo(b)fluoranthene	*2.6*	*3.9*	*0.99*	*44*	*7.1*	*13*
Benzo(k)fluoranthene	*77*	*110*	*37*	*1200*	*190*	*370*
Benzo(a)pyrene	*2.2*	*3.2*	*0.97*	*35*	*5.7*	*11*
Indeno(123cd)pyrene	*27*	*45*	*9.5*	*500*	*82*	*150*
Dibenzo(ah)anthracene	*0.24*	*0.31*	*0.14*	*3.5*	*0.57*	*1.1*
Benzo(ghi)perylene	*320*	*360*	*290*	*3900*	*640*	*1400*
Chlorinated Aliphatic Hydrocarbons						
Vinyl chloride	*0.00064*	*0.00077*	*0.00055*	*0.059*	*3.5*	*4.8*
Trichloroethene (TCE)	*0.016*	*0.017*	*0.041*	*1.2*	*120*	*70*
1,1,1,2 Tetrachlorethane	*1.2*	*1.5*	*0.79*	*110*	*1400*	*1500*
Tetrachlorethene (PCE)	*0.18*	*0.18*	*0.65*	*19*	*1400*	*810*
1,1,1 Trichlorethane	*8.8*	*9*	*48*	*660*	*140000*	*57000*

Notes

1. All values above are in mg/kg
2. **Numbers in bold are SGVs or GAC that are derived based on SGV report input parameters**, *numbers in italics are S4ULs*, ***numbers in bold-italics are based on EIC/AGS/CL:AIRE numbers & input parameters*** and underlined numbers are C4SLs
3. Soil organic matter (SOM) is assumed to be 1% - DEFAULT VALUE
4. Soil type is assumed to be sandy loam - DEFAULT SOIL TYPE
5. For residential, the building type is conservatively assumed to be a small terrace house where the development includes bungalows change to more conservative bungalow setting in computer model
6. For commercial, the building type is conservatively assumed to be a pre 1970s office building, where the proposed development comprises houses, flat with living spaces changes setting in model accordingly
7. For classrooms consider increasing the dust loading fator in the 'Soil and Building Data' of the CLEA 1.04 model from 50 to 100µg m^{-3}
8. Based on vapour saturation limt as suggested by EA / [ ] model value
9. Lowest of o-, m- and p-xylene
10. Based on comparison of inhalation exposure with inhalation TDI
11. Based on comparison of oral, dermal, and inhalation exposure with the oral TDI
12. Based on a comparison of oral and dermal soil exposure with oral Index Dose only
13. Averaged over and based on lifetime exposure
14. Based on critical concentration for skin irritation in humans arising from contact with phenol in aqueous solution (number in brackets based on health effects following long term exposure for illustration)
15. NA: Not applicable

Appendix D Detailed UXO Risk Assessment Report

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Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	Gorton Lane, Manchester
Client	Curtins
Site Address	Gorton, Manchester, M12 5WF
Report Reference	DA6611-00
Date	1st June 2018
Originator	JM

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Executive Summary

Site Location and Description

The site is located in Gorton, east of Manchester City Centre. The boundary comprises three site areas, set to the east of Pottery Lane (A6010), intersected by Gorton Lane and Belle Vue Street.

The site comprises three areas. Site 1 comprises a patch of vegetation. Site 2 comprises open brownfield vegetation with a section of the since redeveloped Clowes Street. Site 3 comprises West Gorton Youth Centre and associated open ground.

The site is approximately centred on the OS grid reference: **SJ 8726796959**.

Proposed Works

The proposed works are understood to involve an intrusive investigation into Sites 1 and 2. This will comprise Cable Percussion boreholes to 10-17m, window sample boreholes to 5.5.m, and trial pits to 3.5m below ground level.

Geology and Bomb Penetration Depth

The British Geological Survey (BGS) map shows the bedrock geology of the site to be underlain by the Etruria Formation - sandstone and mudstone of the Carboniferous Period.. The superficial deposits are comprised of Till, Devensian – diamicton of the Quaternary Period.

Site specific geotechnical information was not available to 1st Line Defence at the time of the production of this report. An assessment of maximum bomb penetration depth can be made once such data becomes available, or by a UXO specialist during on-site support.

It should be noted that the maximum depth that a bomb could reach may vary across a site and will be largely dependent on the specific underlying geological strata and its density.

UXO Risk Assessment

1st Line Defence has assessed that the risk of UXO contamination is not homogeneous at the sites of proposed works. A risk map has been prepared identifying areas of **Low** and **Medium Risk** – see **Annex M**. This assessment is based on the following factors.

- The County Borough of Manchester sustained a relatively low density of bombing according to Home Office statistics, with an average of 27.1 items recorded per 1,000 acres. Aside from the 'Christmas Blitz' of December 1940, Manchester generally escaped the worst of Britain's WWII bombing, particularly when compared with other major UK cities, such as Liverpool or London. Furthermore the peripheries of Manchester were only bombed sporadically, with the major targets in the city consisting of the port, city centre and industry in Stretford.
- No reference could be encountered relating to bombing incidents sustained on or immediately adjacent to any of the three site areas. Moreover, no bombing incidents are recorded on or immediately adjacent to the site within a Manchester bomb and damage map covering 1940 and 1941.
- The majority of the site appears unchanged across pre and post-war OS mapping. Moreover, the majority of the site appears undamaged within aerial photography dated 1948.While gaps in terracing can be seen immediately northwest of Site 2, this is consistent with pre-war mapping. No damage is recorded immediately on or adjacent to the site within the accessed Manchester bomb damage/incident map. The closest recorded damage concerns a pickle factory 130m northeast of Site 1.
- Within these undamaged areas, access is likely to have been relatively frequent throughout WWII owing to the likely occupation of the present residencies, usage of the intersecting roadways, and ownership of the present commercial premises. Evidence of damage caused by an item of UXO is likely to have been evident within these intact structures and roadways, and therefore likely to have been noticed, recorded, and investigated as a result of this access.
- The same cannot be said about an area of clearance visible to the south-east of Site 2. This clearance is not consistent across pre/post-war OS mapping, indicating a wartime change. While this may have been part of wider redevelopment, such clearance may also be indicative of bomb damage, and owing to the lack of information surrounding this the possibility of sustained bombing cannot be entirely discounted. Such damage will have resulted in a suspension of access in this area and the presence of ruin, rubble and debris during the period of conventional bombing. In this case, evidence of UXO may have been obscured, and is less likely to have been noticed and recorded in this area.

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UXO Risk Assessment
• This area, as well as a 'buffer-zone' to account for the possibility of j-curve, by which an item of UXO can come to rest at a lateral offset from its point of entry, has been assessed at Medium Risk. • There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however analogous to those regarding aerial delivered ordnance.

Recommended Risk Mitigation Measures
The following risk mitigation measures are recommended to support the proposed works at the Gorton Lane, site: **All Works** • Site Specific UXO Awareness Briefings to all personnel conducting intrusive works. **Medium Risk Area** • UXO Specialist On-site Support **Boreholes and Piled Foundations** • Intrusive Magnetometer Survey of all borehole and pile locations/clusters down to maximum bomb penetration depth.

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Risk Map



For indicative purposes – not to scale.
Please note that this assessed risk map may not take into account all post-war redevelopment/excavations on site.

Low Risk

Medium Risk

Works in all Areas:

- Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works.

Works in Medium Risk Area:

- Unexploded Ordnance (UXO) Specialist presence on site to support open intrusive works.
- Intrusive Magnetometer Survey of any borehole or pile locations/clusters down to an assessed maximum bomb penetration depth.

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Glossary

Abbreviation	Definition
AA	Anti-Aircraft
AFS	Auxiliary Fire Service
AP	Anti-Personnel
ARP	Air Raid Precautions
AWAS	Air Warfare Analysis Section
DA	Delay-action
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
FP	Fire Pot
GM	G Mine (Parachute mine)
HAA	Heavy Anti-Aircraft
HE	High Explosive
IB	Incendiary Bomb
LAA	Light Anti-Aircraft
LCC	London County Council
LRRB	Long Range Rocket Bomb (V-2)
LSA	Land Service Ammunition
MOL	Molotov (Incendiary Bomb)
OB	Oil Bomb
PAC	Pilotless Aircraft (V-1)
PB	Phosphorous Bomb
PM	Parachute Mine
POW	Prisoner Of War
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RFC	Royal Flying Corps
RNAS	Royal Naval Air Service
ROF	Royal Ordnance Factory
SA	Small Arms
SAA	Small Arms Ammunition
SD1000	1,000kg high explosive bomb
SD2	Anti-personnel “Butterfly Bomb”
SIP	Self-Igniting Phosphorous
U/C	Unclassified bomb
UP	Unrotated Projectile (rocket)
USAAF	United States Army Air Force
UX	Unexploded
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	Flying Bomb (Doodlebug)
V-2	Long Range Rocket
WAAF	Women’s Auxiliary Air Force
X	Exploded

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1st Line Defence Limited
Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: Gorton Lane, Manchester
Client: Curtins

1. Introduction

1.1. Background

1st Line Defence has been commissioned by Curtins to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the proposed works at the Gorton Lane, Manchester site.

Buried UXO can present a significant risk to construction works and development projects. The discovery of a suspect device during works can cause considerable disruption to operations as well as cause unwanted delays and expense.

UXO in the UK can originate from three principal sources:

1. Munitions resulting from wartime activities including German bombing in WWI and WWII, long range shelling, and defensive activities.
2. Munitions deposited as a result of military training and exercises.
3. Munitions lost, burnt, buried or otherwise discarded either deliberately, accidentally, or ineffectively.

This report will assess the potential factors that may contribute to the risk of UXO contamination. If an elevated risk is identified at the site, this report will recommend appropriate mitigation measures, in order to reduce the risk to as low as is reasonably practicable. Detailed analysis and evidence will be provided to ensure an understanding of the basis for the assessed risk level and any recommendations.

This report complies with the guidelines outlined in *CIRIA C681*, 'Unexploded Ordnance (UXO) A Guide for the Construction Industry'.

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2. Method Statement

2.1. Report Objectives

The aim of this report is to conduct a comprehensive assessment of the potential risk from UXO at the Gorton Lane, Manchester site. The report will also recommend appropriate site and work-specific risk mitigation measures to reduce the risk from explosive ordnance during the envisaged works to a level that is as low as reasonably practicable.

2.2. Risk Assessment Process

1st Line Defence has undertaken a five-step process for assessing the risk of UXO contamination:

1. The risk that the site was contaminated with UXO.
2. The risk that UXO remains on the site.
3. The risk that UXO may be encountered during the proposed works.
4. The risk that UXO may be initiated.
5. The consequences of initiating or encountering UXO.

In order to address the above, 1st Line Defence has taken into consideration the following factors:

- Evidence of WWI and WWII German aerial delivered bombing as well as the legacy of Allied occupation.
- The nature and conditions of the site during WWII.
- The extent of post-war development and UXO clearance operations on site.
- The scope and nature of the proposed works and the maximum assessed bomb penetration depth.
- The nature of ordnance that may have contaminated the proposed site area.

2.3. Sources of Information

Every reasonable effort has been made to ensure that relevant evidence has been consulted and presented in order to produce a thorough and comprehensible report for the client. To achieve this the following, which includes military records and archive material held in the public domain, have been accessed:

- The National Archives, Kew and Greater Manchester County Record Office
- Landmark Maps.
- Historic England National Monuments Record.
- Relevant information supplied by Curtins.
- Available material from 33 Engineer Regiment (EOD) Archive.
- 1st Line Defence's extensive historical archives, library and UXO geo-datasets.
- Open sources such as published book and internet resources.

Research involved a visit to the Greater Manchester County Record Office and the National Archives.

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2.4. General Considerations of Historical Research

This desktop assessment is based largely upon analysis of historical evidence. Every reasonable effort has been made to locate and present significant and pertinent information. 1st Line Defence cannot be held accountable for any changes to the assessed risk level or risk mitigation measures, based on documentation or other data that may come to light at a later date, or which was not available to 1st Line Defence during the production of this report.

It is often problematic and sometimes impossible to verify the completeness and accuracy of WWII-era records. As a consequence, conclusions as to the exact location and nature of a UXO risk can rarely be quantified and are to a degree subjective. To counter this, a range of sources have been consulted and analysed. The same methodology is applied to each report during the risk assessment process. 1st Line Defence cannot be held responsible for any inaccuracies or the incompleteness in available historical information.

3. Background to Bombing Records

During WWII bombing records were gathered by the police, Air Raid Precaution (ARP) wardens and military personnel. Records were maintained in the form of local and regional written records, maps depicting the locations of individual strikes, and maps indicating the levels of damage sustained by structures. Records typically documented when, where and what types of bombs had fallen during an air raid. Records of bomb strikes were made either through direct observation or by post-raid surveys. The immediate priority was focused on assisting casualties and minimising damage. As a result some records were incomplete and contradictory.

The quality, detail and nature of record keeping could vary considerably between boroughs and towns. No two areas identically collated or recorded data. While some local authorities maintained records with a methodical approach, sources in certain areas can be considerably more vague, dispersed, and narrower in scope. Many records were even damaged or destroyed in subsequent bombing raids. Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are therefore not always reliable. Furthermore, records of attacks on military or strategic targets were often maintained separately from the general records and have not always survived.

4. Background to Allied Records

During WWII considerable areas of land were requisitioned by the army for the purpose of defence, training, and the construction of airfields and facilities for munitions production. Records relating to military features vary and some may remain censored. Within urban environments datasets will be consulted detailing the location of munition production as well as air and land defences. In rural locations it may be possible to obtain plans of airfields and military establishments, as well as operational training logs, plans and personal memoirs.

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5. UK Regulatory Environment

5.1. General

There is no formal obligation requiring a UXO risk assessment to be undertaken for construction projects in the UK, nor is there any specific legislation stipulating the management or mitigation of UXO risk. However, it is implicit in the legislation outlined below that those responsible for intrusive works (archaeology, site investigation, drilling, piling, excavation etc.) should undertake a comprehensive and robust assessment of the potential risks to employees and that mitigation measures are implemented to address any identified hazards.

5.2. CDM Regulations 2015

The Construction (Design and Management) Regulations 2015 (CDM 2015) define the responsibilities of parties involved in the construction of temporary or permanent structures.

The CDM 2015 establishes a duty of care extending from clients, principle co-ordinators, designers, and contractors to those working on, or affected by, a project. Those responsible for construction projects may therefore be accountable for the personal or proprietary loss of third parties, if correct health and safety procedure has not been applied.

Although the CDM does not specifically reference UXO, the risk presented by such items is both within the scope and purpose of the legislation. It is therefore implied that there is an obligation on parties to:

- Provide an appropriate assessment of potential UXO risks at the site (or ensure such an assessment is completed by others).
- Put in place appropriate risk mitigation measures if necessary.
- Supply all parties with information relevant to the risks presented by the project.
- Ensure the preparation of a suitably robust emergency response plan.

5.3. The 1974 Health and Safety at Work etc. Act

All employers have a responsibility under the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1999, to ensure the health and safety of their employees and third parties, so far as is reasonably practicable and conduct suitable and sufficient risk assessments.

5.4. Additional Legislation

In the event of a casualty resulting from the failure of an employer/client to address the risks relating to UXO, the organisation may be criminally liable under the Corporate Manslaughter and Corporate Homicide Act 2007.

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6. Role of Commercial UXO Contractors and The Authorities

6.1. Commercial UXO Contractors

In the event that a risk of UXO contamination is detected at the proposed site, the support of a UXO specialist may be recommended. A UXO specialist may be able to avoid unnecessary call-outs to the authorities through the disposal or removal of low risk items. In addition a specialist will assist in the swift recognition of high risk items, and will thereafter co-ordinate with the local authority with the objective of causing minimal levels of disruption to site operations, whilst putting in place safe and appropriate measures.

For more information on the role of commercial UXO specialists, see *CIRIA C681*.

6.2. The Authorities

The police have a responsibility to co-ordinate the emergency services in the event of an ordnance-related incident at a construction site. Upon inspection they may impose a safety cordon, order an evacuation, and call the military authorities Joint Services Explosive Ordnance Disposal (JSEOD) to arrange for investigation and/or disposal. In the absence of a UXO specialist, police officers will usually employ such precautionary safety measures, thereby causing works to cease, and possibly requiring the evacuation of neighbouring businesses and properties.

The priority given to the police request will depend on JSEOD's judgement of the nature of the UXO risk, the location, people and assets at risk, as well as the availability of resources. The speed of response varies; authorities may respond immediately or in some cases it may take several days for the item of ordnance to be dealt with.

Depending on the on-site risk assessment the item of ordnance may be removed from the site and/or destroyed by a controlled explosion. The latter process is lengthy and may necessitate the establishment of addition cordons and evacuations.

Following the removal of an item of UXO, the military authorities will only undertake further investigations or clearances in high risk situations. If there are regular UXO finds on a site the JSEOD may not treat each occurrence as an emergency and will recommend the construction company puts in place alternative procedures, such as the appointment of a commercial contractor to manage the situation.

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7. The Site

7.1. Site Location

The site is located in Gorton, east of Manchester City Centre. The boundary comprises three site areas, set to the east of Pottery Lane (A6010), intersected by Gorton Lane and Belle Vue Street.

The site is approximately centred on the OS grid reference: **SJ 8726796959**.

Site location maps are presented in **Annex A**.

7.2. Site Description

The site comprises three areas. Site 1 comprises a patch of vegetation. Site 2 comprises open brownfield vegetation with a section of the since redeveloped Clowes Street. Site 3 comprises West Gorton Youth Centre and associated open ground.

A recent aerial photograph and site plan are presented in **Annex B** and **Annex C** respectively.

8. Scope of the Proposed Works

8.1. General

The proposed works are understood to involve an intrusive investigation into Sites 1 and 2. This will comprise Cable Percussion boreholes to 10-17m, window sample boreholes to 5.5.m, and trial pits to 3.5m below ground level.

9. Ground Conditions

9.1. General Geology

The British Geological Survey (BGS) map shows the bedrock geology of the site to be underlain by the Etruria Formation - sandstone and mudstone of the Carboniferous Period.. The superficial deposits are comprised of Till, Devensian – diamicton of the Quaternary Period.

9.2. Site Specific Geology

Site specific geotechnical data was not available during the production of this report.

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10. Site History

10.1. Introduction

The purpose of this section is to identify the composition of the site pre and post-WWII. It is important to establish the historical use of the site, as this may indicate the site's relation to potential sources of UXO as well as help with determining factors such as the land use, groundcover, likely frequency of access and signs of bomb damage.

10.2. Ordnance Survey Historical Maps

Relevant historical maps were obtained for this report and are presented in **Annex D.** See below for a summary of the site history shown on acquired mapping.

WWI Period		
Date	**Scale**	**Description**
1904	1:2,500	The site areas are shown to comprise areas of terraced residential and commercial property within the map edition. Site 1 is intersected by Miles and Oak Streetm and set just south of Corn Brook, and area of works and industry. Site 2 comprises areas of terraced property, including a pub (The Gorton Brook), and a mission hall. Site 3 comprises terraced property intersected by Brougham Street.

Pre-WWII		
Date	**Scale**	**Description**
1932-1933	1:2,500	Little significant change is visible within any of the three site areas since the previous map edition.

Post-WWII		
Date	**Scale**	**Description**
1948– 1950	1:2,500	Change discernible within this map edition concerns the clearance of an area of terraced property to the south-east of Site 2. Significant redevelopment is visible to the north-east, where the 'Brookhouse Flats' have been constructed.
1984 – 1991	1:1,250	Significant redevelopment is visible within the three sites as well as the surrounding area. The majority of remaining wartime structures have been cleared, with the exception of the Gorton Brook public house within Site 2. The Youth Centre can be seen situated within Site 3.

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11. Aerial Bombing Introduction

11.1. General

During WWI and WWII, many towns and cities across the UK were subjected to bombing which often resulted in extensive damage to city centres, docks, rail infrastructure and industrial areas. The poor accuracy of WWII targeting technology and the nature of bombing techniques often resulted in neighbouring areas to targets sustaining collateral damage.

In addition to raids which concentrated on specific targets, indiscriminate bombing of large areas also took place, this occurred most prominently in the London 'Blitz', though affected many other towns and cities. As discussed in the following sections, a proportion of the bombs dropped on the UK did not detonate as designed. Although extensive efforts were made to locate and deal with these UXBs at the time, many still remain buried and can present a potential risk to construction projects.

The main focus of research for this report will concern German aerial delivered weapons dropped during WWII, although WWI bombing will also be considered.

11.2. Generic Types of WWII German Aerial-delivered Ordnance

An understanding of the type and characteristics of the ordnance used by the Luftwaffe during WWII allows an informed assessment of the hazards posed by any unexploded items that may remain in situ on a site.

Generic Types of WWII German Aerial Delivered Ordnance		
Type	**Frequency**	**Likelihood of detection**
High Explosive (HE) bombs	In terms of weight of ordnance dropped, HE bombs were the most frequently deployed by the Luftwaffe during WWII.	Although efforts were made to identify the presence of unexploded ordnance following an air raid, often the damage and destruction caused by detonated bombs made observation of UXB entry holes impossible. The entry hole of an unexploded bomb can be as little as 20cm in diameter and was easily overlooked in certain ground conditions (see **Annex E**). Furthermore, ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded 50kg bomb. UXBs therefore present the greatest risk to present–day intrusive works.
Aerial or Parachute mines (PM)	There were deployed less frequently than HE and IBs due to size, cost and the difficulty of deployment.	If functioning correctly, PMs generally would have had a slow rate of descent and were very unlikely to have penetrated the ground. Where the parachute failed, mines would have simply shattered on impact if the main charge failed to explode. There have been extreme cases when these items have been found unexploded. However, in these scenarios, the ground was either extremely soft or the munition fell into water.
1kg Incendiary bombs (IB)	In terms of the number of weapons dropped, small IBs were the most numerous. Millions of these were dropped throughout WWII.	IBs had very limited penetration capability and in urban areas would often have been located in post-raid surveys. If they failed to initiate and fell in water, on soft vegetated ground, or bombed rubble, they could have gone unnoticed.
Large Incendiary bombs (IB)	These were not as common as the 1kg IBs, although they were more frequently deployed than PMs and AP bomblets.	If large IBs did penetrate the ground, complete combustion did not always occur and in such cases they could remain a risk to intrusive works.
Anti-personnel (AP) bomblets	These were not commonly used and are generally considered to pose a low risk to most works in the UK.	SD2 bomblets were packed into containers holding between 6 and 108 submunitions. They had little ground penetration ability and should have been located by the post-raid survey unless they fell into water, dense vegetation or bomb rubble.

Images and brief summaries of the characteristics of the above listed German aerial delivered ordnance are presented in **Annex F**.

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11.3. Failure Rate of German Aerial-delivered Ordnance

It has been estimated that 10% of WWII German aerial delivered HE bombs failed to explode as designed. Reasons for why such weapons might have failed to function as designed include:

- Malfunction of the fuze or gain mechanism (manufacturing fault, sabotage by forced labour or faulty installation).
- Many were fitted with a clockwork mechanism that could become immobilised on impact.
- Failure of the bomber aircraft to arm the bombs due to human error or an equipment defect.
- Jettisoning the bomb before it was armed or from a very low altitude. This most likely occurred if the bomber aircraft was under attack or crashing.

From 1940 to 1945 bomb disposal teams dealt with a total of 50,000 explosive items of 50kg, over, 7,000 anti-aircraft projectiles and 300,000 beach mines. Unexploded ordnance is still regularly encountered across the UK, see press articles in **Annex G**.

11.4. V-Weapons

From mid-1944, Hitler's 'V-weapon' campaign began. It used newly developed unmanned cruise missiles and rockets. The V1 known as the *Flying Bomb* or *Doodlebug* and the V2, a Long Range Rocket, were launched from bases in Germany and occupied Europe. One V-1 Pilotless Aircraft fell within the County Borough of Manchester.

Although these weapons caused considerable damage their relatively low numbers allowed accurate records of strikes to be maintained. These records have mostly survived. It should be stressed that there is a negligible risk from unexploded V-weapons on land today since even if the 1000kg warhead failed to explode, the weapons are so large that they would have been observed and the threat dealt with at the time. Therefore V-weapons are referenced in this report not as a viable risk factor, but primarily in order to help account for evidence of damage and clearance reported.

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12. UXB Ground Penetration

12.1. General

An important consideration when assessing the risk from a UXB is the likely maximum depth of burial. There are several factors which determine the depth that an unexploded bomb will penetrate:

- Mass and shape of bomb.
- Height of release.
- Velocity and angle of bomb.
- Nature of the ground cover.
- Underlying geology.

Geology is perhaps the most important variable. If the ground is soft, there is a greater potential of deeper penetration. For example, peat and alluvium are easier to penetrate than gravel and sand, whereas layers of hard strata will significantly retard and may stop the trajectory of a UXB.

12.2. The J-Curve Effect

J-curve is the term used to describe the characteristic curve commonly followed by an aerial delivered bomb dropped from height after it penetrates the ground. Typically, as the bomb is slowed by its passage through underlying soils, its trajectory curves towards the surface. Many UXBs are found with their nose cone pointing upwards as a result of this effect. More importantly however is the resulting horizontal offset from the point of entry. This is typically a distance of about one third of the bomb's penetration depth, but can be up to 15m.

12.3. WWII UXB Penetration Studies

During WWII the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1,328 bombs as reported by bomb disposal (BD) teams. Conclusions were made as to the likely average and maximum depths of penetration of different sized bombs in different geological strata.

For example, the largest common German bomb (500kg) had a likely concluded penetration depth of 6m in sand or gravel but 11m in clay. The maximum observed depth for a 500kg bomb was 11.4m and for a 1,000kg bomb 12.8m. Theoretical calculations suggested that significantly greater penetration depths were probable.

12.4. Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the site of proposed works the following parameters have been used:

- WWII geology – Eturia Formation.
- Impact angle and velocity – 10-15° from vertical and 270 metres per second.
- Bomb mass and configuration – The 500kg SC HE bomb, without retarder units or armour piercing nose (this was the largest of the common bombs used against Britain).

It has not been possible to determine maximum bomb penetration capabilities at this stage due to the lack or limitations of site specific borehole geotechnical information. An assessment can be made once such information becomes available or by an UXO Specialist on-site.

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13. Initiation of Unexploded Ordnance

13.1. General

Unexploded ordnance does not spontaneously explode. All high explosive filling requires significant energy to create the conditions for detonation to occur. In the case of unexploded German bombs discovered within the construction site environment, there are a number of potential initiation mechanisms.

13.2. UXB Initiation Mechanisms

UXB Initiation	
Direct Impact	Unless the fuze or fuze pocket is struck, there needs to be a significant impact e.g. from piling or large and violent mechanical excavation, onto the main body of the weapon to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
Re- starting the Clockwork Fuze	A small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion would have taken place within the fuze mechanism over the last 70+ years that would prevent clockwork mechanisms from functioning. Nevertheless, it was reported that the clockwork fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-start.
Friction Impact	The most likely scenario resulting in the detonation of a UXB is friction impact initiating the shock-sensitive fuze explosive. The combined effects of seasonal changes in temperature and general degradation over time can cause explosive compounds to crystallise and extrude out from the main body of the bomb. It may only require a limited amount of energy to initiate the extruded explosive which could detonate the main charge.

Annex G2 details incidents where intrusive works have caused items of UXO to detonate, resulting in death or injury and damage to plant.

13.3. Effects of Detonation

When considering the potential consequences of a detonation, it is necessary to identify the significant receptors that may be affected. The receptors that may potentially be at risk from a UXO detonation on a construction site will vary depending on the site specific conditions but can be summarised as follows:

- People – site workers, local residents and general public.
- Plant and equipment – construction plant on site.
- Services – subsurface gas, electricity, telecommunications.
- Structures – not only visible damage to above ground buildings, but potentially damage to foundations and the weakening of support structures.
- Environment – introduction of potentially contaminating materials.

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14. The Risk from German Aerial Delivered UXBs

14.1. World War I

Areas of the UK, especially London, were bombed during WWI by Zeppelins and Gotha Bombers. A WWI bomb plot and naval bombardment map shows that these attacks were on a national scale and is presented in **Annex H**. No significant WWI-era air raids are recorded to have taken place within Greater Manchester.

WWI bombs were generally smaller than those used in WWII and were dropped from a lower altitude, resulting in limited UXB penetration depths. Aerial bombing was often such a novelty at the time that it attracted public interest and even spectators to watch the raids in progress. For these reasons there is a limited risk that UXBs passed undiscovered in the urban environment. When combined with the relative infrequency of attacks and an overall low bombing density the risk from WWI UXBs is considered low and will not be further addressed in this report.

14.2. World War II Bombing of Manchester

Manchester, like many other cities in England, was targeted by the Luftwaffe's bombing campaigns. The Luftwaffe's objective was to paralyse the city, a crucial port and industrial centre. Additionally Trafford Park, in neighbouring Stretford, was a well-known and essential hub of armament production.

The site was located within the County Borough of Manchester, albeit in a peripheral area of the borough, which sustained a low density of bombing according to Home Office statistics. Luftwaffe target photography (see **Annex I**) specifically highlights a Gas Works at Clayton, approximately 2.2km to the north-east. This shows that, even though the site was located some distance from the major targets in the port, city centre and Stretford, the Luftwaffe did have bombing targets on the outskirts of the city. The presence of these targets can contribute to the presence of bombing in the Gorton area, as well as the general bombing of the civilian population. However, no specific evidence could be found that the site itself was identified as a target by the German authorities.

Records of bombing incidents in Manchester were collected by the Air Raid Precautions wardens and collated by the Civil Defence Office. Records would be in the form of typed or hand written incident notes, maps and statistics. Bombing data was carefully analysed, not only due to the requirement to identify those parts of the capital most needing assistance, but also in an attempt to find patterns in the Germans' bombing strategy in order to predict where future raids might take place.

Records of bombing incidents for the County Borough of Manchester are presented in the following sections.

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14.3. Second World War Bombing Statistics

The following tables summarise the quantity of German bombs (excluding 1kg incendiaries and anti-personnel bombs) falling on the County Borough of Manchester between 1940 and 1945.

Record of German Ordnance Dropped on the County Borough of Manchester		
Area Acreage		**27,255**
Weapons	High Explosive Bombs (all types)	712
	Parachute Mines	18
	Oil Bombs	7
	Phosphorus Bombs	0
	Fire Pot	0
	Pilotless Aircraft (V1)	1
	Long Range Rockets (V2)	0
Total		**738**
Number of Items per 1000 acres		**27.1**

Source: Home Office Statistics
This table does not include UXO found during or after WWII.

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. Although the incendiaries are not particularly significant in the threat they pose, they nevertheless are items of ordnance that were designed to cause damage and inflict injury and should not be overlooked in assessing the general risk to personnel and equipment. The anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous.

14.4. Manchester Air Raid Precautions Bomb Census and Damage Map

A bomb census map compiled by Manchester City Council showing High Explosive strikes on the borough was obtained from Manchester University Library. A section of the map, showing the site location, is displayed in **Annex J**.

Manchester Consolidated Bomb Map – Annex J	
Date Range	**Comments**
Consolidated bomb plot and damage map: 1940 - 1941	No damage or bombing incidents are recorded on or immediately adjacent to the site within this map edition, which uses a 1935 edition. The closest recorded damage concerns a pickle factory 130m northeast of Site 1.

14.5. Manchester Damage Records

A street index of damage records was accessed at the Greater Manchester County Record Office. No reference could be found relating to damage sustained by any of the streets on, intersecting or adjacent to any of the three sites of proposed works.

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14.6. WWII-Era Aerial Photography

A high resolution scan of WWII-era aerial photography for the site area was obtained from the National Monuments Record Office (Historic England). This photograph provides a record of the potential composition of the site during the war, as well as its condition immediately following the war (**see Annex K**).

WWII-Era Aerial Photography – Annex K	
Date	**Description**
16th May 1948	The majority of the site is shown absent of bomb damage, with terraced property intact and consistent with pre-war OS mapping. The exception is an area of clearance visible to the southeast of Site 2. Brook House Flats can be seen developed to the general northeast.

14.7. Abandoned Bombs

A post air-raid survey of buildings, facilities, and installations would have included a search for evidence of bomb entry holes. If evidence of an entry hole was encountered, Bomb Disposal Officer Teams would normally have been requested to attempt to locate, render safe, and dispose of the bomb. Occasionally, evidence of UXBs was discovered but due to a relatively benign position, access problems, or a shortage of resources the UXB could not be exposed and rendered safe. Such an incident may have been recorded and noted as an 'abandoned bomb'.

Given the inaccuracy of WWII records and the fact that these bombs were 'abandoned', their locations cannot be considered definitive or the lists exhaustive. The MoD states that 'action to make the devices safe would be taken only if it was thought they were unstable'. It should be noted that other than the 'officially' abandoned bombs, there will inevitably be UXBs that were never recorded.

1st Line Defence holds no records of officially registered abandoned bombs at or near the site of the proposed works.

14.8. Bomb Disposal Tasks

The information service from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD) is currently facing considerable delay. It has therefore not been possible to include any updated official information regarding bomb disposal/clearance tasks with regards to this site. A database of known disposal/clearance tasks has been referred to which does not make reference to such instances occurring within the site of proposed works. If any relevant information is received at a later date Curtins will be advised.

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14.9. Evaluation of German Aerial Delivered UXB Risk

Factors	Conclusion
Density of Bombing *It is important to consider the bombing density when assessing the possibility that UXBs remain in an area. High levels of bombing density could allow for error in record keeping due to extreme damage caused to the area.*	The County Borough of Manchester sustained a low density of bombing according to Home Office statistics, with an average of 27.1 items recorded per 1,000 acres. Aside from the 'Christmas Blitz' of December 1940, Manchester generally escaped the worst of Britain's WWII bombing, particularly when compared with neighbouring Liverpool or London. While the peripheries of the city were bombed sporadically, the major targets in the city were the port, city centre and industry in Stretford. No reference could be encountered relating to bombing incidents sustained on or immediately adjacent to any of the three site areas. Moreover, no bombing incidents are recorded on or immediately adjacent to the site within a Manchester bomb and damage map covering 1940 and 1941.
Damage *If buildings or structures on a site sustained bomb or fire damage any resulting rubble and debris could have obscured the entry holes of unexploded bombs dropped during the same, or later, raids. Similarly, a High Explosive bomb strike in an area of open agricultural land will have caused soil disturbance, increasing the risk that a UXB entry hole would be overlooked.*	The majority of the site appears unchanged across pre and post-war OS mapping. Moreover, the majority of the site appears undamaged within aerial photography dated 1948, with a lack of significant clearance in terraced property. While gaps in terracing can be seen immediately northwest of Site 2, this is consistent with pre-war mapping. Moreover, no damage is recorded immediately on or adjacent to the site within the accessed Manchester bomb damage/incident map. The closest recorded damage concerns a pickle factory 130m northeast of Site 1. The exception to this is an area of clearance visible to the south-east of Site 2. This clearance is not consistent across pre/post-war OS mapping, indicating a wartime change. While this may have been part of wider redevelopment, such clearance may be indicative of bomb damage, and owing to the lack of information surrounding this the possibility of sustained bombing cannot be entirely discounted at this point. .
Access Frequency *UXO in locations where access was irregular would have a greater chance of passing unnoticed than at those that were regularly occupied. The importance of a site to the war effort is also an important consideration as such sites are likely to have been both frequently visited and subject to post-raid checks for evidence of UXO.*	Access throughout the majority of the site will have been relatively frequent throughout the war owing to the likely occupation of the present residencies, usage of the intersecting roadways, and ownership of the present commercial premises. Any evidence of UXO is likely to have been noticed, recorded, and investigated as a result of this access. The same cannot be said about the area of clearance visible to the southeast of Site 2. There is the potential that this clearance occurred as a result of bomb damage, which will have resulted in a suspension of access in this area during the period of conventional bombing. As a result, evidence of UXO is less likely to have been noticed and recorded in this area.
Ground Cover *The nature of the ground cover present during WWII would have a substantial influence on any visual indication that may indicate UXO being present.*	The majority of the site appears in a relatively good condition within acquired aerial photography dated 1948. Any damage caused by an unexploded bomb is likely to have been fairly evident upon intact structures and roadways. Again the exception to this is the area of clearance to the southeast of Site 2, within which conditions of ruin and debris may have obscured evidence of UXO such as entry holes.

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Bomb Failure Rate	There is no evidence to suggest that the bomb failure rate in the locality of the site would have been dissimilar to the 10% normally used.
Abandoned Bombs	1st Line Defence holds no records of abandoned bombs at or within the site vicinity.
Bombing Decoy sites	1st Line Defence could find no evidence of bombing decoy sites within the site vicinity.
Bomb Disposal Tasks	1st Line Defence could find no evidence of bomb disposal tasks within the site boundary and immediate area.

15. The Risk from Allied Ordnance

15.1. General

The potential risk of encountering Allied ordnance on construction sites is particularly elevated in areas previously associated with military activity. This includes munitions deposited by military training exercises, dumped as a result of poor working practices, or deliberately placed to prevent adversary occupation and from other home defence activities. For example, contamination from items of Land Service (LSA) and Small Arms Ammunition (SAA) may result from historical occupation of an area or its use for military training.

15.2. His Majesty's Explosives Factory: West Gorton

A works known as His Majesty's Explosive Factory was situated approximately 150m west of the site on what is now Wenlock Way. The factory was a chemical works which produced a variety of explosives for use in weapons produced for the First World War. This included trinitrotoluene (TNT), mononitrotoluene (MNT) and one of the UK's first attempts at creating synthetic phenol for use in explosives. It should be noted that no evidence could be found to indicate that completed items of explosive ordnance were manufactured within the works. In any case, the works was not situated on or in a proximity to the site thought to have caused a relevant association.

15.3. Defending the UK From Aerial Attack

During WWII the Ministry of Defence employed a number of defence tactics against the Luftwaffe from bombing major towns, cities, manufacturing areas, ports and airfields. These can be divided into passive and active defences (examples are provided in the table below).

Active Defences	Passive Defences
• Anti-aircraft gun emplacements to engage enemy aircraft. • Fighter aircraft to act as interceptors. • Rockets and missiles were used later during WWII.	• Blackouts and camouflaging to hinder the identification of Luftwaffe targets. • Decoy sites were located away from targets and used dummy buildings and lighting to replicate urban, military, or industrial areas. • Barrage balloons forced enemy aircraft to greater altitudes. • Searchlights were often used to track and divert adversary bomber crews during night raids.

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Active defences such as anti-aircraft artillery present a greater risk of UXO contamination than passive defences. Unexploded ordnance resulting from dogfights and fighter interceptors is rarely encountered and difficult to accurately qualify.

15.4. Anti-Aircraft Artillery (AAA)

During WWII three main types of gun sites existed: heavy anti-aircraft (HAA), light anti-aircraft (LAA) and 'Z' batteries (ZAA). If the projectiles and rockets fired from these guns failed to explode or strike an aircraft they would descend back to land. The table below provides further information on the operation and ordnance associated with these type of weapons.

Anti-Aircraft Artillery				
Item	**Description**			
HAA	These large calibre guns such as the 3.7" QF (Quick Firing) were used to engage high flying enemy bombers., They often fired large HE projectiles, which were usually initiated by integral fuzes triggered by impact, area, time delay or a combination of aforementioned mechanisms The closest HAA was located approximately 2.3km south-east of the site, however the range of a projectile can be up to 15km.			
LAA	These mobile guns were intended to engage fast, low flying aircraft. They were typically rotated between locations on the perimeters of towns and strategically important industrial works. As they could be moved to new positions with relative ease when required, records of their locations are limited. The most numerous of these were the 40mm Bofors gun which could fire up to 120 x 40mm HE projectiles per minute to over 1,800m.			
Variations in HAA and LSA Ammunition	**Gun type**	**Calibre**	**Shell Weight**	**Shell Dimensions**
	3.0 Inch	76mm	7.3kg	76mm x 356mm
	3.7 Inch	94mm	12.7kg	94mm x 438mm
	4.5 Inch	114mm	24.7kg	114mm x 578mm
	40mm	40mm	0.9kg	40mm x 311mm
Z-AA	The three inch unrotated rocket/projectile known as the UP-3 had initially been developed for the Royal Navy. The UP-3 was also used in ground-based single and 128-round launchers known as ''Z'' batteries. The rocket, containing a high explosive warhead was often propelled by cordite.			
29mm Spigot Mortars (Blacker Bombards)	This was an infantry anti-tank weapon. A heavy steel rod (spigot) would be driven into the hollow tail of a projectile to ignite the explosive charge located in the rear of the projectile, and lead to it being propelled toward a target. It was not an effective method of air defence and was mainly used in defensive positons at key locations. If encountered, a spigot mortar projectile will resemble a mortar round, but with an elongated metal tail rod.			
Quick Firing (QF) 1 and 2 Pounder	QF 1 and 2 Pounders, or 'pom poms' were a light battery most often used by the navy. During the beginning of WWII they were used to defend targets in the absence of more effective LAA or HAA.			
Machine Gun Posts	These were established at some significant military and industrial positions. Machine guns were a largely ineffective form of AAA. Machine guns usually fired the .303 Round.			

The conditions in which an HAA or LAA projectiles may have fallen unnoticed within a site area are analogous to those regarding aerial delivered ordnance. For detailed analysis on the ground conditions and access frequency within the proposed site, see the evaluation of German Bombing Records in, **Section 14**.

Unexploded HAA ammunition is likely to be found close to WWII ground level. If encountered, the high explosive fill and fragmentation hazard of these items could present a significant risk to workers and equipment.

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Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at **Annex L**.

15.5. Evaluation of Allied Ordnance Risk

1st Line Defence has considered the following potential sources of Allied ordnance contamination:

Sources of Contamination	Conclusion
Military Camps *Military camps present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training.*	1st Line Defence could find no evidence of a military camp within the site.
Anti-Aircraft Defences *Anti-Aircraft defences were employed across the country. Proximity to anti-aircraft defences increases the chance of encountering AA projectiles.*	1st Line Defence could find no evidence of Anti-Aircraft defences such as a HAA or LAA gun emplacement occupying or bordering the site. The closest HAA was located approximately 2.3km south-east of the site, however the range of a projectile can be up to 15km. The conditions in which HAA or LAA projectiles may have fallen unnoticed within a site footprint are analogous to those regarding German aerial delivered ordnance.
Home Guard Activity *The Home Guard regularly undertook training and ordnance practice in open areas, as well as burying ordnance as part of anti-invasion defences.*	Evidence of Home Guard training areas and activities is difficult to obtain. 1st Line Defence has no evidence of any Home Guard activities on the site.
Defensive Positions *Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.*	There is no evidence of any defensive features formerly located on or bordering the site footprint.
Training or firing ranges *Areas of ordnance training saw historical ordnance usage in large numbers, often with inadequate disposal of expended and live items. The presence of these ranges significantly impact on the risk of encountering items of ordnance in their vicinity.*	There is no evidence of such features affecting the site.
Defensive Minefields *Minefields were placed in strategic areas to defend the country in the event of a German invasion. Minefields were not always cleared with an appropriate level of vigilance.*	There is no evidence of defensive minefields affecting the site.
Ordnance Manufacture *Ordnance manufacture indicates an increased chance that items of ordnance were stored, or disposed of, within a location.*	No information of ordnance being stored, produced, or disposed of within the proposed site could be found.
Military Related Airfields *Military airfields present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training or bombing practice.*	The site was not situated within the perimeters or vicinity of a military airfield.

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16. Ordnance Clearance and Post-WWII Ground Works

16.1. General

It is important to consider the extent to which any explosive ordnance clearance (EOC) activities or extensive ground works have occurred on site. This may indicate previous ordnance contamination or reduce the risk that ordnance remains undiscovered.

16.2. UXO Clearance

1st Line Defence has no evidence that any official ordnance clearance operations have taken place on site. Note however that we have not received confirmation of this fact from 33 EOD Regiment.

16.3. Post-war Redevelopment

Post-war redevelopment has involved the demolition of all existing wartime structures. Sites 1 and 2 have remained undeveloped, with a youth centre constructed in Site 3. The risk from deep-buried unexploded bombs is only considered mitigated at locations where post war piling or deep foundations have taken place.

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17. 1st Line Defence Risk Assessment

17.1. Risk Assessment Stages

Taking into account the quality of the historical evidence, the assessment of the overall risk from unexploded ordnance is based on the following five considerations:

1. That the site was contaminated with unexploded ordnance.
2. That unexploded ordnance remains on site.
3. That such items will be encountered during the proposed works.
4. That ordnance may be initiated by the works operations.
5. The consequences of encountering or initiating ordnance.

UXO Risk Assessment	
Quality of the Historical Record	The research has evaluated pre- and post-WWII Ordnance Survey maps, Luftwaffe reconnaissance imagery, historical OS mapping, a Manchester bomb damage/incidents map, Manchester damage cards, and anecdotal resources. The record set is of a generally good quality, with incidents confirmed across multiple sources. However, while an index of damage to industry has been located at the Great Manchester Archives it has not been possible to access them during the time scale available for the production of this report.
The Risk that the Site was Contaminated with UXO	1st Line Defence has assessed that the risk of UXO contamination is not homogeneous at the sites of proposed works. A risk map has been prepared identifying areas of **Low** and **Medium Risk** – see **Annex M**. This assessment is based on the following factors: • The County Borough of Manchester sustained a relatively low density of bombing according to Home Office statistics, with an average of 27.1 items recorded per 1,000 acres. Aside from the 'Christmas Blitz' of December 1940, Manchester generally escaped the worst of Britain's WWII bombing, particularly when compared with other major UK cities, such as Liverpool or London. Furthermore the peripheries of Manchester were only bombed sporadically, with the major targets in the city consisting of the port, city centre and industry in Stretford. • No reference could be encountered relating to bombing incidents sustained on or immediately adjacent to any of the three site areas. Moreover, no bombing incidents are recorded on or immediately adjacent to the site within a Manchester bomb and damage map covering 1940 and 1941. • The majority of the site appears unchanged across pre and post-war OS mapping. Moreover, the majority of the site appears undamaged within aerial photography dated 1948.While gaps in terracing can be seen immediately northwest of Site 2, this is consistent with pre-war mapping. No damage is recorded immediately on or adjacent to the site within the accessed Manchester bomb damage/incident map. The closest recorded damage concerns a pickle factory 130m northeast of Site 1. • Within these undamaged areas, access is likely to have been relatively frequent throughout WWII owing to the likely occupation of the present residencies, usage of the intersecting roadways, and ownership of the present commercial premises. Evidence of damage caused by an item of UXO is likely to have been evident within these intact structures and roadways, and therefore likely to have been noticed, recorded, and investigated as a result of this access. • The same cannot be said about an area of clearance visible to the south-east of Site 2. This clearance is not consistent across pre/post-war OS mapping, indicating a wartime change. While this may have been part of wider redevelopment, such clearance may also be indicative of bomb damage, and owing to the lack of information surrounding this the possibility of sustained bombing cannot be

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	entirely discounted. Such damage will have resulted in a suspension of access in this area and the presence of ruin, rubble and debris during the period of conventional bombing. In this case, evidence of UXO may have been obscured, and is less likely to have been noticed and recorded in this area. • This area, as well as a 'buffer-zone' to account for the possibility of j-curve, by which an item of UXO can come to rest at a lateral offset from its point of entry, has been assessed at Medium Risk. • There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however analogous to those regarding aerial delivered ordnance.
The Risk that UXO Remains on Site	Post-war redevelopment has involved the demolition of all existing wartime structures. Sites 1 and 2 have remained undeveloped, with a youth centre constructed in Site 3. The risk of UXO remaining is considered to have been mitigated at the location of and down to the depth of post-war foundations and excavations.
The Risk that UXO may be Encountered during the Works	The most likely scenarios under which items of UXO could be encountered during construction works is during piling, drilling operations or bulk excavations for basement levels. The risk of encountering will depend on the extent of the works, such as the numbers of boreholes/piles (if required) and the volume of the excavations. An aerial delivered bomb may come to rest at any depth between just below ground level and its maximum penetration depth. Consequently there is also a possibility that UXBs could be encountered during shallow excavations (for services or site investigations) into the original WWII ground level. There is not considered to be any significant risk of encountering UXO during works planned within the footprint and down to the depth of any post-war buildings/excavations. Beyond these depths and away from these areas, a risk of encounter could remain.
The Risk that UXO may be Initiated	The risk that UXO could be initiated if encountered will depend on its condition, how it is found, and the energy with which it is struck. Certain construction activities such as piling and percussive drilling pose a greater risk of initiating UXO in comparison to machine excavation, where the force of impact is generally lower and the item is more likely to be observed. If a UXB is struck by piling or percussive drilling equipment, the force of the impact can be sufficient to detonate the main high explosive charge irrespective of the condition of the fuze or other components. Violent vibration might also impart enough energy to a chemical detonator for it to function, and there is a potential risk that clockwork fuzes could restart. If piling works are planned at Gorton Lane, Manchester, there is a potential risk that a UXB, if present, could be initiated. The risk of initiation is assessed to be lower for any shallow intrusive works planned.
The Consequences of Encountering or Initiating Ordnance	The repercussions of the inadvertent detonation of items of UXO during intrusive ground works are potentially severe, both in terms of human and financial cost. A serious risk to life and limb, damage to plant and total site shutdown during follow-up investigations are potential outcomes. If appropriate risk mitigation measures are undertaken, the chances of initiating an item of UXO during ground works is comparatively low. The primary consequence of encounter of UXO will therefore be economic. This would be particularly notable in the case of sites with a high-profile or where it is necessary to evacuate the public from the surrounding area. A site may be closed from a few hours to a week with potentially significant cost in lost time.

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	It should be noted that even the discovery of suspected or possible items of UXO during intrusive works (if handled solely through the authorities), may also involve loss of production. Generally, the first action of the police in most cases will be to isolate the locale whilst awaiting military assistance, even if this becomes unnecessary.

17.2. Assessed Risk Level

Taking into consideration the findings of this study, 1st Line Defence has assessed that the risk of UXO contamination is not homogenous throughout the site areas. While the majority of the site of proposed works is regarded at **Low risk**, an area of **Medium risk** has been recorded within the south-eastern section of Site 2.

Low Risk Areas

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs		✓		
German 1kg Incendiary Bombs		✓		
Anti-Aircraft Artillery Projectiles		✓		
Allied Military Land Service Ammunition (Grenades, Mortars etc.)	✓			

Medium Risk Area

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs			✓	
German 1kg Incendiary Bombs			✓	
Anti-Aircraft Artillery Projectiles			✓	
Allied Military Land Service Ammunition (Grenades, Mortars etc.)	✓			

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18. Proposed Risk Mitigation Methodology

18.1. General

The following risk mitigation measures are recommended to support the proposed works at the Gorton Lane, Manchester site:

Type of Work	Recommended Mitigation Measure
All Works	• **Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.** As a minimum precaution, all personnel working on the site should be briefed on the basic identification of UXO and what to do in the event of encountering a suspect item. This should in the first instance be undertaken by a UXO Specialist. Posters and information on the risk of UXO can be held in the site office for reference.
Shallow Intrusive Works/Open Excavations - Medium Risk Area	• **Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works** When on site the role of the UXO Specialist would include: • Monitoring works using visual recognition and instrumentation, including immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by the ground workers on site. • Providing UXO awareness briefings to any uninformed staff and advise staff of the need to modify working practices to take account of the ordnance risk. • To aid incident management which would involve liaison with the local authorities and police should ordnance be identified and present an explosive hazard.
Borehole/Piles - Medium Risk Area	• **Intrusive Magnetometer Survey of all borehole and pile locations down to a maximum bomb penetration depth:** 1st Line Defence can deploy a range of intrusive magnetometer techniques to clear pile locations. The appropriate technique is influenced by a number of factors, but most importantly the site's ground conditions. The appropriate survey methodology would be confirmed once the enabling works have been completed.

In making this assessment and recommending these risk mitigation measures, if known, the works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, 1st Line Defence should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

1st Line Defence Limited **1st June 2018**

This Report has been produced in compliance with the Construction Industry Research and Information Association (CIRIA) C681 guidelines for the writing of Detailed UXO Risk Assessments.

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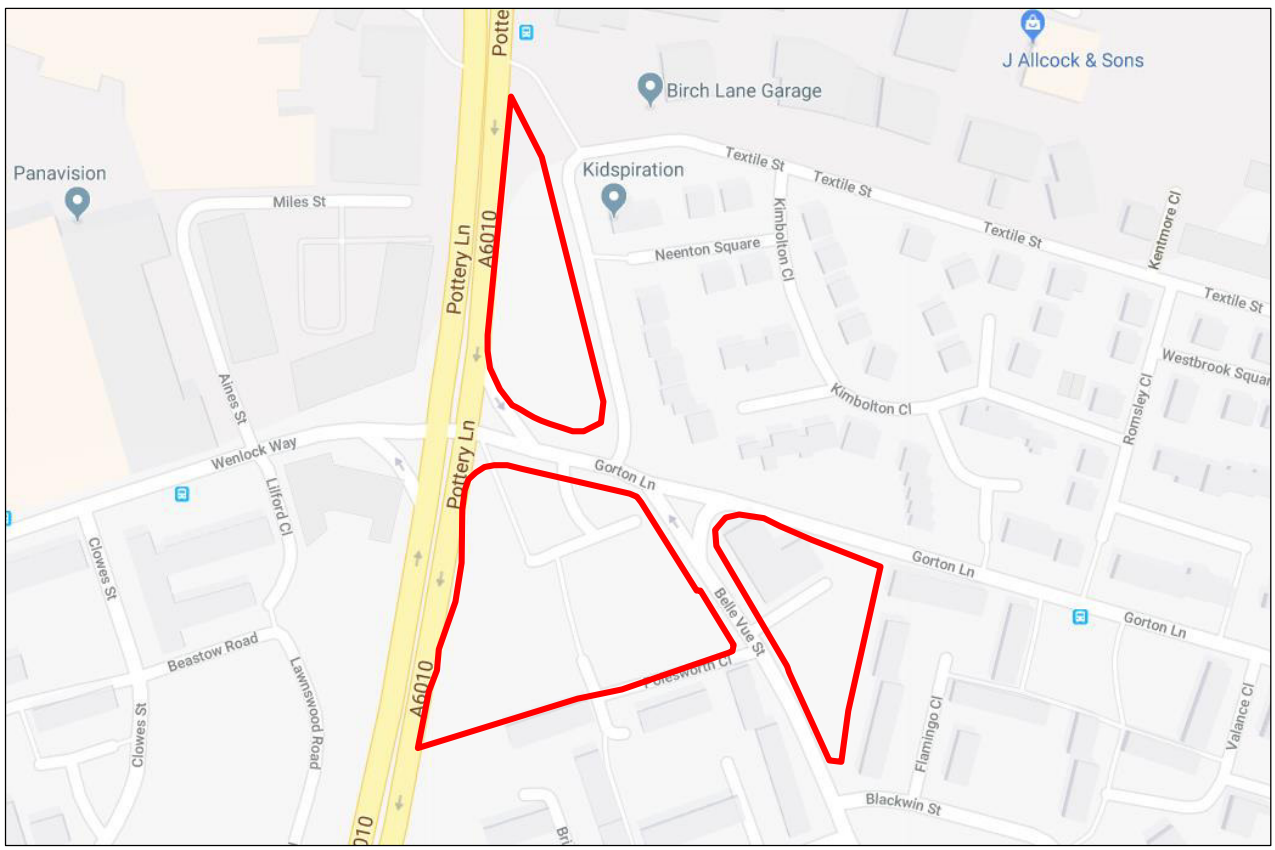
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Site Location Maps

Annex: **A**





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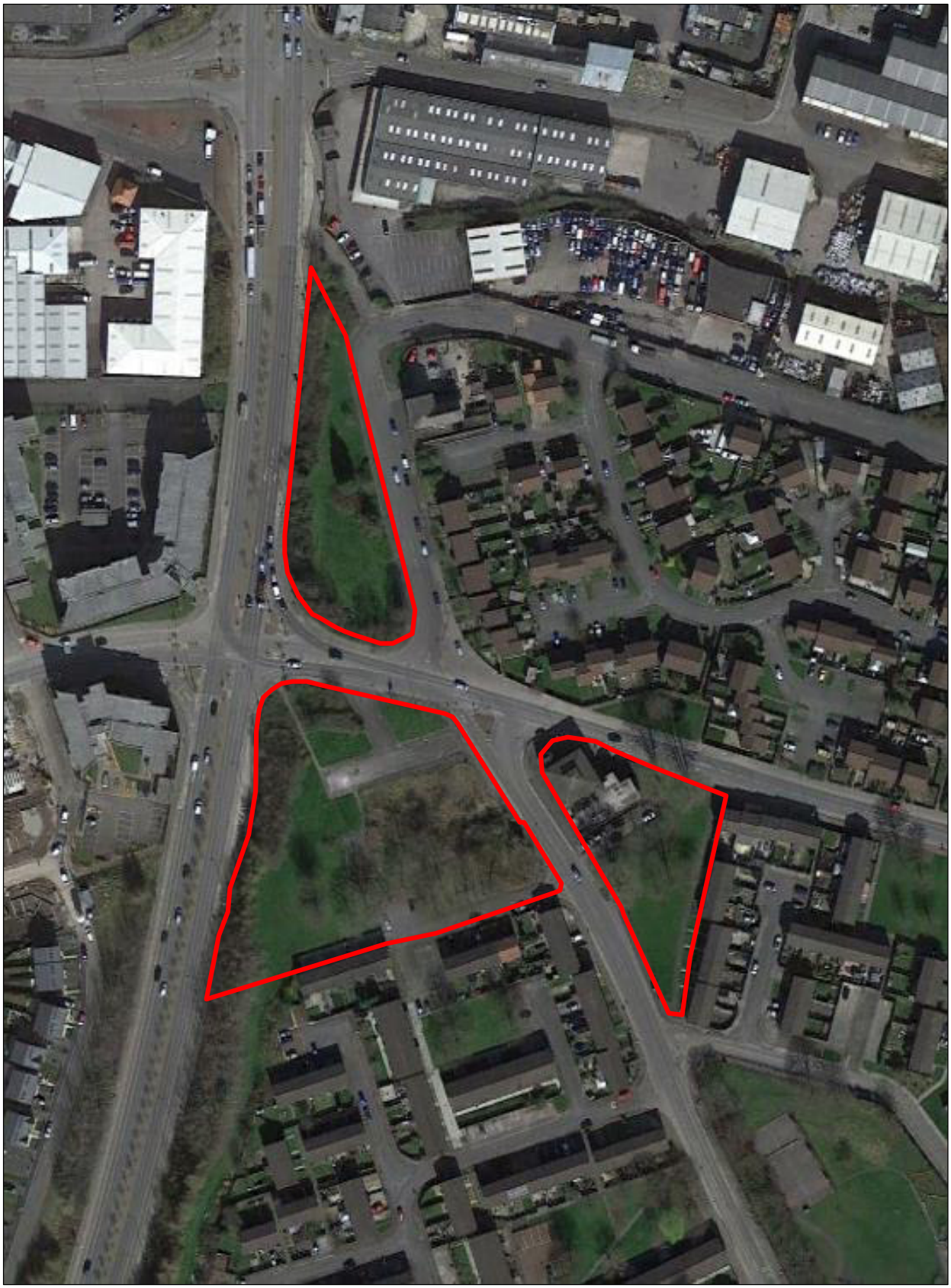
Unit 3, Maple Park
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Hertfordshire. EN11 0EX
Email: info@1stlinedefence.co.uk
Tel: +44 (0)1992 245 020

Client:	**Curtins**	**Approximate site boundary**	N
Project:	**Gorton Lane, Manchester**		
Ref:	**DA6611-00**	Source: Google Maps	

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Recent Aerial Photography

Annex: **B**



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Project: **Gorton Lane, Manchester**

Ref: **DA6611-00**

Source: Google Earth ™ Mapping Services

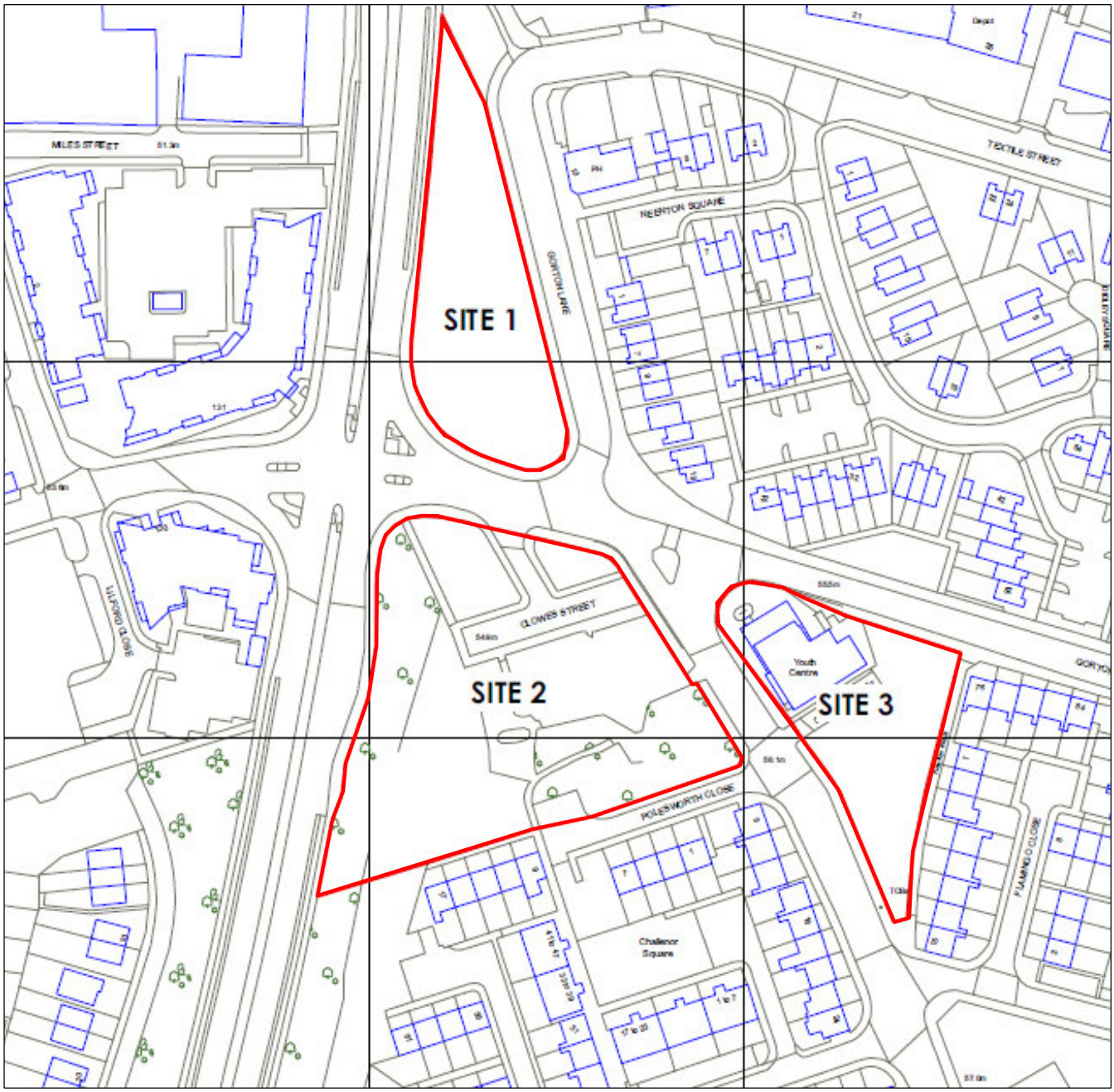
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Client Provided Site Plan

Annex: **C**



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Client: **Curtins**

Approximate site boundary

N

Project: **Gorton Lane, Manchester**

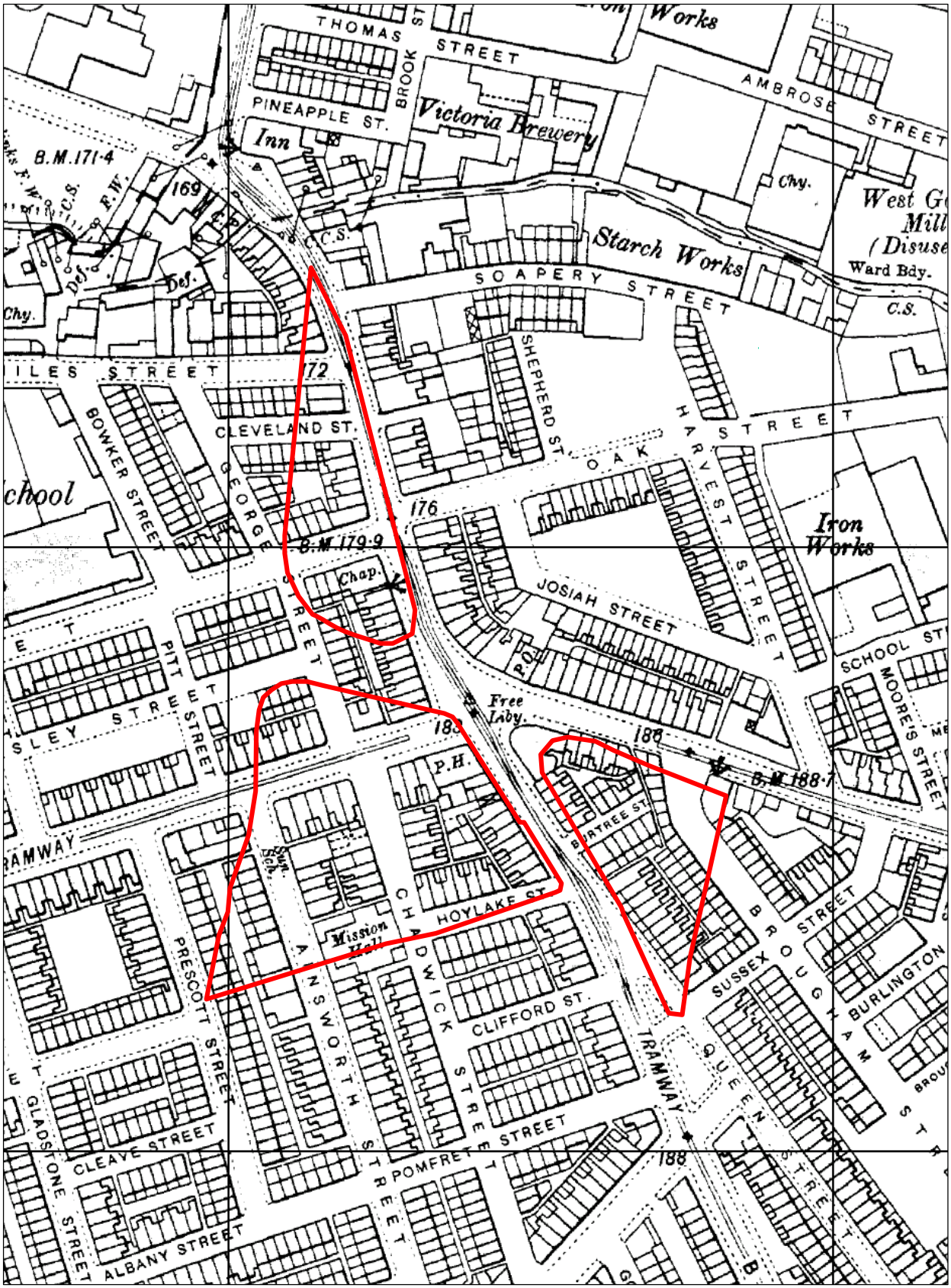
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1908 Historical Map

Annex: D1



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Project: **Gorton Lane, Manchester**

Ref: **DA6611-00**

Source: Landmark Maps

Approximate site boundary

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1932-1933 Historical Map

Annex: D2



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Project: **Gorton Lane, Manchester**

Ref: **DA6611-00**

Source: Landmark Maps

Approximate site boundary

N

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1948-1950 Historical Map

Annex: **D3**



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Client: **Curtins**

Approximate site boundary

N

Project: **Gorton Lane, Manchester**

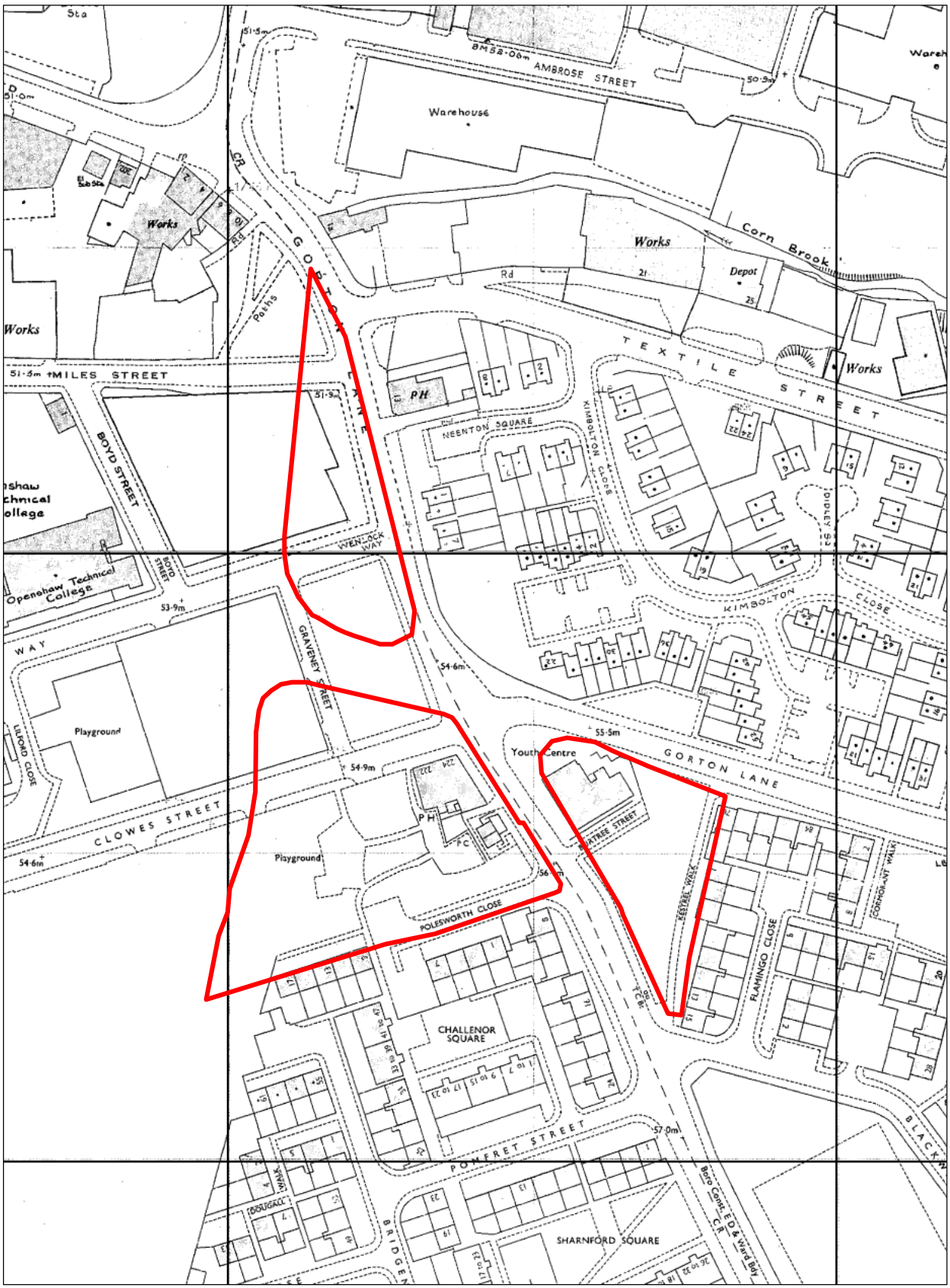
Ref: **DA6611-00**

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1984-1991 Historical Map

Annex: D4



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Project: **Gorton Lane, Manchester**

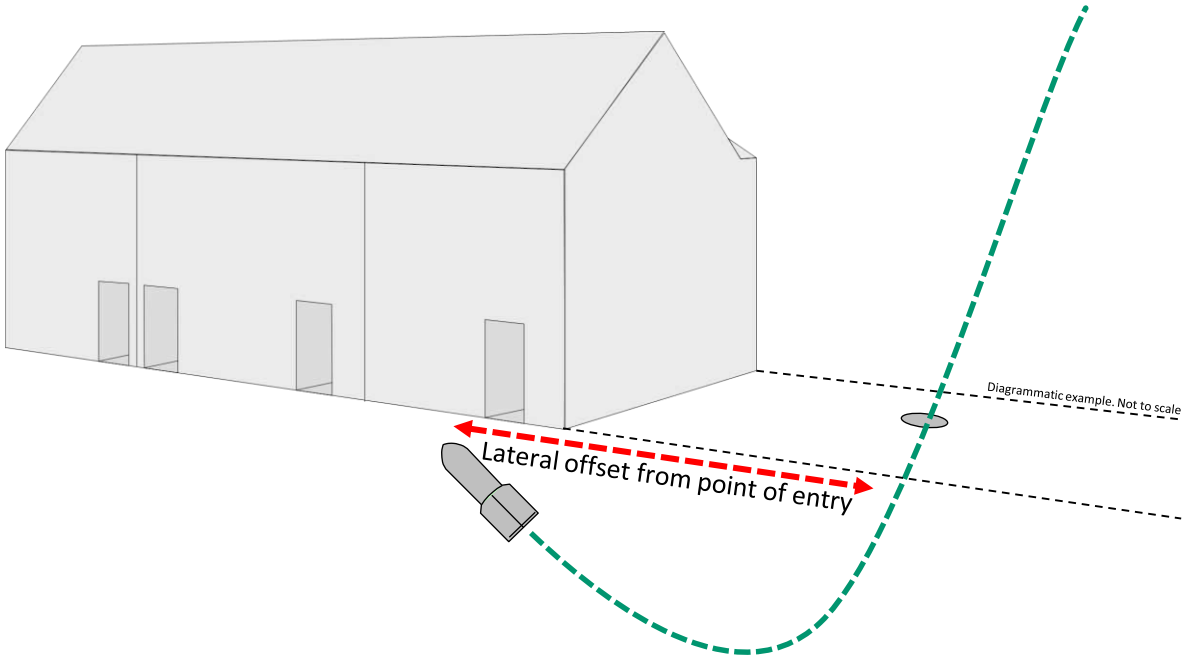
Ref: **DA6611-00**

Source: Landmark Maps

Approximate site boundary

N

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Top: J-curve Effect - Due to angle of entry, unexploded bombs would often end their trajectory at a lateral offset from point of entry, often ending up beneath adjacent extant structures/sites.

One of the most common scenarios for the above occurring was where a UXB fell into a ‘bomb site’ (such as the area shown **Top Left**), the entry hole of the bomb obscured by debris and rubble present. Note that the entry hole of a 50kg UXB could be as little as 20cm in diameter (**Left**).

Photograph **above** shows 250kg bomb found in Bermondsey pointing upwards, demonstrating ‘J-curve’

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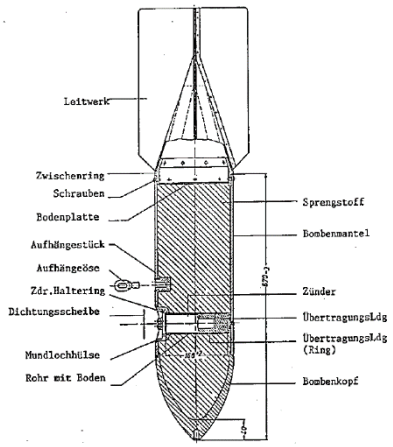
Source: Various sources

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Examples of German Air-Delivered Ordnance

SC 50kg High Explosive Bomb

Bomb Weight	40-54kg (88-119lb)
Explosive Weight	c25kg (55lb)
Fuze Type	Impact fuze/electro-mechanical time delay fuze
Bomb Dimensions	1,090 x 280mm (42.9 x 11.0in)
Body Diameter	200mm (7.87in)
Use	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.

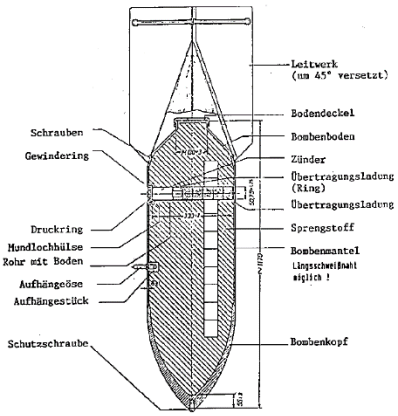






SC 250kg High Explosive Bomb

Bomb Weight	245-256kg (540-564lb)
Explosive Weight	125-130kg (276-287lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1640 x 512mm (64.57 x 20.16in)
Body Diameter	368mm (14.5in)
Use	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.
Remarks	It could be carried by almost all German bomber aircraft, and was used to notable effect by the Junkers Ju-87 Stuka (Sturzkampfflugzeug or dive-bomber).



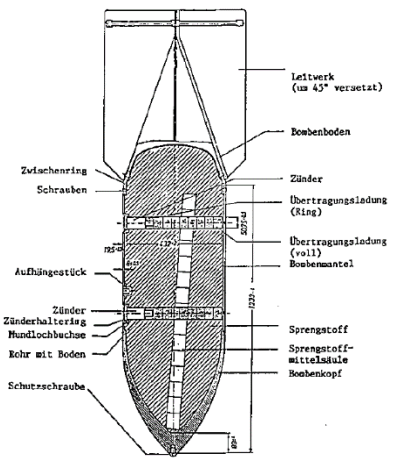


SC250 bomb being loaded onto German bomber

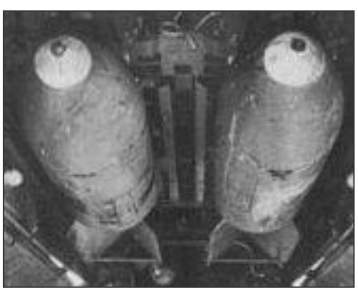


SC 500kg High Explosive Bomb

Bomb Weight	480-520kg (1,058-1,146lb)
Explosive Weight	250-260kg (551-573lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1957 x 640mm (77 x 25.2in)
Body Diameter	470mm (18.5in)
Use	Against fixed airfield installations, hangars, assembly halls, flyovers, underpasses, high-rise buildings and below-ground installations.
Remarks	40/60 or 50/50 Amatol TNT, trialene. Bombs recovered with Trialen filling have cylindrical paper wrapped pellets 1-15/16 in. in length and diameter forming







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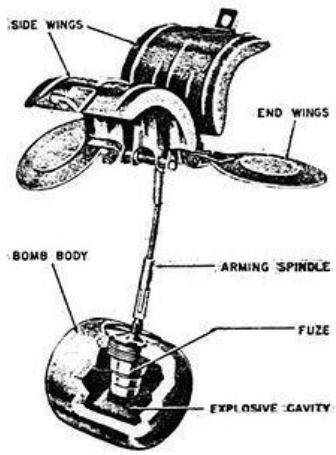
Source: Various sources

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Examples of German Air-Delivered Ordnance

SD2 Anti-Personnel 'Butterfly Bomb'

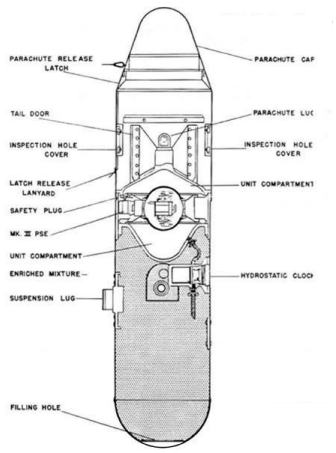
Bomb Weight	2kg (4.41lb)
Explosive Weight	7.5oz (225 grams) of Amatol surrounded by a layer of bituminous composition.
Fuze Type	41 fuze (time) , 67 fuze (clockwork time delay) or 70 fuze (anti-handling device)
Body Diameter	3in (7.62 cm) diameter, 3.1in (7.874) long
Use	Designed as an anti-personnel/ fragmentation weapon. They were delivered by air, being dropped in containers of 23-144 sub-munitions that opened at a predetermined height, thus scattering the bombs.
Remarks	Very rare. First used against Ipswich in 1940, but were also dropped on Kingston upon Hull, Grimsby and Cleethorpes in June 1943, amongst various other targets in UK. As the bombs fell the outer case flicked open by springs which caused four light metal drogues with a protruding 5 inch steel cable to deploy in the form of a parachute & wind vane which armed the device as it span.

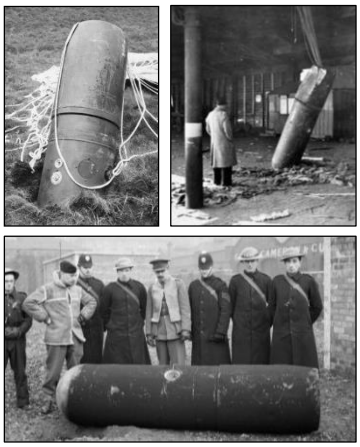




Parachute Mine (Luftmine B / LMB)

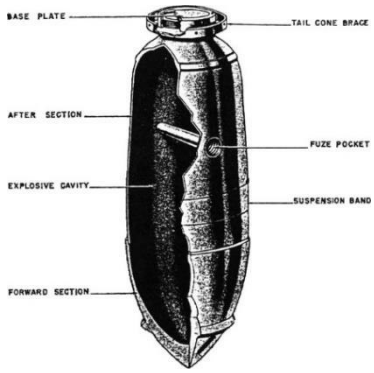
Bomb Weight	Approx. 990kg (2176lb)
Explosive Weight	Approx. 705kg (1,554lb)
Fuze Type	Impact/ Time delay / hydrostatic pressure fuze
Dimensions	2.64m x 0.64m (3.04m with parachute housing)
Use	Against civilian, military and industrial targets. Used as blast bombs and designed to detonate above ground level to maximise damage to a wider area.
Remarks	Deployed a parachute when dropped in order to control its descent. Had the potential to destroy a whole street of housing in a 100m radius.





SC 1000kg

Bomb Weight	993-1027kg (2,189-2,264lb)
Explosive Weight	530-620kg (1168-1367lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Filling	Mixture of 40% amatol and 60% TNT, but when used as an anti-shipping bomb it was filled with Trialen 105, a mixture of 15% RDX, 70% TNT and 15% aluminium powder.
Bomb Dimensions	2800 x 654mm (110 x 25.8in)
Body Diameter	654mm (18.5in)
Use	SC type bombs are General Purpose Bombs used primarily for general demolition work. Constructed of parallel walls with comparatively heavy noses. They are usually of three piece welded construction





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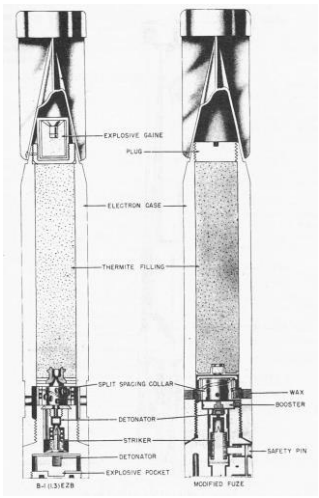
Source: Various sources

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German Incendiary Bombs

1kg Incendiary Bomb

Bomb Weight	1.0 and 1.3kg (2.2 and 2.9lb)
Explosive Weight	680g (1.3lb) Thermite 8-15gm Explosive Nitropenta
Fuze Type	Impact fuze
Bomb Dimensions	350 x 50mm (13.8 x 1.97in)
Body Diameter	50mm (1.97in)
Use	As incendiary – dropped in clusters against towns and industrial complexes
Remarks	Magnesium alloy case. Sometimes fitted with high explosive charge. The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze.

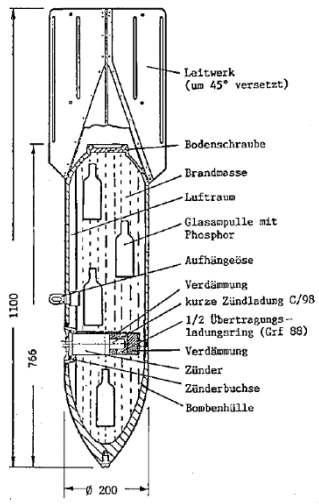


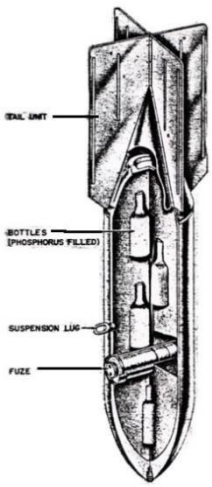




C50 A Incendiary Bomb

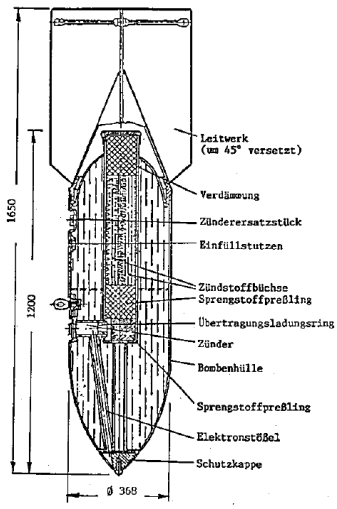
Bomb Weight	c41kg (90.4lb)
Explosive Weight	0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzine 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against all targets where an incendiary effect is required
Remarks	Early fill was a phosphorous/carbon disulphide incendiary mixture





Flam C-250 Oil Bomb

Bomb Weight	125kg (276lb)
Explosive Weight	1kg (2.2lb)
Fuze Type	Super-fast electrical impact fuze
Filling	Mixture of 30% petrol and 70% crude oil
Bomb Dimensions	1,650 x 512.2mm (65 x 20.2in)
Body Diameter	368mm (14.5in)
Use	Often used for surprise attacks on ground troops, against troop barracks and industrial installations. Thin casing – not designed for ground penetration





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Bermondsey bomb: World War Two device safely removed

24 March 2015 London Share



The bomb measured about 5ft (1.5m) in length

An unexploded World War Two bomb found in south London has been driven away safely under police and Army escort.

The 500lb (250kg) device was found on a building site in Grange Walk, Bermondsey on Monday.

250kg HE bomb found in Bermondsey March 2015

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Bethnal Green WW2 bomb: Experts remove unexploded device

11 August 2015 London Share



The MoD said the German WW2 air delivered bomb could have caused "mass destruction" if it had detonated

An unexploded World War Two bomb that prompted the evacuation of 700 people in east London has been made safe and removed by the military.

Families spent the night in a school hall after the 500lb bomb was found in the basement of a building site on Temple Street, in Bethnal Green, on Monday afternoon.

250kg HE bomb found in Bethnal Green, Aug 2016

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Bath WW2 bomb scare: Device defused, police say

13 May 2016 Somerset Share



The bomb was found on the site of a former school on Thursday

A 500lb World War Two bomb found on the site of a former school in Bath has been defused and made safe.

250kg HE bomb found in Bath, May 2016

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England Regions London

Wembley WW2 live bomb posed 'risk to life'

22 May 2015 London Share



A blast wall was put up around the bomb to minimise damage if it exploded

An unexploded World War Two bomb uncovered by builders near Wembley Stadium posed "a genuine risk to life", the Army has said.

50kg HE bomb found in Wembley, May 2015

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Ref: **DA6611-00** Source: BBC News

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Examples of Unexpected Detonation of WWII Bombs

BASF has confirmed that an explosive device, most likely a World War II-era bomb, caused the blast that left one person injured Tuesday at a plant construction site in Germany.

The explosion was reported at BASF's Ludwigshafen toluene diisocyanate (TDI) plant, which recently broke ground for a 300,000 metric tons per year TDI production plant and other construction to expand its facilities.



1st March 2013

BASF is expanding their its Ludwigshafen location by expanding several plants and building a TDI plant, which was the site of an explosion on Tuesday (Feb. 26). One person was injured in the blast, which BASF believes was caused when excavation work detonated a bomb.

Early reports had speculated that excavation work had detonated a bomb from World War II. While the age of the bomb has not been confirmed, BASF has said that an explosive device was detonated.

BASF Provides Some Details

Responding to a request from *PaintSquare News* for more information on Wednesday (Feb. 27), BASF's manager of media relations and corporate communications Europe, Ursula von Stetten, wrote in an email, "So here [are] the facts: The detonation took place at 10:00 a.m. One person was injured; the injury is not serious. He will be kept in the hospital for some days.

"Cause of the detonation was an explosive device, presumably a bomb deriving from the Second World War. The device detonated when grounding work was done. No details on [a] delay [are] available. At the moment, the exact circumstances of the incident are [being] evaluated."

World War II Bomb Explodes on German Motorway

A highway construction worker in Germany accidentally struck an unexploded World War II bomb, causing an explosion which killed him and wrecked several passing cars.

Tweet 0 Recommend 1



23rd October 2006

AP

A cutting machine lies wrecked by the side of the A3 motorway next to a small crater left by the explosion.

A World War II bomb has exploded during construction work on a German highway, killing one worker and injuring several motorists who were driving past, police said.

The worker had been cutting through the road surface near the south-western town of Aschaffenburg when his machine struck the bomb and triggered it. Police said they weren't sure yet what type of bomb it was. "The explosion seems to have been too small for it to have been an aircraft bomb," a police spokesman said.

The A3 Autobahn linking the cities of Frankfurt and Würzburg has been blocked in both directions.

More than 60 years since the end of World War II, construction workers still frequently unearth unexploded bombs and it is not uncommon for whole city districts to be cordoned off and even evacuated while bomb disposal experts defuse them.

Indeed, just last week, some 22,000 people were evacuated from their homes in Hanover when three World War II bombs were discovered.

Allied pilots rained nearly 2 million tons of explosives on Germany during the war. Landmines, hand grenades, mortar bombs and anti-tank devices from the fighting on German soil at the end of the war are also found, and authorities say it will take decades before the country is cleared of duds.

Between 400 and 600 bombs are discovered a year in the state of North Rhine-Westphalia alone, where the heavily industrialized Ruhr region was a major target for Allied bombers.



19th September 2013

WWII bomb injures 17 at Hattingen construction site

Published: 19 Sep 08 16:53 CET

Share +1 0 Tweet 0

Seventeen people were injured on Friday when a construction crew unwittingly detonated a buried World War II-era bomb in Hattingen.

- Liberals grit teeth ahead of May state election (17 Mar 12)
- Nazi death camp guard Demjanjuk dies (17 Mar 12)
- Stupid stunt causes bomb scare chaos (16 Mar 12)

An excavator apparently drove over a 250-kilogramme (550 pound) American bomb, damaging surrounding buildings. Most of the injured suffered auditory trauma from the blast, and the excavator operator suffered injuries to his hands, police in the German state of North Rhine-Westphalia said.

"The hole was astoundingly small for such a large bomb full of so many explosives," Armin Gebhard, head of the Arnsberg department for military ordnance removal, told The Local. "But of course it damaged all the surrounding buildings too. We are really happy it wasn't worse."

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2 June 2010 Last updated at 15:37

Share

World War II bomb kills three in Germany

Three people have been killed and six injured trying to defuse a World War II bomb in central Germany.

Workers building a sports stadium had earlier unearthed the bomb in the town of Goettingen.

It was not immediately clear why the bomb, reportedly weighing 500kg (1,100lb), had detonated.

Unexploded WWII bombs dropped by Allied planes are frequently found in Germany, though it is unusual for them to explode unexpectedly.

A special commission is investigating the causes of the explosion, while prosecutors are considering whether the team leader should face charges of manslaughter through culpable negligence, the BBC's Oana Lungescu reports from Berlin.

The blast happened an hour before the defusing operation was due to start.

Officials said the three men who died were experienced sappers, or combat engineers, who over 20 years had defused up to 700 bombs.

More than 7,000 people were immediately evacuated when the 500kg bomb was found. Several schools, a kindergarten and local companies remain closed.



2nd June 2010

AFP

All the victims were involved in an operation to defuse the bomb



June 2006

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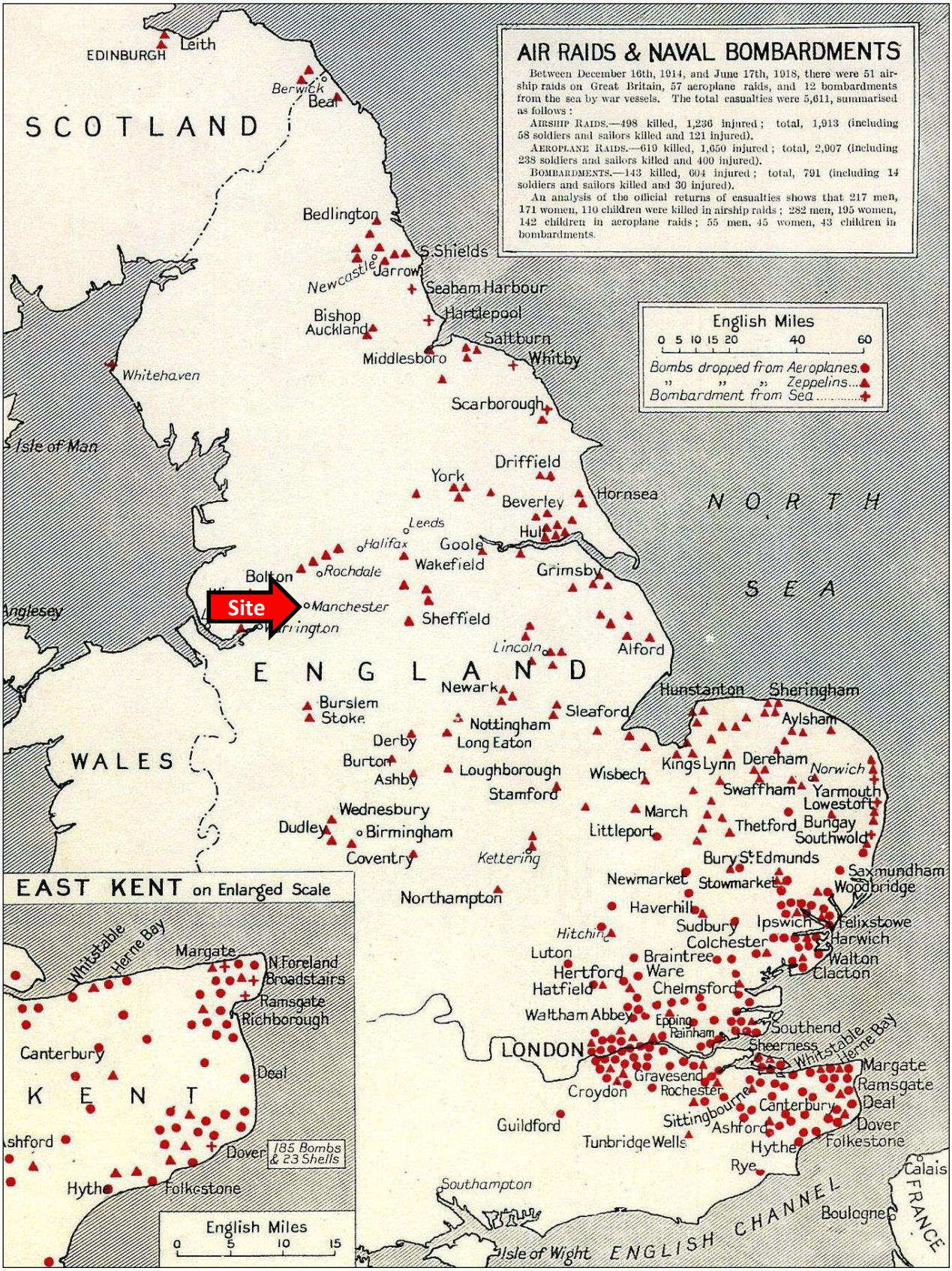
Ref: **DA6611-00**

Source: Various news sources

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WWI Map of Air Raids and Naval Bombardments

Annex: H



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Source: J. Morris, *German Air Raids on Britain*

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Luftwaffe Photograph - 1940



Clayton – East Manchester

Pictured: Gas works. The site is located approximately 2.2km to the south-west of this photograph.

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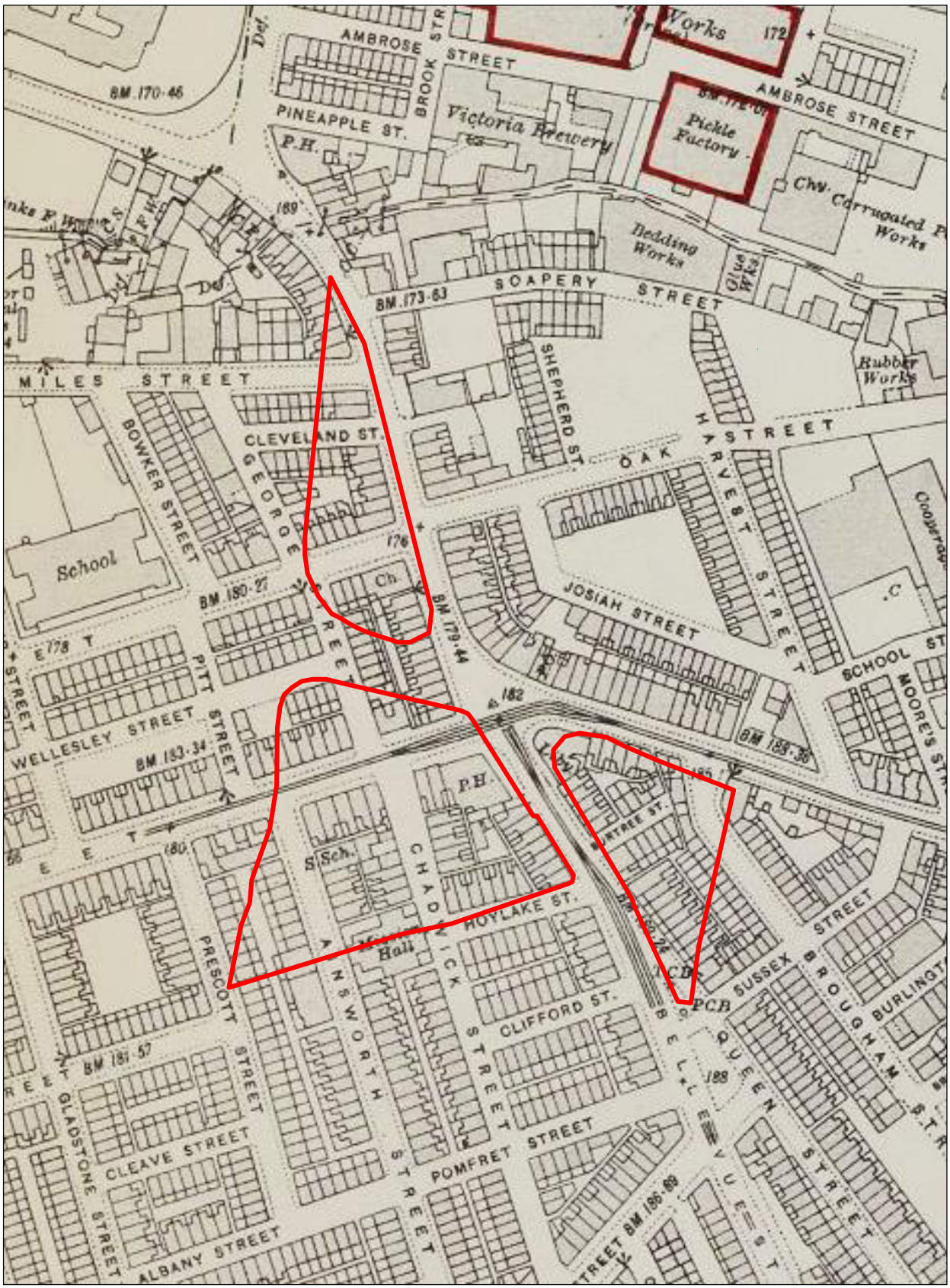
Ref: **DA6611-00**

Source: Nigel J. Clarke, "Adolf Hitler's British Holiday Snaps"

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Manchester Bomb/Damage Map 1940-1941

Annex: J



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Source: http://enriqueta.man.ac.uk

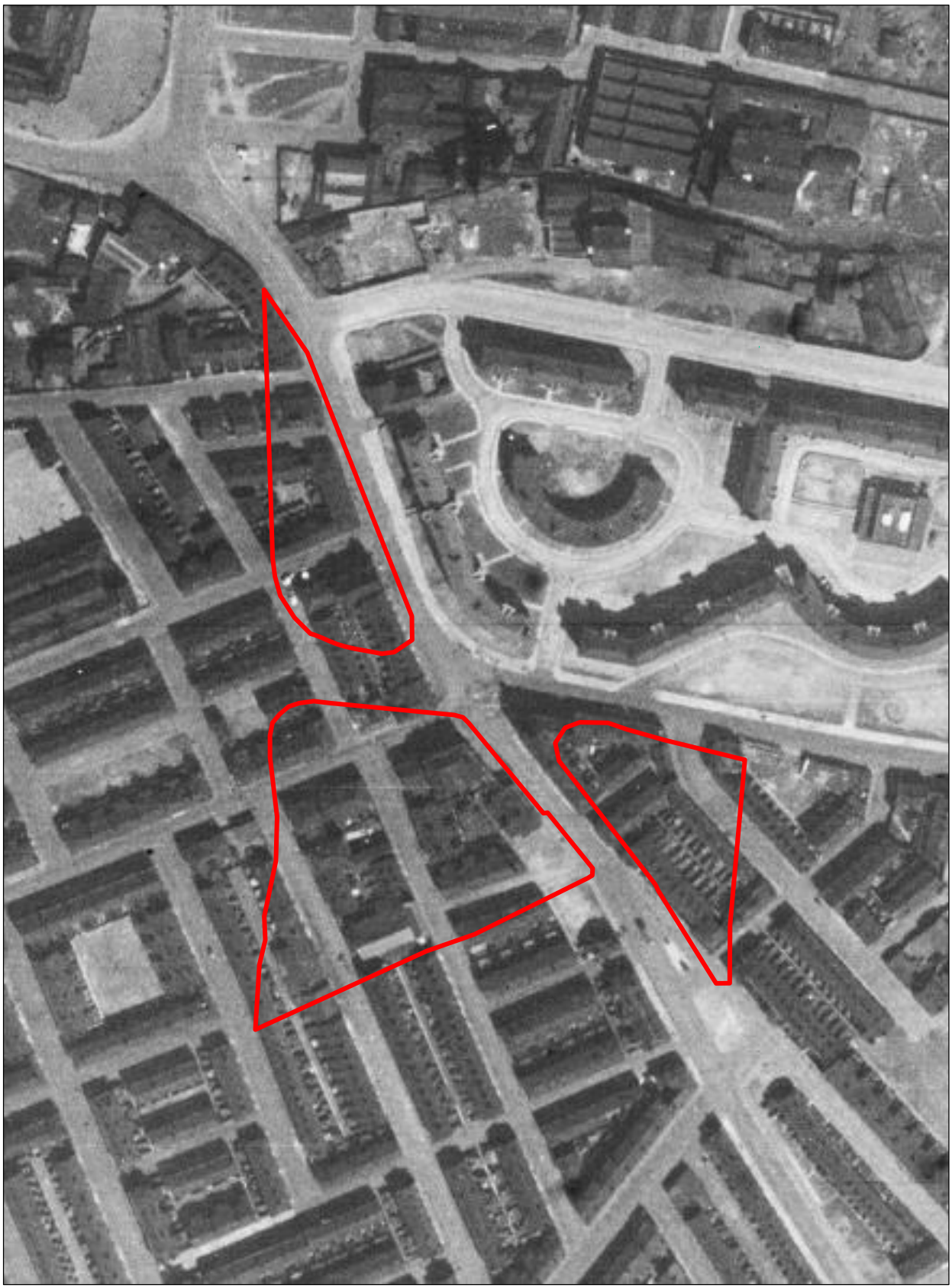
Approximate site boundary

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1948 Aerial Photography

Annex: **K1**



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Source: Landmark Maps

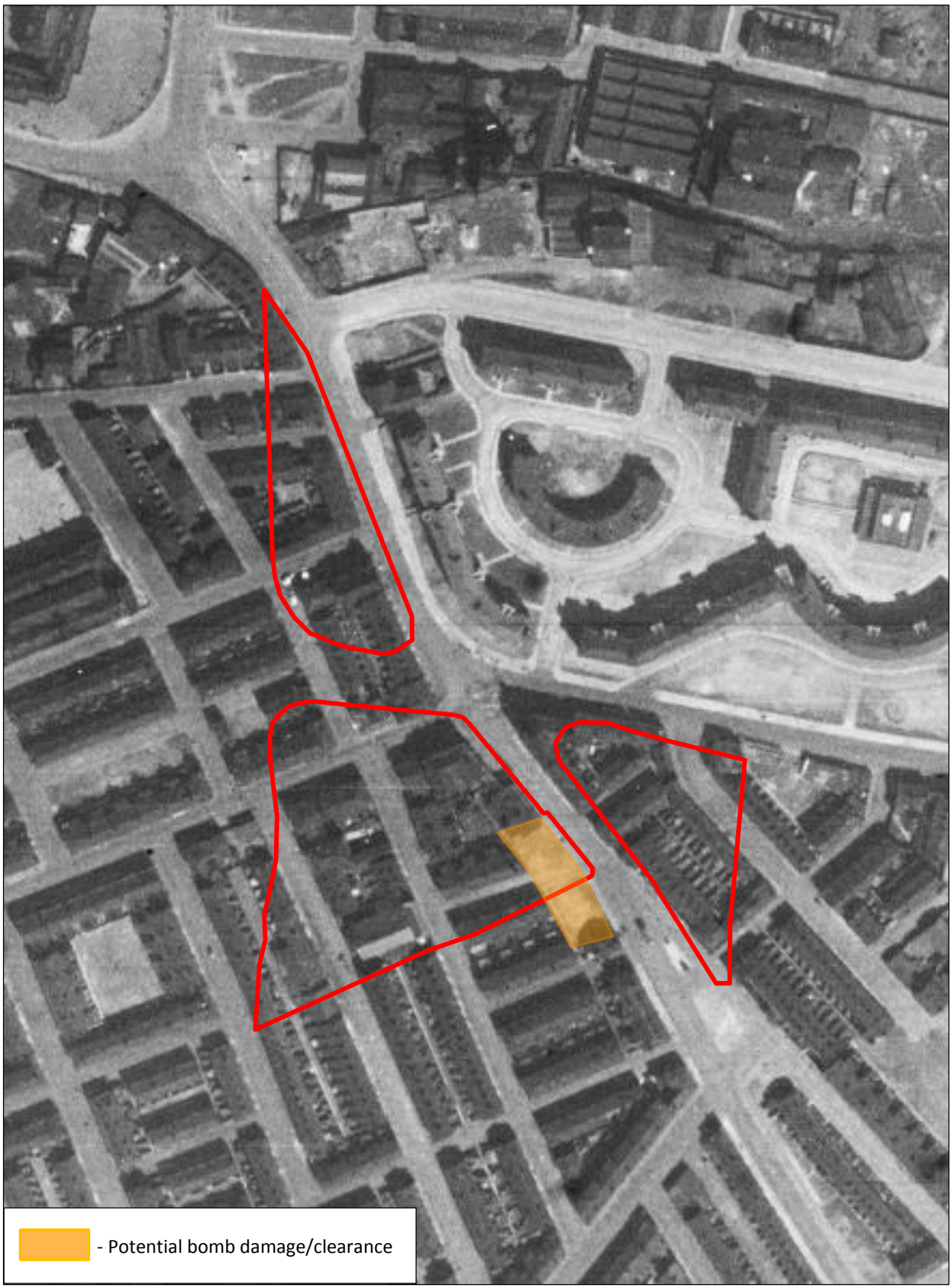
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1948 Aerial Photography

Annex: **K2**



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Source: Landmark Maps

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Examples of Anti-Aircraft Projectiles

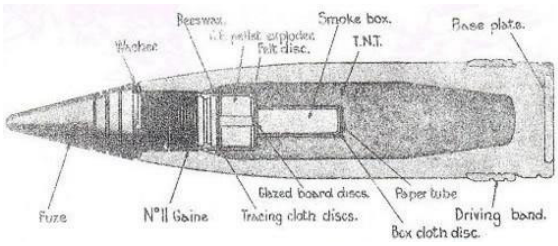
Annex: L

3.7 Inch QF Anti-Aircraft Projectile

Projectile Weight	28lb (12.6 kg)
Explosive Weight	2.52lbs
Fuze Type	Mechanical Time Fuze
Dimensions	3.7in x 14.7in (94mm x 360mm)
Rate of Fire	10 to 20 rounds per minute
Use	The 3.7in AA Mks 1-3 were the standard Heavy Anti-Aircraft guns of the British Army.
Ceiling	30,000ft to 59,000ft





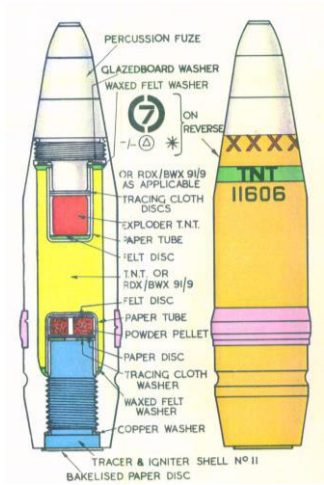


40mm Bofors Projectile

Projectile Weight	1.96lb (0.86kg)
Explosive Weight	300g (0.6lb)
Fuze Type	Impact Fuze
Rate of Fire	120 rounds per minute
Projectile Dimensions	40 x 180mm
Ceiling	23,000ft (7000m)
Remarks	Light quick fire high explosive anti-aircraft projectile. Each projectile fitted with small tracer element. If no target hit, shell would explode when tracer burnt out. Designed to engage aircraft flying below 2,000ft



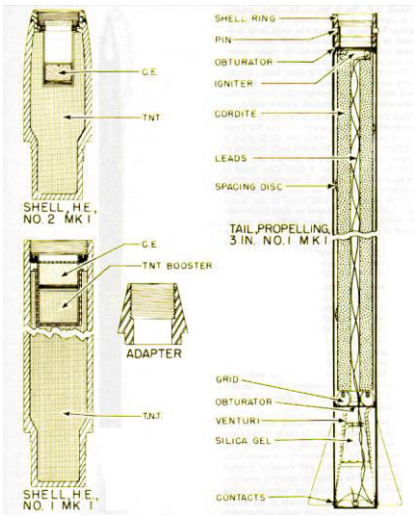




3in Unrotated Projectile (UP) Anti-Aircraft Rocket ("Z" Battery)

HE Projectile Weight	3.4kg (7.6lb)
Explosive Weight	0.96kg (2.13lb)
Filling	High Explosive – TNT. Fitted with aerial burst fuzing
Dimensions of projectile	236 x 83mm (9.29 x 3.25in)
Remarks	As a short range rocket-firing anti-aircraft weapon developed for the Royal Navy. It was used extensively by British ships during the early days of World War II. The UP was also used in ground-based single and 128-round launchers known as Z Batteries. Shell consists of a steel cylinder reduced in diameter at the base and threaded externally to screw into the shell ring of the rocket motor





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Client: **Curtins**

Project: **Gorton Lane, Manchester**

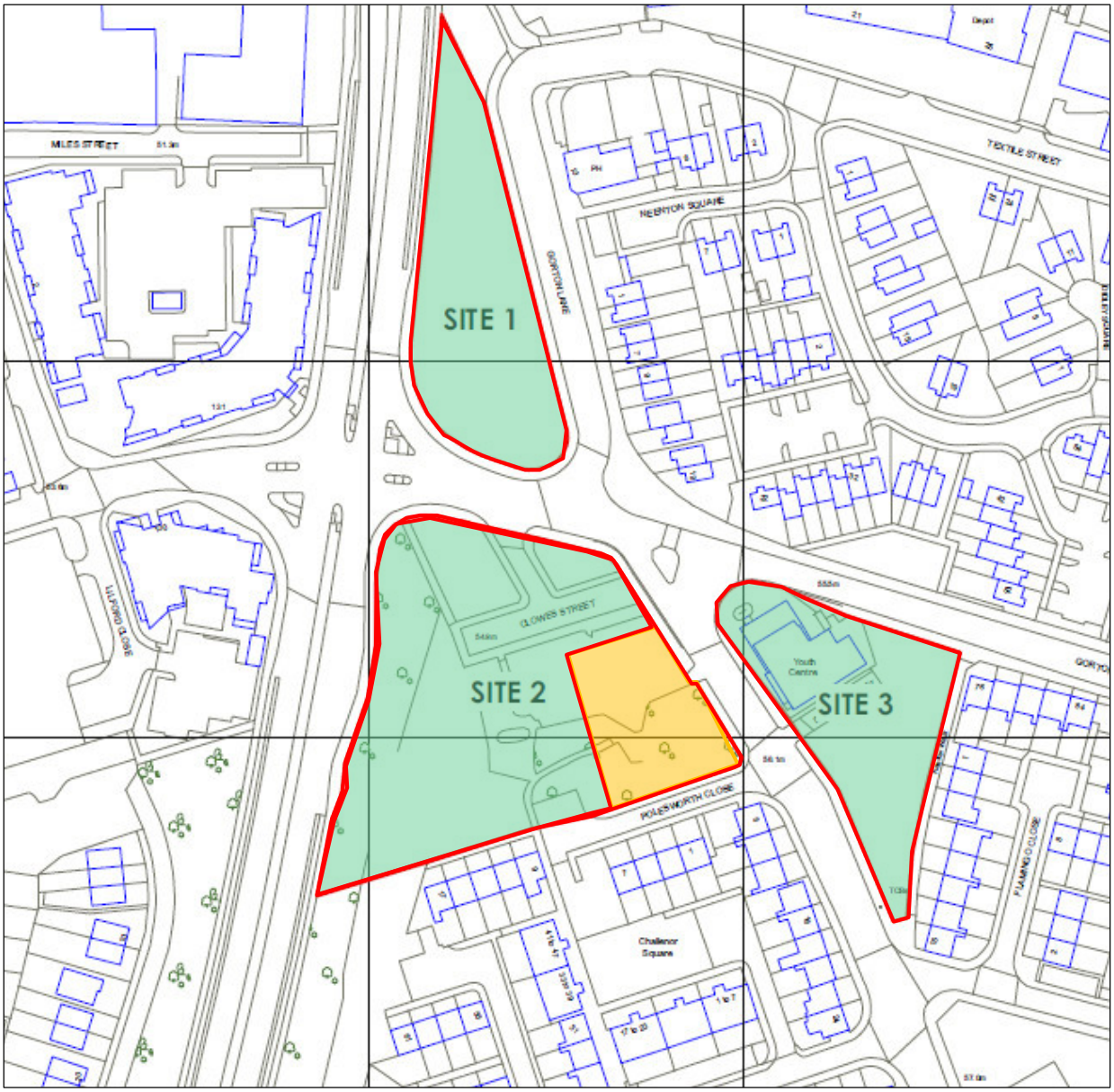
Ref: **DA6611-00**

Source: Various sources

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Risk Map – Site Plan Overlay

Annex: **M**



Low Risk

Medium Risk

All Risk Areas:

- Site Specific Unexploded Ordnance Awareness Briefings to all personnel conducting intrusive works

Medium Risk Area:

- Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works
- Intrusive Magnetometer Survey of all Borehole and pile locations down to a maximum bomb penetration depth

For indicative purposes – not to scale

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Approximate site boundary

N

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