Phase I Geoenvironmental Site Assessment
Ryebank Road
Manchester,
Chorlton
Reference:13-533-R1-2
Date: March 2020

PHASE I GEOENVIRONMENTAL SITE ASSESSMENT

Ryebank Road,
Manchester,
Chorlton
M21 9LU

Prepared for:

Manchester Metropolitan University

Report Ref: 13-533-R1-2
Date Issued: 30/03/2020

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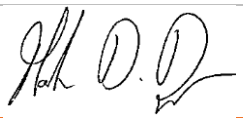
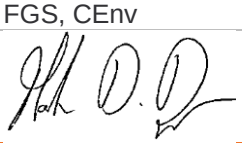
SIGNATURE			

EXECUTIVE SUMMARY

Site Address	Land north of Ryebank Road / Longford Road, Chorlton, Manchester, M21 9LU	
Grid Reference	E 381090, N 394580	
Site Area	4.60 Ha	
Current Site Use	The subject site is an irregular shaped parcel of land located to the north of Ryebank Road / Longford Road in Chorlton referred to as Ryebank Fields. The site is vacant and predominantly used by walkers. The site is surfaced by overgrown grasses and semi mature and mature trees, which are notably dense around the perimeter of the site. The Nico ditch is known to intersect the centre of the site which is a linear earthwork stretching across Manchester (9.7 km) and is of archeological importance. There are no structures present on site, however an area of hardstanding is present to the south east of the site. A bund surfaced by grass is located adjacent to the area of hard standing in the south east of the site. A number of pedestrian paths intersect the site. The site is predominantly flat in topography but gradually falls from south to north.	
Proposed Development	E3P understands that Manchester Metropolitan University (MMU) are considering the proposed divestment of their asset at Ryebank Fields, Chorlton which is deemed to be surplus to requirement. As part of the divestment a Development Framework was approved by Manchester City Council in June 2019 that promotes a high-quality residential development across the site with associated gardens, estate roads and infrastructure. The Development Framework contains the proposed development layout for the site.	
Environmental Setting	**Drift Geology**	Glaciofluvial Sheet Deposits (North West)- SAND and GRAVEL Glacial Till (Majority of site) - SAND, GRAVEL and CLAY)
	Bedrock Geology	Wilmslow SANDSTONE Formation - SANDSTONE
	Hydrogeology	The site is predominantly underlain by a Secondary Undifferentiated aquifer with Secondary A Aquifer in the north west of the site within the drift geology, overlying a Principal aquifer (bedrock geology). There are three groundwater abstraction points situated within 1 km of the site which are operated by Trafford Metal Finishers Manchester Ltd utilised as process water. The three abstraction licenses relate to these boreholes.
	Hydrology	The Nico Ditch (referred to as a drain) is intersecting the centre of the site however it is noted to be dry. A drain is located 156 m west of the site. Moreover, United Utilities have indicated that the route of the Thirlmere Aqueduct runs across the northern boundary of the site. Longford Brook (culverted) is located circa 210 m west of the site. Longford Brook historically flowed through the site, however has since been diverted.

	Flood Risk	The site is situated in a Flood Risk Zone 1; defined as land assessed as having less than 1 in 1,000 annual probability of river or sea flooding (< 0.1%).
	Ecology	The surrounding trees and hedges may be a potential habit for wildlife. A Preliminary Ecological Appraisal has been completed by Ascerta (Report Ref: *P.1254.19B)* and should be read in conjunction with this report.
	Subsidence Hazards	No hazard identified in data searches with the exception of a moderate risk of compressible ground.
Site History	Historical mapping suggests that the site was undeveloped agricultural land with Longford Brook traversing the site west to east. In the late 1800's a pond was present in the centre of the site with a small structure in the south-western corner. In the early 1900's residential properties were present in the south-east of the site; furthermore, a brick works is present along the eastern boundary of the site. Mapping from 1930-1938 identifies a Clay Pit and two ponds in the north of the site, with embankments present across the entire site likely to be indicative of areas of excavation. Mapping from 1950 show all previous features to no longer be present, with a drain traversing the site west to east. An unspecified building was present in the west of the site from mapping dated 1971-1981 and was demolished at some point between 2003 and 2005.	
Utility Locations	A full GPR survey has not been completed however a review of online service records has identified an intermediate pressure gas main to dissect the site north to south, with a low pressure gas main present in the south-west of the site. BT and electricity service infrastructure are present in the south-western corner of the site. United Utilities have noted the presence of a surface water sewer in the south of the site with an overflow sewer within the north of the site. Adjacent to the northern boundary are 3 trunk mains one of which is named the Thirlmere Aqueduct, an LDTM Treated Water Trunk Main.	
Landfill Sites and Ground Gases	There are no current or historical landfill sites within 250 m of the subject site. However, mapping circa 1908 and 1989 indicates that the site has been subject to historical infilling (pits, quarries, pond, marsh, river, streams). In particular historical mapping shows significant topographical changes, steep slopes, infilled clay pits and ponds within the site boundary. There are also ten locations of potentially infilled land within 250 m of the site from historical mapping dating 1848 to 1955 with an unknown input type including two on-site from 1989 mapping.	
Invasive Plant Species	No invasive plant species were identified during the site walkover; however, some areas of the site were inaccessible due to dense woodland and therefore their presence cannot be ruled out at this time.	
Radon	Unaffected – No special precautions required.	
Coal Mining/Land Stability	The site is not located in a coal mining affected area.	

Previous Reports	E3P have been provided with a Geo-Environmental Appraisal prepared by WSP Parsons Brinckerhoff for Manchester Metropolitan University (Report Ref: 70014100, dated 18the September 2015, noted Highly Confidential) along with an Environmental Input (Report Ref: 70014100, dated October 2015, noted Confidential). The pertinent points from these reports are summarised in section 2.4.

GEOTECHNICAL ASSESSMENT

- Extensive depths of Made Ground is anticipated beneath the site associated with the infilling of former clay pits and more recently, the demolition of former buildings. If volatile determinants are identified within the Made Ground they will require removal from site. Likely elevated levels of heavy metals and PAHs can be mitigated with the installation of a clean cover system within gardens and landscaped areas.
- Made Ground present beneath the site is likely to be loosely compacted and possibly prone to collapse.
- Footings will require deepening in accordance with NHBC guidance 2016 Chapter 4.2 if the development incorporates any existing and proposed trees within any cohesive drift deposits;
- The underlying superficial geology will likely comprise a cohesive soil matrix and, as such, is not likely to offer the required degree of permeability to make soak-away drainage viable in this instance;
- The site has been determined to be at moderate risk of having compressible soils and this will require further investigation during a ground investigation.

CONTAMINATED LAND RISK ASSESSMENT

Human Health	Based on the information available to review, it is considered that there will be a moderate risk to human health. However, as the site has been subject to infilling and significant historical development, the site is thought to be underlain by significant depths of Made Ground. Made Ground may be potentially impacted with TPHs, heavy metals, PAHs and asbestos. Should these determinants be present it is likely that they can be mitigated through the placement of a 600mm clean cover system to all gardens and landscaped areas. Should any volatile determinants be identified these are likely to require removal during remediation and enabling works in order to determine their retention on site and to not pose a risk to future end users.
Controlled Waters	The site is underlain by a Principal Aquifer and the Nico Ditch (referred to as a drain) is intersecting the centre of the site however it is noted to be dry. A drain is located 156 m west of the site. Longford book (culverted) is located circa 210 m west of the site. There are also three groundwater abstraction points situated within 1 km of the site which may create a potential linkage. Made Ground across the site resulting from historic development and infilling may be a potential source of metals, hydrocarbon compounds, chlorinated solvents and PAHs. The site is anticipated to be underlain by low permeability cohesive drift deposits which will afford protection to the underlying aquifer. The closest surface water feature is not considered to be within influencing distance of the site. A detailed controlled water risk assessment will be required in order to confirm the absence of risk to controlled waters. It is likely that the Environment Agency will be consulted as part of any future planning application for a residential development.

Ground Gas	Significant depths of Made Ground, associated with former infilling and historical development of the site, are anticipated to be underlying the subject site which may be a potential source of ground gas such as methane and carbon dioxide. Hazardous ground gases may pose a low-level risk to construction workers and residential end users. Carbon dioxide and methane can migrate to indoor air spaces through service ducts and collect in deep excavations and have associated asphyxiation and explosive risks, respectively. If a gas risk is identified, then mitigation may be required through the design and installation of appropriate gas protection measures as specified within BS8485 (2015)+A1(2019) Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.

RECOMMENDATIONS

The desk study has not identified any contaminated land or geotechnical issues that cannot be mitigated by sustainable remediation to achieve betterment to the environs, ensure no risk to identified receptors and engineering design.

A detailed Phase II intrusive geoenvironmental ground investigation should be undertaken in order to confirm the findings of the initial conceptual site model and value engineer a development solution.

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1. INTRODUCTION

1.1. BACKGROUND

E3P Ltd has been commissioned by Manchester Metropolitan University to undertake a Phase I Geoenvironmental Site Assessment at land north of Ryebank Road in Chorlton. This report is required to determine potential contaminated land and geotechnical liabilities associated with a proposed future residential development.

1.2. PROPOSED DEVELOPMENT

E3P understands that Manchester Metropolitan University (MMU) are considering the proposed divestment of their asset at Ryebank Fields, Chorlton which is deemed to be surplus to requirement. As part of the divestment a Development Framework was approved by Manchester City Council in June 2019 that promotes a high-quality residential development across the site with associated gardens, estate roads and infrastructure. The Development Framework contains the proposed development layout for the site.

1.3. OBJECTIVES

The objectives of the geoenvironmental investigation are as follows:

- Review historical plans, geology, hydrogeology, site sensitivity, floodplain issues, mining records and any local authority information available in order to complete a desk study in line with Environment Agency (EA) document *Model Procedures for the Management of Contaminated Land (Contaminated Land Report 11 (CLR11)*).
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors.
- Assess the desk-study information and, where possible, provide preliminary recommendations in relation to foundations, pavement construction and floor slabs.
- Provide recommendations regarding future works required and undertake a preliminary pre-construction cost appraisal.

1.4. LIMITATIONS

The limitations of this report are presented in Appendix I.

1.5. SOURCES OF INFORMATION

Background information was sought from the following sources:

- Envirocheck Search (Report Ref EC222286198_1_1);
- Historical mapping dated 1848 to 2019;
- Online planning records held by Manchester City Council;
- Consultations with representatives of Manchester City Council;
- Magic Map Groundwater Vulnerability Map;
- *Radon: Guidance on protective measures for new buildings* (BRE Document BR 211, 2007);
- British Geological Survey Map;
- https://zeticauxo.com/downloads-and-resources/risk-maps/; and
- https://flood-map-for-planning.service.gov.uk.

1.6. CONFIDENTIALITY

E3P has prepared this report solely for the use of the client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed. Should any third party wish to use or rely upon the contents of the report, written approval must be sought from E3P; a charge may be levied against such approval.

2. SITE SETTING

2.1. SITE DETAILS

TABLE 2.1 SITE DETAILS

Site Address	Land north of Ryebank Road / Longford Road, Chorlton, Manchester, M21 9LU
National Grid Reference	E 381090, N 394580
Site Area	4.60 Ha

All acronyms used within this report are defined in the Glossary presented in Appendix II.

A site location plan is presented in Appendix III as Drawing 13-533-001.

2.2. CURRENT SITE USE

E3P has undertaken a site walkover of the entire site and a description of the key findings are summarised in Table 2.2.

TABLE 2.2 SITE DESCRIPTION

Occupancy/Use	The subject site is an irregular shaped parcel of land located to the north of Ryebank Road / Longford Road in Chorlton referred to as Ryebank Fields. The site is vacant and predominantly used by walkers. The site is surfaced by overgrown grasses and semi mature and mature trees, which are notably dense around the perimeter of the site. The Nico ditch is known to intersect the centre of the site which is a linear earthwork stretching across Manchester (9.7 km) and is of archeological importance. The Nico Ditch is noted to be dry and overgrown with scrub vegetation. There are no structures present on site, however an area of hardstanding is present to the south east of the site. A bund surfaced by grass is located adjacent to the area of hard standing in the south east of the site. A number of pedestrian paths intersect the site. The site is predominantly flat in topography but gradually falls from south to north.
Structures	There are no structures present on site, however an area of hardstanding is present to the south east. An electricity substation is present outside but adjacent to the south-western boundary of the site.
Access	The site can be accessed by pedestrians and vehicles from the south of the site off Ryebank Road / Longford Road. Whilst access from the north of the site off Ryebank Road is suitable only for pedestrians, and should not be access via vehicles due to the presence of the Thirlmere aqueduct, which is adjacent the northern boundary of the site, where transport over is restricted.
Slope	The site is predominantly flat in topography but gradually falls from south to north. However, the Nico ditch is present in the centre of the site which causes a depression in the topography in this area. A small bund is located in the south east of the site, adjacent the car park.
Retaining Structures	There are no retaining walls present on site.

Surface Cover (%)	Buildings:	0%
	Hardstand:	5%
	Soft cover:	95%
Vegetation/Ecology	The site is predominantly surfaced by overgrown grasses and semi mature and mature trees, which are dense around the perimeter of the site. Ascerta have completed a Preliminary Ecological Appraisal (Report Ref: *P.1254.19B)* and should be read in conjunction with this report. Dense scrubland is present along the western boundary of the site, and in the centre of the site along the Nico Ditch. Semi-improved neutral grassland is present in the south-western corner of the site. Broadleaved woodland is present along the north western and south eastern boundaries of the site.	
Hazardous Material Storage	No above-ground storage tanks (AST) or underground storage tanks (UST) were observed at the site during the preliminary site walkover.	
Asbestos-Containing Material (ACM)	No evidence of ACM was noted across the site during the site walkover. However, there may be the potential for asbestos to be present within any Made Ground deposits underlying the site given it has been utilised as a landfill historically and the age of former buildings on site.	
Polychlorinated Biphenyls (PCBs)	There is an electric substation present adjacent to south western boundary of the site, however this is understood to be outside of the red line boundary.	
Waste Storage	Potentially hazardous waste streams are unlikely to be generated at the site and none were observed during the preliminary site inspection.	
Drainage	A full GPR survey has not been completed however a review of online service records have identified an intermediate pressure gas main to dissect the site north to south, with a low pressure gas main present in the south-west of the site. BT and electricity service infrastructure is present in the south-western corner of the site. United Utilities have noted the presence of a surface water sewer in the south of the site with an overflow sewer within the north of the site. Adjacent to the northern boundary is the Thirlmere Aqueduct, an LDTM Treated Water Trunk Main.	

2.3. SURROUNDING AREA

The surrounding area land uses are summarised in Table 2.3.

TABLE 2.3 SURROUNDING LAND USES HIST

DIRECTION	LAND USE
North	Residential properties.
East	Residential properties, St. Johns R.C. Primary School and playing fields.
South	Residential properties.
West	Golf Course, playing fields and Longfords Health & Fitness Club.

2.4. PREVIOUS REPORTS

E3P have been provided with a Geo-Environmental Appraisal prepared by WSP Parsons Brinckerhoff for Manchester Metropolitan University (Report Ref: 70014100, dated 18the September 2015, noted Highly Confidential) along with an Environmental Input (Report Ref: 70014100, dated October 2015, noted Confidential). The pertinent points from these reports are summarised below:

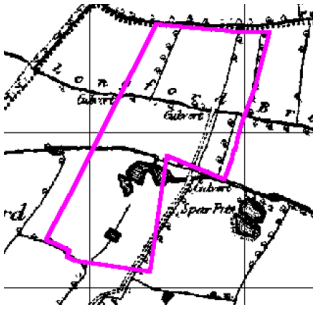
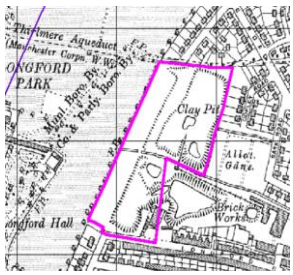
- The topography of the site is generally flat however a ditch runs through the centre of the site noted to be dry and overgrown with scrub with a crossing over the ditch in the centre of the site.
- The Chorlton Ess and Ivy Green Local Nature Reserve (LNR) and the Broad Eees Dole LNR are located within 2km of the site.
- The site largely comprises semi-improved neutral grassland and surrounded by mature and semi-mature trees.
- The underlying bedrock geology of the majority of the site is the Wilmslow Sandstone Formation (Principal Aquifer) with superficial deposits of Glacial Till (Unproductive strata).
- The closest main river known as the culverted Longford Brook flows through Longford Park, approximately 0.2km to the west of the site.
- The site does not lie within or adjacent to an Air Quality Management Area (AQMA).
- Potential geotechnical risks include the presence of Made Ground of potentially variable depth and composition, potential for backfill materials to be unsuitable for use as engineered fill without treatment or ground improvement, significant earthworks required to create a developable platform, and potential for shallow groundwater.
- There is moderate potential for unexploded ordnance to be on site, or for the site to have been used as an anti-aircraft site during WWII.
- There is potential for contamination to be on site associated with the backfill of former clay pits. Organic deposits may be present that could generate a ground gas risk.
- The risk presented by contamination is considered to be low.
- Mitigation measures are likely to be required as part of the proposed development.
- It is recommended an intrusive ground investigation is completed along with a UXO desk study.

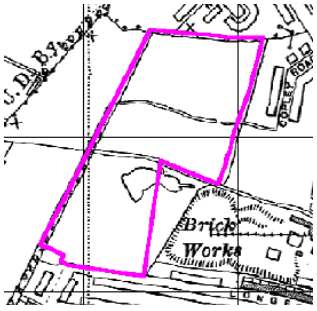
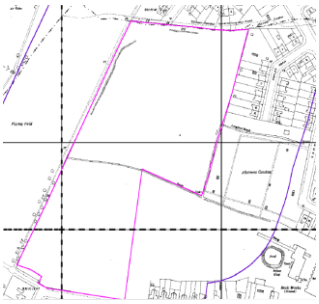
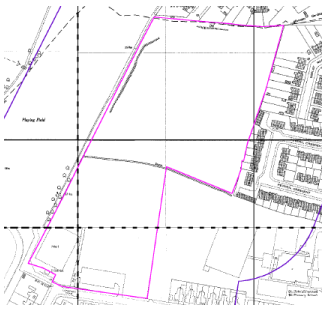
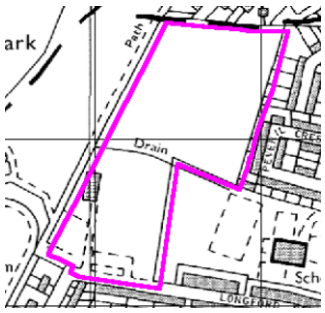
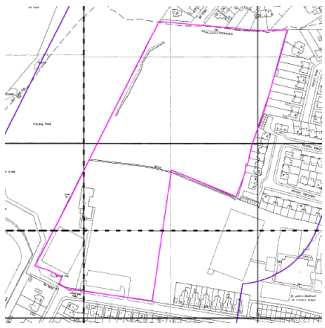
3. SITE HISTORY

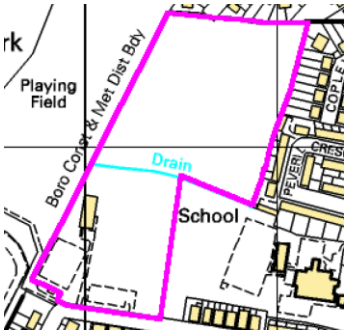
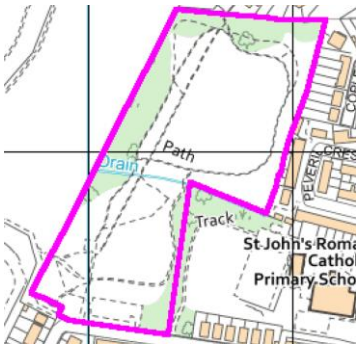
3.1. ON-SITE HISTORICAL DEVELOPMENT

A review of historical mapping pertinent to the site is summarised in Table 3.1. In addition, historical site features are presented on Drawing No 13-533-003 in Appendix III.

TABLE 3.1 SITE HISTORICAL DEVELOPMENT

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1848 1:10,560	The site comprises an undeveloped parcel of land. There is a field boundary/ Nico ditch horizontally intersecting the centre of the site, bordered by several trees. Longford Brook intersects the north of the site. A pond is located in the south-east of the site. an unspecified structure is present in the south of the site.	
1894 1:2,500	There are no significant changes to site. the unspecified structure in the south of the site is no longer present.	
1907 1:2,500	The pond located in the south east of the site has extended. Cardiff Road with several terraced residential houses are present in the south east of the site.	
1932 - 1934 1:10,560	The majority of the site is utilised as a clay pit, with two ponds present in the northern sector of the site, still present within the southern sector of the site.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
1938 1:10,560	The site is no longer utilised as a clay pit, with a pond remaining in the south of the site, and the brooks in the centre and north of the site.	
1951-1955 1:1,250	The pond located in the south east, the Longford Brook intersecting the north and the residential houses encroaching into the south east of the site are no longer present. There are two areas of embankments along the north and north west boundaries. The field boundary/ Nico ditch intersecting the centre of the site is referred to as a drain.	
1955-1980 1:2,500	There are unspecified boundaries in the south of the site; in the south west referred to as *Met*. The boundaries are intersected by a path.	
1980-1984 1:10,000	A building is present along the western boundary of the site.	
1992 1:2500	No significant changes to site. The building in the west appears to have been extended.	

MAP EDITION	HISTORICAL LAND USE	HISTORICAL MAP EXCERPT
2000 1:2,500	A number of mature trees are present along the site boundaries and intersect the centre of the site. The building in the west is still present.	
2006 1:10,000	No significant changes to site.	
2019 1:10,000	The building in the south wets of the site is no longer present. Areas of woodland are present along the boundaries of the site, with a number of paths dissecting across the site.	

3.2. OFF-SITE HISTORICAL DEVELOPMENT

A review of potentially contaminative uses identified on historical Ordnance Survey maps within a 250 m radius of the site is summarised in Table 3.2.

TABLE 3.2 SURROUNDING POTENTIALLY CONTAMINATIVE LAND USES

SURROUNDING FEATURE	DISTANCE	DATES	DIRECTION
Electric Sub Station	2 m	Pre 1978-Present	South West
Pond (x2) …then no longer present and replaced with Brick Works	33 m	Pre 1848 - Pre 1907 Pre 1908 - Present	East
Infilled Ground (Slope) …then no longer present	35 m	Pre 1907-Pre 1951 Pre 1955-Present	South East
Pond (x2) …then no longer present	33-62 m	Pre 1848 - Pre 1923 Pre 1923 - Present	South-East
Pond (x3) …then no longer present	35-139 m	Pre 1848 - Pre 1894 Pre 1894 - Present	West
Brick Works No longer present	100 m	Pre 1907-Pre 1955 Pre 1955-Present	South East
Reservoir Replaced by Glazed Roof Building	104 m	Pre 1907- Pre 1955 Pre 1955- Present	West
Pond and Refuse Heap No longer present	110 m	Pre 1951-Pre 1980 Pre 1980-Present	South East
Brick Works (Disused) …then no longer present	147 m	Pre 1951 - Pre 1980 Pre1980 - Present	South East
Tank No longer present	180 m	Pre 1951-Pre 1980 Pre 1980-Present	South East
Chimney No longer present	199 m	Pre 1907-Pre 1955 Pre 1955-Present	South East

3.3. PLANNING HISTORY

E3P has undertaken a detailed search of on-line planning records held by Manchester City Council which has identified that there have been some previous planning applications relating to the site. These have been detailed in Table 3.3.

Table 3.3 Previous Planning Applications.

PLANNING APPLICATION	DETAILS	DATE	OUTCOME
F02019/LA	Application for Deemed Planning Permission. Use of land for recreational facilities for Manchester Polytechnic comprising sports pavilion, rugby and soccer playing fields, with car parking for 40 cars.	May 1975	Approved
049013/OO/SOUTH2/95	Outline application for a residential development including public open space and children's play area	June 1996	Refused

PLANNING APPLICATION	DETAILS	DATE	OUTCOME
F07322	Erection of a 1.40 m high chain link fence around boundary of playing field.	October 1977	Approved

4. ENVIRONMENTAL SETTING

4.1. GEOLOGY AND HYDROGEOLOGY

The British Geological Survey (BGS) map for the site, (1:50,000, Solid and Drift edition) and online records indicate that the site is underlain by the geological sequence presented in Table 4.1.

TABLE 4.1 SUMMARY OF UNDERLYING GEOLOGY

GEOLOGICAL UNIT	CLASSIFICATION	DESCRIPTION	AQUIFER CLASSIFICATION
Drift (Majority of the site)	Till, Devensian - Diamicton	SAND, GRAVEL and CLAY	Secondary Undifferentiated
Drift (North-west)	Glaciofluvial Sheet Deposits	SAND and GRAVEL	Secondary A Aquifer
Solid	Wilmslow Sandstone Formation	SANDSTONE	Principal Aquifer

TABLE 4.2 SUMMARY OF BGS BOREHOLE RECORDS

LOCATION	DEPTH	MADE GROUND	DRIFT	SOLID
270 m East (SJ89SW5)	7.32 m	Cinders <0.30 m	CLAY, SAND and GRAVEL 7.32 m	N/A
548 m North (SJ 89NW1713)	7.00 m	Clay and Topsoil <0.50m	SAND, GRAVEL and CLAY >7.00 m	N/A
624 m South East (SJ89SW42)	28.96 m	Made Ground <1.50 m	CLAY >28.96 m	N/A

There are three groundwater abstraction points situated within 1 km of the site which are all located 593 m north of the site and operated by Trafford Metal Finishers Manchester Ltd utilised as process water. The site is not located within a Groundwater Source Protection Zone or a Drinking Water Safeguard Zone.

4.2. GEOTECHNICAL DATA

Geotechnical data presented within a commercially available environmental database is summarised within Table 4.3.

TABLE 4.3 SUMMARY OF GEOTECHNICAL DATA

HAZARD	DESIGNATION
Shrink-Swell Clay	No hazard - Very low risk
Landslides	Very low risk
Ground Dissolution	No hazard
Compressible Ground	No hazard - Moderate risk
Collapsible Deposits	Very low risk
Running Sand	Very low risk
Natural Cavities	None recorded within 2000 m
Manmade Cavities	None recorded within 2000 m

4.3. COAL MINING

The EnviroCheck Report does not identify the site to be in an area affected by coal mining, and states the site is in an area that might not be affected by mining.

To determine the initial risk classification of the proposed development site, a search of the Coal Authority Gazetteer (http://mapapps2.bgs.ac.uk/coalauthority/home.html) has been undertaken to assess the locality of the proposed development in relation to known or potential areas of mining risk.

The results of this search has confirmed that the proposed development site is located outside of the Coal Mining Authority's reporting area, therefore no further assessment is required.

4.4. HYDROLOGY

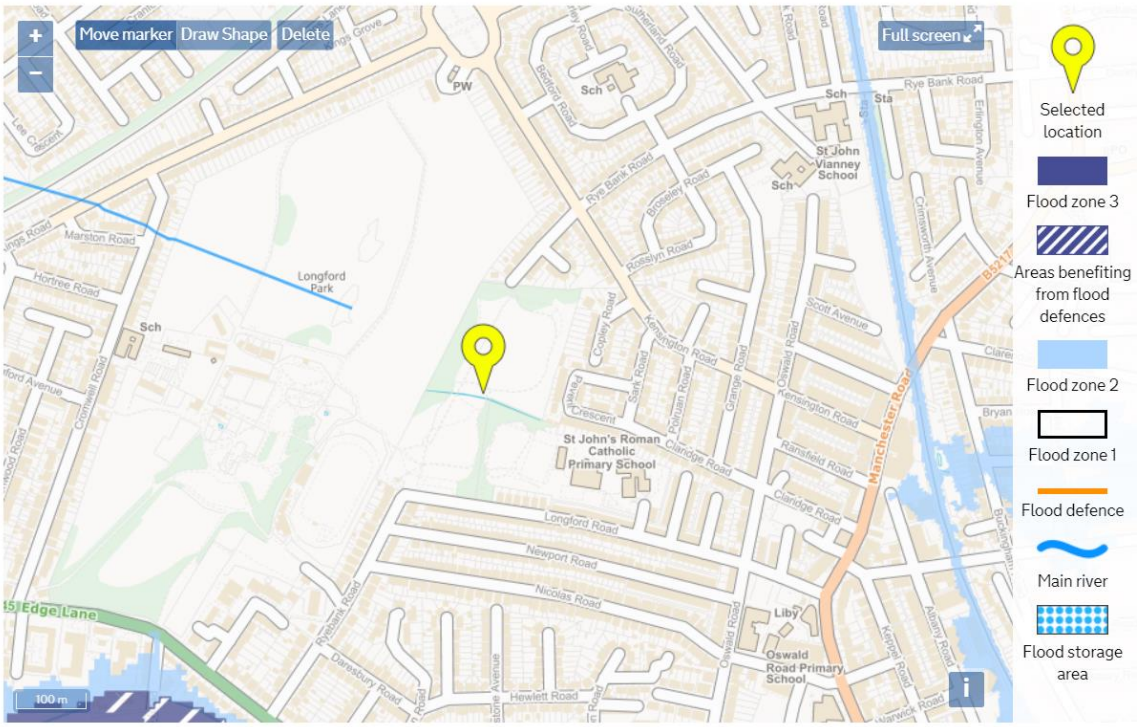
The Nico Ditch intersects the centre of the site. Furthermore, an inland river, named Bent Lanes Brook is present 156 m north west of the site. United Utilities have indicated that the route of the Thirlmere Aqueduct runs across the northern boundary of the site.

Longford book (culverted) is located circa 210 m west of the site. Longford Brook historically flowed through the site, however has since been diverted.

The site is located within a currently defined Flood Risk Zone 1; defined as land assessed as having less than 1 in 1,000 annual probability of river or sea flooding (< 0.1%), and as such is considered to be unaffected by river flooding. In addition, the Envirocheck Report states that within the majority of the site there is a limited potential for groundwater flooding to occur at the site, with the potential for groundwater flooding or property situated below ground level along the western boundary of the site.

The Fluvial Flood Risk Map is presented in Figure 4.1.

FIGURE 4.1 FLUVIAL FLOOD RISK MAP



Source - https://flood-map-for-planning.service.gov.uk/

An Environmental Constraints Plan provided by WSP Parsons Brinckerhoff (Reference 70014100, dated September 2015) has noted that the north of the site is at risk of potential reservoir flooding from the Audenshaw (1, 2 and 3) and Gorton Upper reservoirs however they have determined that this does not limit the development.

4.5. RADON RISK POTENTIAL

The Envirocheck Report indicates that the site is located in in an area where less than 1% of homes are above the Action Level. The BGS reports that full radon protective measures are not necessary in the construction of new dwellings or extensions.

4.6. INDUSTRIAL LAND USES

There are three contemporary trade directory entries within 250 m of the site of which one is still active. The closest active contemporary trade directory entry relates Press It, an ironing and home laundry service located 162 m east of the subject site.

There are two currently open fuel stations located within 1 km of the site, the closest of which relates to ESSO Chorlton Express located 514 m south east.

4.7. SENSITIVE LAND USES

Residential properties are located adjacent to the northern, southern and eastern boundaries of the site with St. Johns R.C. Primary School located immediately east of the site.

There are no other sensitive land uses in close proximity to the subject site.

4.8. SITE SENSITIVITY ASSESSMENT

The site is assessed to be located within a **High** sensitivity setting as discussed within Table 4.4.

TABLE 4.4 SITE SENSITIVITY ASSESSMENT

SENSITIVITY PROFILE	DISCUSSION	RATING
Sensitive Land Uses Within Close Proximity (e.g. Residential, School, Nursery, Local Nature Reserves)	There are residential houses immediately north, south and east of the site with St. Johns R.C. Primary School is located immediately east of the site.	**High**
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	The site is not located in a Groundwater Source Protection Zone or Drinking Water Safeguard Zone	**Low**
Distance to the Closest Groundwater Abstraction Point	There are three groundwater abstraction points located 593 m north of the site which are all operated by Trafford Metal Finishers Manchester Ltd and utilised for process water.	**Moderate**
Aquifer Classification in Superficial Drift Deposits	Secondary A and Secondary Undifferentiated aquifers underlie the subject site. The underlying superficial deposits are likely to comprise gravelly sands interbedded with low-permeability clay soils to depths in excess of 5 m, which may reduce the potential for mobile phase contaminants to migrate towards the bedrock aquifer.	**Moderate**

SENSITIVITY PROFILE	DISCUSSION	RATING
Aquifer Classification in Bedrock	Principal Aquifer.	**High**
Is the Site Underlain by Low-Permeability Drift to Depths in Excess of 10 m?	BGS borehole records in close proximity to the site confirm the presence of granular deposits interbedded with CLAY to depths in excess of 5.00 m bgl	**Moderate**
Is the Site Located Within 50 m of a Surface Watercourse?	The Nico Ditch intersects the centre of the site and a culverted inland river is located 156 m north west of the site. Moreover, United Utilities have indicated that the route of the Thirlmere Aqueduct runs adjacent to the northern boundary of the site. Longford book (culverted) is located circa 210 m west of the site.	**High**
OVERALL SITE ENVIRONMENTAL SENSITIVITY		**High**

4.9. NICO DITCH

The Nico Ditch is known to intersect the centre of the site which is a linear earthwork stretching across Manchester which is 9.70 km in length. It is understood the historical use of the ditch include the ditch was used as a drainage channel, an agricultural boundary, an administrative boundary or a defensive ditch. There are speculations about the date of the construction of the ditch, where it could date back to the seventh century, whilst other sources say that it was developed later between AD 890 and 910. The Nico ditch is considered to be of great historical and agricultural importance and will require a full archaeological assessment. Information provided by *http://history.aboutmanchester.co.uk/nico-ditch/* accessed 25th February 2020.

4.10. PRELIMINARY GEOTECHNICAL ASSESSMENT

E3P has completed an assessment of potential geotechnical constraints based on the available desk-study information within the context of the proposed residential/commercial development. This assessment is summarised in Table 4.5.

TABLE 4.5 SUMMARY OF POTENTIAL GEOTECHNICAL CONSTRAINTS

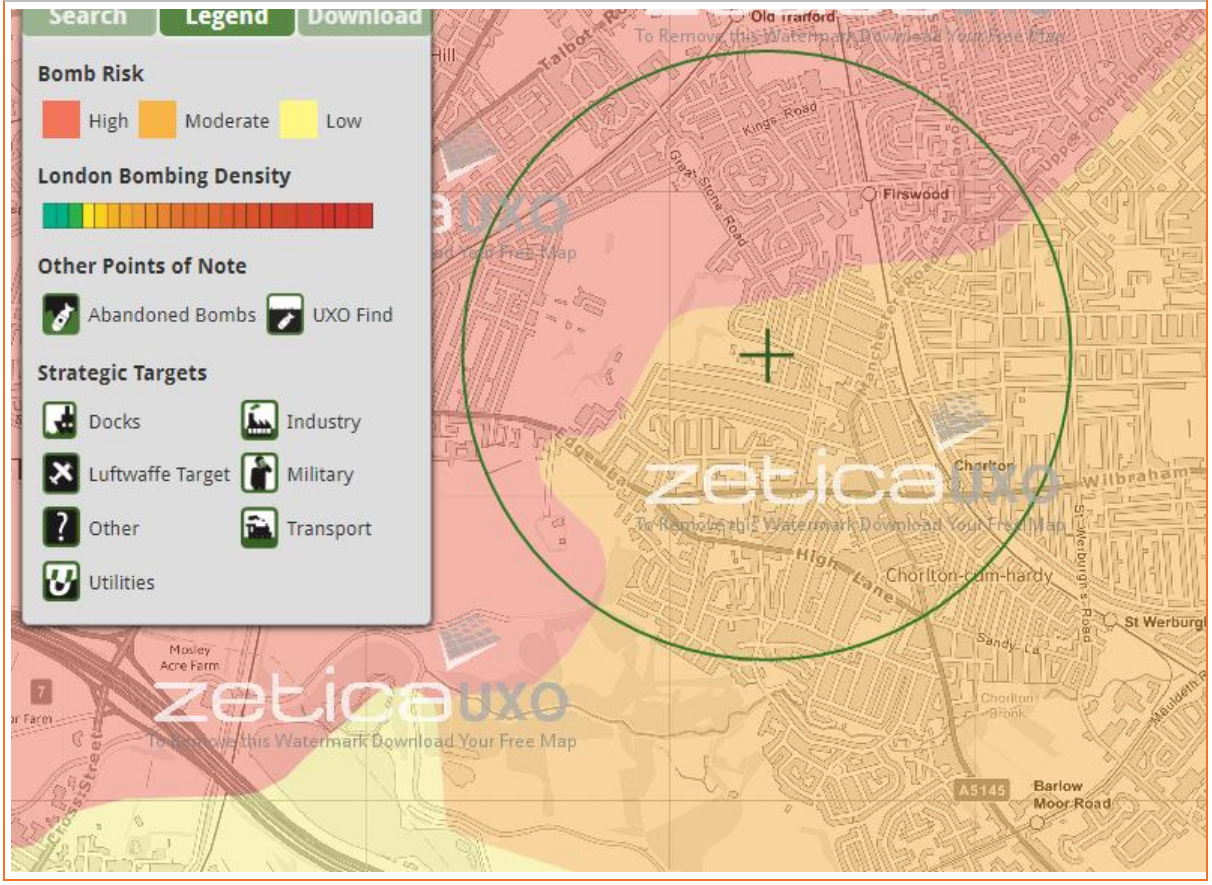
POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Remediation of Contaminated Soils	All	100	Extensive depths of Made Ground is anticipated beneath the site associated with the infilling of former clay pits and more recently, the demolition of former buildings. If volatile determinants are identified within the Made Ground they will require removal from site. Likely elevated levels of heavy metals and PAHs can be mitigated with the installation of a clean cover system within gardens and landscaped areas. In the unlikely event that material deemed to have a potential vapour risk is identified, materials may require hotspot removal, in which a void will be formed which would require infilling and possible reengineering and therefore resulting in a deeper or specialist foundations may be required.
Obstructions	South West / South East	20	Site has been subject to significant historical development and infilling. While above-ground structures have been removed, potential subsurface obstruction from relict foundations and slabs remain.
Artificially Levelled and Filled Platforms	All	100	Historical mapping suggests that the site has been subject to infilling following the use of the site as clay pits associated with neighbouring brick works. The filling of former clay pits was completed pre 1960s and likely comprises incinerated materials (ash), which are likely to contain reduced organic putrescible content therefore mitigating long term subsidence by degradation risk. The stability and composition of this potentially infilled ground will need to be further assessed during a detailed site investigation.
Trench Collapse	All	100	Made Ground present beneath the site is likely to be loosely compacted and possibly prone to collapse.
Infilled Pond/ clay pits/ Hedges	Throughout	15	Historical mapping displays the presence of several infilled ponds, clay pits and infilled field boundaries. All known former infilled ponds and areas of clay pits should be clearly identified, demarked and investigated to assess the nature of materials and extent of any deleterious elements.
Mature Trees	Periphery	60	Arboriculture survey assessed against proposed development layout and final finished levels (FFLs) to determine areas of potential tree influence.

POTENTIAL ABNORMAL CONSTRAINT	LOCATION ON SITE	ESTIMATED AREA OF SITE AT RISK (%)	ASSESSMENT AND MITIGATION
Volume Change Potential Clay	All	100	The site is likely to be underlain by cohesive and granular soils in areas not undergone infilling. Should cohesive soils be present, an assessment of the volume change potential will be required, and therefore heave precautions may be required at the site. The full extent of precautions will only be determined after site investigation.
Running Sands	NA	–	Data searches indicate very low risk.
Ground Dissolution	NA	–	Data searches indicate no hazard.
Compressible	–	TBC	Data searches indicate moderate risk. This will need to be confirmed during a ground investigation.
Concrete Design	TBC	-	The full extent of concrete design will be determined following site investigation.
Low-Permeability Ground	All	100	Soakaways unlikely to be effective in areas where low-permeability cohesive deposits are present or in areas of deep Made Ground.
Services/Sensitive Structures	-	TBC	An intermediate pressure gas main is present in the west of the site, bisecting north to south. The Thirlmere Aqueduct is present along with northern boundary along with an overflow sewer. BT and electricity is present in the south-west of the site. Vibratory works will be limited in the vicinity of these infrastructure.
Abnormal Foundation Solutions	All	100	Should significant Made Ground and soft clays be identified on site, that will be subject to volume change an abnormal foundation solution (MTF, VCC, Pile) may be required. Intrusive site investigation will be required to determine the required foundation solution.

4.11. UNEXPLODED ORDNANCE

The regional unexploded bomb risk map from Zetica (2014) indicates that south of the site is in an area at moderate risk from possible Unexploded Ordnance (UXO) resulting from the Second World War whilst the north of the site is at a high risk.

FIGURE 4.2 ZETICA UXO RISKS MAP



Source: https://zeticauxo.com/downloads-and-resources/risk-maps/

Preliminary and detailed UXO risk assessments have been completed for the subject site and amended to this report.

The recommended risk mitigation measures include UXO safety awareness briefings prior to all intrusive works, on-site supervision with EOD engineer during all site investigation works and open excavations, and intrusive magnetometer probe survey for all pile positions.

5. CONSULTATIONS

5.1. LANDFILL SITES AND WASTE TREATMENT SITES

There are no current or historical landfill sites within 250 m of the subject site. However, historical mapping indicates that the site has been subject to historical infilling (pits, quarries, pond, marsh, river, streams). In particular historical mapping shows significant topographical changes, steep slopes, infilled clay pits and ponds within the site boundary. The filling of former clay pits was completed pre 1960s and likely comprises incinerated materials (ash), which are likely to contain reduced organic putrescible content therefore mitigating long term subsidence by degradation risk. The stability and composition of this potentially infilled ground will need to be further assessed during a detailed site investigation.

There are also ten locations of potentially infilled land within 250 m of the site from historical mapping dating 1848 to 1955 with an unknown input type including two on-site from 1989 mapping.

5.2. REGULATORY DATABASE

The information summarised in Table 5.1 has been obtained from a commercially available environmental database. The summary table only includes records from within 250 m of the subject site and not otherwise detailed in the report.

TABLE 5.1 SUMMARY OF ENVIRONMENTAL DATA

RECORD	ENTRIES WITHIN 250 m	DETAILS
Contaminated Land Register Entries and Notices	0	None identified
Authorised Industrial Processes (IPC/IPPC/LAPPC)	0	None identified
Fuel Stations Entries	0	None identified
Licensed Radioactive Substances	0	None identified
Enforcements, Prohibitions or Prosecutions	0	None identified
Discharge Consents	0	None identified
Pollution Incidents	1	A Category 3 – Minor Incident occurred in September 1995 75 m south west of the site. The pollutant was unknown.
Consents Issued Under the Planning (Hazardous Substances) Act 1990	0	None identified
Control of Major Accident Hazard (COMAH) Sites	0	None identified

6. INITIAL CONCEPTUAL SITE MODEL

In accordance with Environment Agency, LCRM (2019) and BSI 10175 (Code of Practice for Investigation of Potentially Contaminated Land), E3P Ltd has developed an initial CSM to identify potential contamination sources, migration pathways and receptors within the study area. This is summarised within Table 6.1

TABLE 6.1 INITIAL CONCEPTUAL SITE MODEL

POLLUTANT LINKAGE	PATHWAY	RECEPTOR	CONTAMINANT (SOURCE)	PROBABILITY	RISK	ASSESSMENT AND RECOMMENDATIONS	RESIDUAL RISK AFTER MITIGATION
PL1	Dermal Contact & Ingestion.	Future site users. Off-site receptors.	Heavy metals and PAH (Made Ground).	Likely	Moderate	**Assessment:** Heavy metal and PAH contamination may be present as a result of the potential Made Ground infill material from the demolition works previously undertaken on-site and extensive infilling throughout the site of former clay pits (likely completed with incinerated materials). Heavy metals and non-volatile PAHs may pose a short-term risk to construction workers who may be exposed to impacted soils during earthworks. The risk of contamination on site is considered to be low. **Recommendation:** Construction workers may come into contact with impacted soils during earthworks. All construction works must be undertaken using the appropriate Personal Protective Equipment (PPE) to remove this potential risk. Future residential users may come into contact with impacted soils within any landscaped or garden areas within the site. Whilst risks are also present with regards to the consumption of home-grown produce should contamination be present, therefore a 600mm cover system to garden and landscaped areas will prevent exposure to future site users.	**To be determined**

POLLUTANT LINKAGE	PATHWAY	RECEPTOR	CONTAMINANT (SOURCE)	PROBABILITY	RISK	ASSESSMENT AND RECOMMENDATIONS	RESIDUAL RISK AFTER MITIGATION
PL2	Inhalation of vapours. Migration through permeable strata and preferential pathways.	Future site users. Off-site receptors.	Volatile Contaminants such as hydrocarbons, chlorinated solvents (Made Ground)	Likely	Moderate	**Assessment:** The site has previously undergone extensive infilling following the use of the site as a clay pit. Materials which were deposited may have included waste hydrocarbon containing products, which at this stage cannot be ruled out. **Recommendation:** Intrusive investigation required.	**To be determined**
PL3	Inhalation of dust.	Future site users. Buildings. Off-site land users.	ACM in MADE GROUND.	Low likelihood	Moderate	**Assessment:** No ACM was noted during the site walkover survey; however, there may be the potential for asbestos present within any Made Ground deposits from the demolition of former buildings given their age, or during the infilling works completed on site. **Recommendation:** ACM poses a risk through fibre and dust inhalation and if present may pose a risk to construction workers during any future earthworks / demolition and to adjacent third-party property should dust be generated during those works. Intrusive investigation required to confirm.	**To be determined**

POLLUTANT LINKAGE	PATHWAY	RECEPTOR	CONTAMINANT (SOURCE)	PROBABILITY	RISK	ASSESSMENT AND RECOMMENDATIONS	RESIDUAL RISK AFTER MITIGATION
PL4	Inhalation of gas. Migration through permeable strata and preferential pathways. Explosion in confined Spaces.	Future site users. Buildings. Off-site land users.	Methane, carbon dioxide. (infilled features on and within 250 m of the site.)	Low likelihood	Moderate	**Assessment:** Made Ground may be a potential source of hazardous ground gas such as methane and carbon dioxide. The site has been subject to extensive historical infilling of ponds, clay pits and field boundaries. Hazardous ground gases may pose a low-level risk to construction workers and residential end users. Carbon dioxide and methane can migrate to indoor air spaces through service ducts and collect in deep excavations and have associated asphyxiation and explosive risks, respectively. **Recommendation:** If a gas risk is identified, then mitigation may be required through the design and installation of appropriate gas protection measures as specified within BS8485 (2015)+A1(2019) Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. Intrusive investigation required.	**To be determined**

POLLUTANT LINKAGE	PATHWAY	RECEPTOR	CONTAMINANT (SOURCE)	PROBABILITY	RISK	ASSESSMENT AND RECOMMENDATIONS	ASSESSMENT AND RECOMMENDATIONS
PL5	Surface run-off. Migration through permeable strata and preferential pathways. Perched waters migration.	Groundwater (Secondary A aquifer, Secondary Undifferentiated aquifer, Principal aquifer, Drains and Thirlmere Aqueduct). Surface water (Longford Brook)	Mobile contaminants such as metals, PAHs, hydrocarbons, volatile compounds (Made Ground).	Unlikely	Moderate	**Assessment:** Made Ground across the site resulting from historic development may be a potential source of metals, hydrocarbon compounds, chlorinated solvents and PAHs. There are also three groundwater abstraction points located within 1 km of the site, operated by Trafford Metal Finishers Manchester Ltd and is thought to have an industrial usage. The abstraction point may create a potential pollution linkage. Longford book (culverted) is located circa 210 m west of the site. However, it is anticipated that CLAY is present underlying the site which will afford protection to the underlying aquifer. **Recommendation:** Sampling of groundwater and surface water required.	**To be determined**

POLLUTANT LINKAGE	PATHWAY	RECEPTOR	CONTAMINANT (SOURCE)	PROBABILITY	RISK	ASSESSMENT AND RECOMMENDATIONS	ASSESSMENT AND RECOMMENDATIONS
PL6	Sulphate attack on concrete.	Building structure.	Sulphate (potential ash within made ground).	Low likelihood	Low	**Assessment:** The presence of pH and sulphate within any Made Ground deposits may result in corrosion of buried concrete. Likely probability as ash is anticipated within the Made Ground across the site which may be in contact with concrete used in future buildings. **Recommendation:** Intrusive investigation required.	**To be determined**
PL7	Ingestion of tainted water supply.	Future site users. Water pipes.	Organic contaminants such as hydrocarbons, solvents (made ground).	Likely	Moderate	**Assessment:** Likely probability as significant contamination anticipated at pipeline depth across the site (0.75-1.35m). **Recommendation:** Intrusive investigation required.	**To be determined**

POLLUTANT LINKAGE	PATHWAY	RECEPTOR	CONTAMINANT (SOURCE)	PROBABILITY	RISK	ASSESSMENT AND RECOMMENDATIONS	ASSESSMENT AND RECOMMENDATIONS
PL8	Direct contact (plant uptake).	Flora.	Phytotoxic contaminants (made ground).	Unlikely	Low	**Assessment:** The surrounding trees and hedges may be a potential habit for wildlife and potentially take up contamination. A Preliminary Ecological Appraisal has been completed by Ascerta (Report Ref: *P.1254.19B)* and should be read in conjunction with this report. Furthermore, Ascerta have completed a Preliminary Arboricultural Impact Assessment for the site (Report Ref: P.1254.19). **Recommendation:** Further investigation work is required as part of PL1.	**To be determined**

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. SITE SUMMARY

Current site use	The subject site is an irregular shaped parcel of land located to the north of Ryebank Road / Longford Road in Chorlton referred to as Ryebank Fields. The site is predominantly used by walkers and is surfaced by overgrown grasses and semi mature and mature trees, which are notably dense around the perimeter of the site. The Nico ditch is known to intersect the centre of the site which is a linear earthwork stretching across Manchester (9.7 km) and is of archeological importance. There are no structures present on site, however an area of hardstanding is present to the south east of the site. A bund surfaced by grass is located adjacent to the area of hard standing in the south east of the site. A number of pedestrian paths intersect the site. The site is predominantly flat in topography but gradually falls from south to north.
Historical Site Use	Historical mapping suggests that the site was undeveloped agricultural land with Longford Brook traversing the site west to east. In the late 1800's a pond was present in the centre of the site with a small structure in the south-western corner. In the early 1900's residential properties were present in the south-east of the site; furthermore, a brick works is present along the eastern boundary of the site. Mapping from 1930-1938 identifies a Clay Pit and two ponds in the north of the site, with embankments present across the entire site likely to be indicative of areas of excavation. Mapping from 1950 show all previous features to no longer be present, with a drain traversing the site west to east. An unspecified building was present in the west of the site from mapping dated 1971-1981 and was demolished at some point between 2003 and 2005.
Site Sensitivity	The site has been determined to be located within a high sensitivity setting due to the presence of residential houses immediately north, south and east of the site and St. Johns R.C. Primary School located immediately east of the site. There are three groundwater abstraction points situated within 1 km of the site which are operated by Trafford Metal Finishers Manchester Ltd utilised as process water. The site is also underlain by a Principal Aquifer and Longford book (culverted) is located circa 210 m west of the site. The Nico Ditch intersects the centre of the site and a culverted inland river is located 156 m north west of the site. Moreover, United Utilities have indicated that the route of the Thirlmere Aqueduct runs adjacent to the northern boundary of the site.

7.2. CONTAMINATION ISSUES

Human Health	Based on the information available to review, it is considered that there will be a moderate risk to human health. However, as the site has been subject to infilling and significant historical development, the site is thought to be underlain by significant depths of Made Ground. Made Ground may be potentially impacted with TPHs, heavy metals, PAHs and asbestos. Should these determinants be present it is likely that they can be mitigated through the placement of a 600mm clean cover system to all gardens and landscaped areas. Should any volatile determinants be identified these are likely to require removal during remediation and enabling works in order to determine their retention on site and to not pose a risk to future end users.
Controlled Waters	The site is underlain by a Principal Aquifer and there is a drain (Nico Ditch) located on-site and 156 m west of the site. The Nico Ditch has been noted to be dry and overgrown with scrub with a crossing over the ditch in the centre of the site. Longford book (culverted) is located circa 210 m west of the site. There are also three groundwater abstraction points situated within 1 km of the site which may create a potential linkage. Made Ground across the site resulting from historic development and infilling may be a potential source of metals, hydrocarbon compounds, chlorinated solvents and PAHs. The site is anticipated to be underlain by low permeability cohesive drift deposits which will afford protection to the underlying aquifer. The closest surface water feature is not considered to be within influencing distance of the site. A detailed controlled water risk assessment will be required in order to confirm the absence of risk to controlled waters. It is likely that the Environment Agency will be consulted as part of any future planning application for a residential development.
Ground Gas	Significant depths of Made Ground, associated with former infilling and historical development of the site, are anticipated to be underlying the subject site which may be a potential source of ground gas such as methane and carbon dioxide. Hazardous ground gases may pose a low-level risk to construction workers and residential end users. Carbon dioxide and methane can migrate to indoor air spaces through service ducts and collect in deep excavations and have associated asphyxiation and explosive risks, respectively. If a gas risk is identified, then mitigation may be required through the design and installation of appropriate gas protection measures as specified within BS8485 (2015)+A1(2019) Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.
Potable Waters	Potential sources of PAHs, TPHs and chlorinated solvents have been identified within the site boundary which may mean that It will be unsuitable to use PE water pipework, however a detailed a UKWIR risk assessment will be required following intrusive ground investigation.

7.3. GEOTECHNICAL ISSUES

Geological	• Extensive depths of Made Ground is anticipated beneath the site associated with the infilling of former clay pits and more recently, the demolition of former buildings. If volatile determinants are identified within the Made Ground they will require removal from site. Likely elevated levels of heavy metals and PAHs can be mitigated with the installation of a clean cover system within gardens and landscaped areas. • Made Ground present beneath the site is likely to be loosely compacted and possibly prone to collapse. • Footings will require deepening in accordance with NHBC guidance 2016 Chapter 4.2 if the development incorporates any existing and proposed trees within any cohesive drift deposits; • The underlying superficial geology will likely comprise a cohesive soil matrix and, as such, is not likely to offer the required degree of permeability to make soak-away drainage viable in this instance; • The site has been determined to be at moderate risk of having compressible soils and this will require further investigation during a ground investigation.
Civil and Structural	The site is generally homogenous topographically with a slight slope from south to north. To construct a low-rise residential development, limited earthworks will be required to create a level developable platform Given the previously developed nature of the site and that the site has been subject to significant infilling, it is likely there will be Made Ground fill deposits and underground obstructions. All relic foundations and underground obstructions will require grubbing out in their entirety, prior to the construction of the proposed development. A full GPR survey has not been completed however a review of online service records have identified an intermediate pressure gas main to dissect the site north to south, with a low pressure gas main present in the south-west of the site. BT and electricity service infrastructure is present in the south-western corner of the site. United Utilities have noted the presence of a surface water sewer in the south of the site with an overflow sewer within the north of the site. Adjacent to the northern boundary is the Thirlmere Aqueduct, an LDTM Treated Water Trunk Main. Vibratory works will be limited in the vicinity of these infrastructure. Intrusive investigation will be required to assess the ground conditions and undertake in-situ geotechnical testing to determine possible foundation solutions. The Nico ditch intersects the centre of the site and is deemed to be of great historical and archaeological importance. The ditch will therefore be protected during future development of the site and will require archaeological assessment.
Abnormal Foundations	Should significant Made Ground and soft clays be identified on site, that will be subject to volume change may require an abnormal foundation solution may be required (MTF, VCC, Pile). Intrusive site investigation will be required to determine the required foundation solution.

END OF REPORT

APPENDIX I
LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between E3P and the Client as indicated in Section 1.3.

2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.

3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.

4. During the site walkover, reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover, no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.

5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.

6. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.

7. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials, this is for indicative purposes only and do not constitute or replace full and proper surveys.

8. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.

9. E3P cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by E3P is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by E3P in this connection without their explicit written agreement there to by E3P.

10. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.

APPENDIX II
GLOSSARY

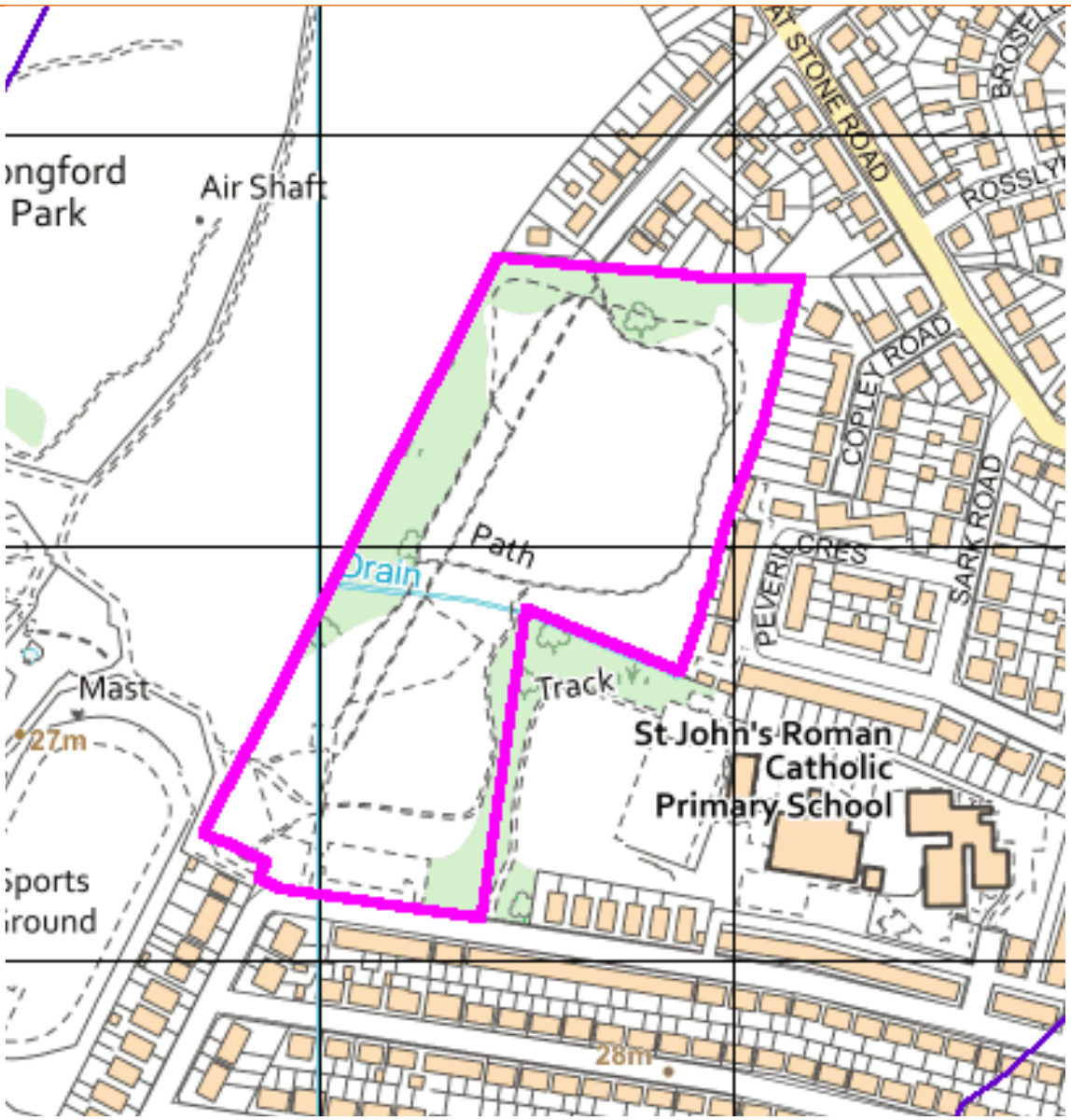
TERMS

ACM	Asbestos-containing material	**MMP**	Materials management plan
ADS	Acoustic design statement	**ND**	Not detected
AST	Above-ground storage tank	**NDP**	Nuclear density probe
BGS	British Geological Survey	**NMP**	Noise management plan
BSI	British Standards Institute	**NPSE**	Noise policy statement for England
BTEX	Benzene, toluene, ethylbenzene, xylenes	**NR**	Not recorded
CA	Coal Authority	**PAH**	Polycyclic aromatic hydrocarbon
CBR	California bearing ratio	**PCB**	Polychlorinated biphenyl
CIEH	Chartered Institute of Environmental Health	**PI**	Plasticity index
CIRIA	Construction Industry Research Association	**PID**	Photo ionisation detector
CLEA	Contaminated land exposure assessment	**POS**	Public open space
CML	Council of Mortgage Lenders	**PPE**	Personnel protective equipment
CoC	Contaminants of concern	**ProPG**	Professional practice guidance
CSM	Conceptual site model	**QA**	Quality assurance
DNAPL	Dense non-aqueous phase liquid (chlorinated solvents, PCB)	**SGV**	Soil guideline value
DWS	Drinking water standard	**SPH**	Separate-phase hydrocarbon
EA	Environment Agency	**SPT**	Standard penetration test
EQS	Environmental quality standard	**SVOC**	Semi-volatile organic compound
FFL	Finished floor level	**TPH**	Total and speciated petroleum hydrocarbon
GAC	General assessment criteria	**TPH CWG**	Total Petroleum Hydrocarbon (Criteria Working Group)
GL	Ground level	**UKWIR**	United Kingdom Water Infrastructure Risk
GSV	Gas screening value	**UST**	Underground storage tank
HCV	Health criteria value	**VCC**	Vibro-concrete column
ICSM	Initial conceptual site model	**VOC**	Volatile organic compound
LEL	Lower explosive limit	**VRSC**	Vibro-replacement stone columns
LMRL	Lower method reporting limit	**VSC**	Vibro-stone columns
LNAPL	Light non-aqueous phase liquid (petrol, diesel, kerosene)	**WHO**	World Health Organisation
MCV	Moisture condition value	**WRAP**	Waste and Resources Action Programme
MIBK	Methyl isobutyl ketone	**WTE**	Water table elevation
m	Metres	**ppm**	Parts per million

km	Kilometres	**mg/m^3**	Milligram per metre cubed
% v/v	Percent volume in air	**m bgl bgl**	Metres below ground level
mb	Millibars (atmospheric pressure)	**m bcl**	Metre below cover level
l/hr	Litres per hour	**mAOD**	Metres above ordnance datum (sea level)
µg/l	Micrograms per litre (parts per billion)	**kN/m^2**	Kilonewtons per metre squared
ppb	Parts per billion	**µm**	Micrometre
mg/kg	Milligrams per kilogram (parts per million)		

APPENDIX III
DRAWINGS

DRAWING 13-533-001 – SITE LOCATION PLAN



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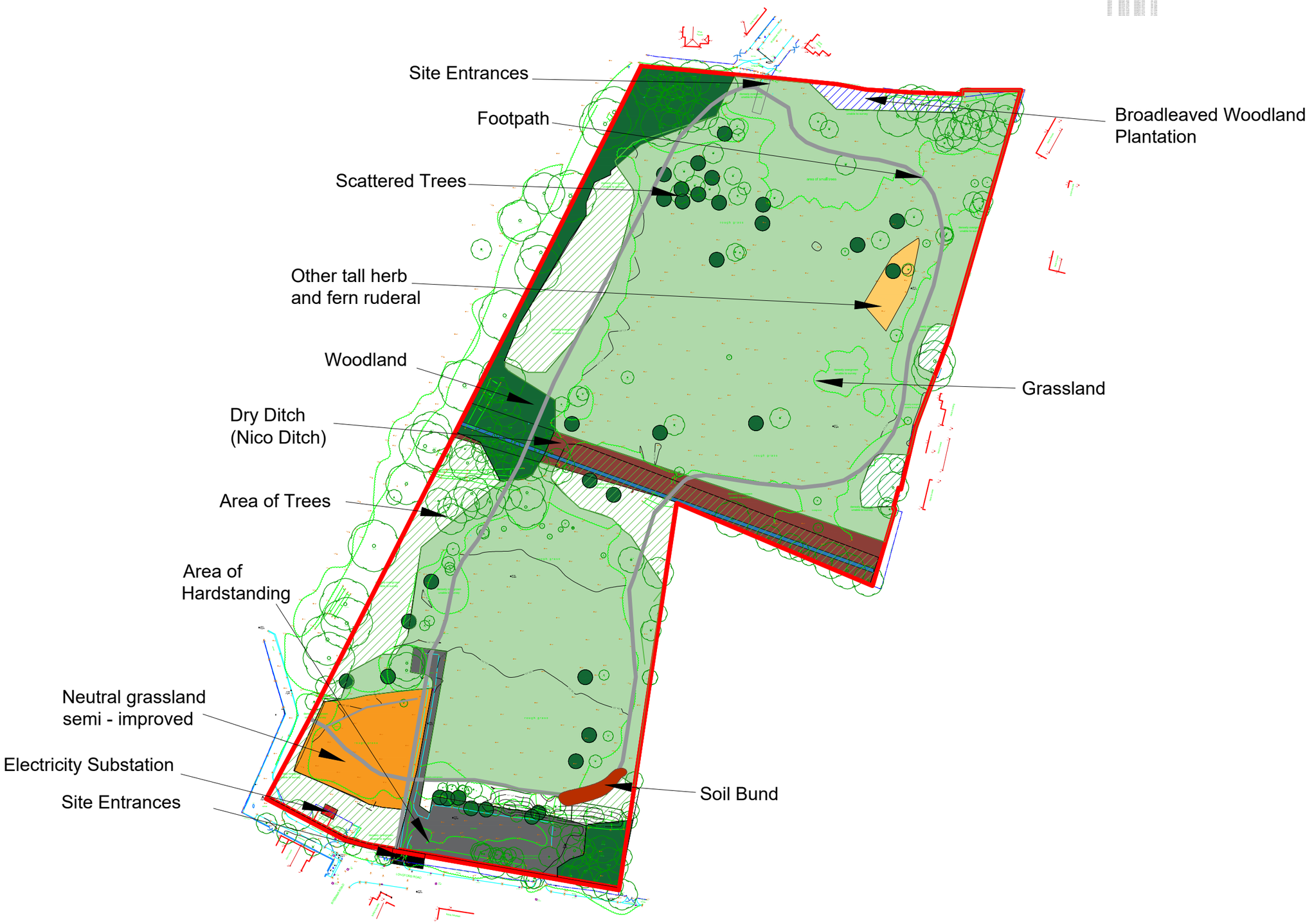

Site Features

- Hardstanding
- Broadleaved woodland semi-natural
- Dry Ditch
- Footpath
- Sub Station
- Neutral Grassland semi-improved
- Scrub - Dense/Continuous
- Scattered Trees
- Broadleaved Woodland Plantation
- Footpath
- Dry Ditch (Nico)
- Other tall herb and fern ruderal
- Soil Bund
- Grassland
- Site Entrances

Notes:

Phase	Revision	Date	Issue	Drawn	Checked
P1	R1	02.03.2020	REVISION	LM	BH
P1	-	05.11.2019	DRAFT	LM	BH

Client: Manchester Metropolitan University

Job No: 13-533

Date: 02.03.2020

Drawing No: 002

Scale: NTS

Job Title: Rye Bank Road, Chorlton

Drawing Title: Site Features Plan

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City Heliport & Business Centre
Eccles, Manchester, M30 7RU
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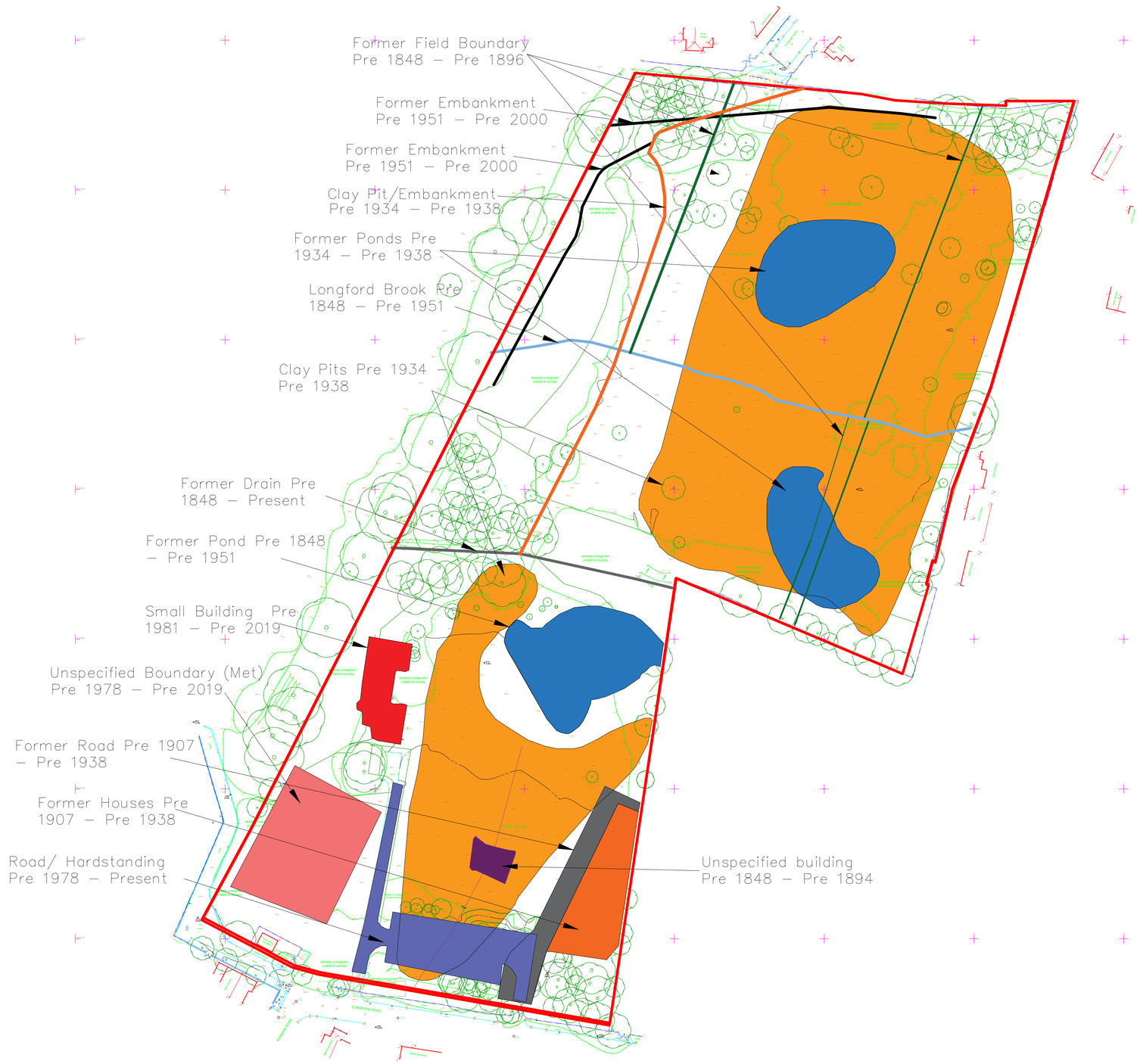
Website: www.e3p.co.uk



Historical Features

- Small Building Pre 1981 - Pre 2019
- Former Pond Pre 1848 - Pre 1951 / Pre 1934 - Pre 1938
- Former Houses Pre 1907 - Pre 1938
- Former Road Pre 1907 - Pre 1938
- Unspecified Building Pre - 1848 - Pre 1894
- Unspecified Boundary (Met) Pre 1978 - Pre 2019
- Former Clay Pits Pre 1934 - Pre 1938
- Road/Hardstanding Pre 1978 - Present
- Longford Brook Pre 1848 - Pre 1951
- Former Field Boundary Pre 1848 - Pre 1896
- Former Drain Pre 1848 - Present
- Former Embankment Pre 1951 - Pre 2000
- Former Clay pit/embankment Pre 1934 - Pre 1938

Notes:

Phase	Revision	Date	Issue	Drawn	Checked
P3	R2	02.03.2020	REVISION	LM	RH
P2	R1	28.02.2020	REVISION	LM	RH
P1	-	14.01.2020	DRAFT	LM	EM

Client: Manchester Metropolitan University

Job No: 13-533

Date: 02.03.2020

Drawing No: 003

Scale: NTS

Job Title: Rye Bank Road, Chorlton

Drawing Title: Historical Features Plan

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APPENDIX IV
PHOTOGRAPHS

PLATE 1 ELECTRCITY SUBSTATION ADJACENT TO SOUTHERN BOUNDARY

PLATE 2 HARD STANDING IN THE SOUTH OF THE SITE

PLATE 3 VIEW OF THE SOUTH WEST OF THE SITE

PLATE 4 VIEW OF SOUTHERN SECTOR OF SITE

PLATE 5 VIEW OF NORTHERN SECTOR OF SITE

PLATE 6 VIEW OF NORTH WEST OF SITE

PLATE 7 VIEW OF NORTHERN SECTOR LOOKING SOUTH

PLATE 8 VIEW OF NORTHERN SECTOR LOOKING SOUTH

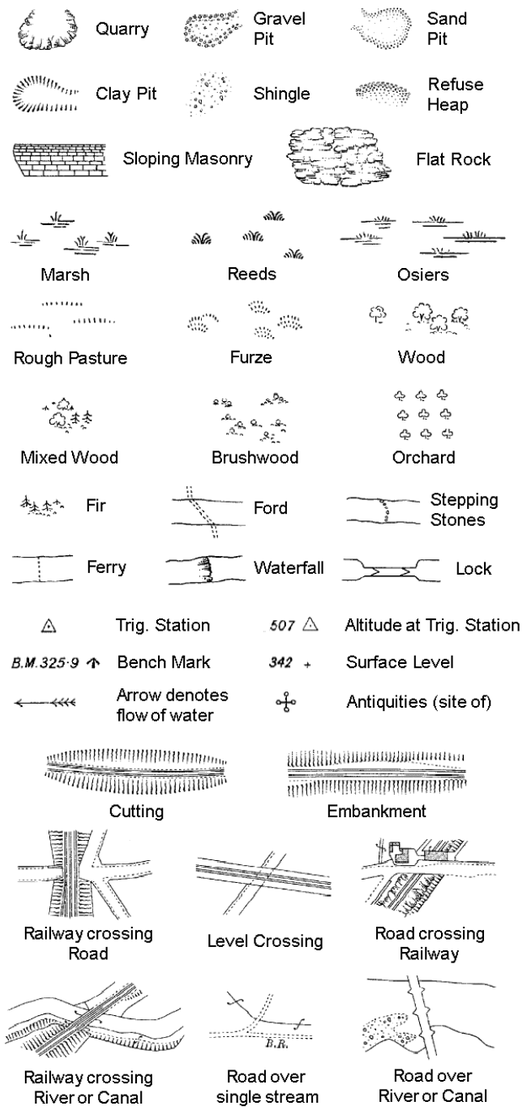
PLATE 9 NICO DITCH

PLATE 10 AREA OF NICO DITCH

APPENDIX V
HISTORICAL MAPS

Historical Mapping Legends

Ordnance Survey County Series and Ordnance Survey Plan 1:2,500



County Boundary (Geographical)

County & Civil Parish Boundary

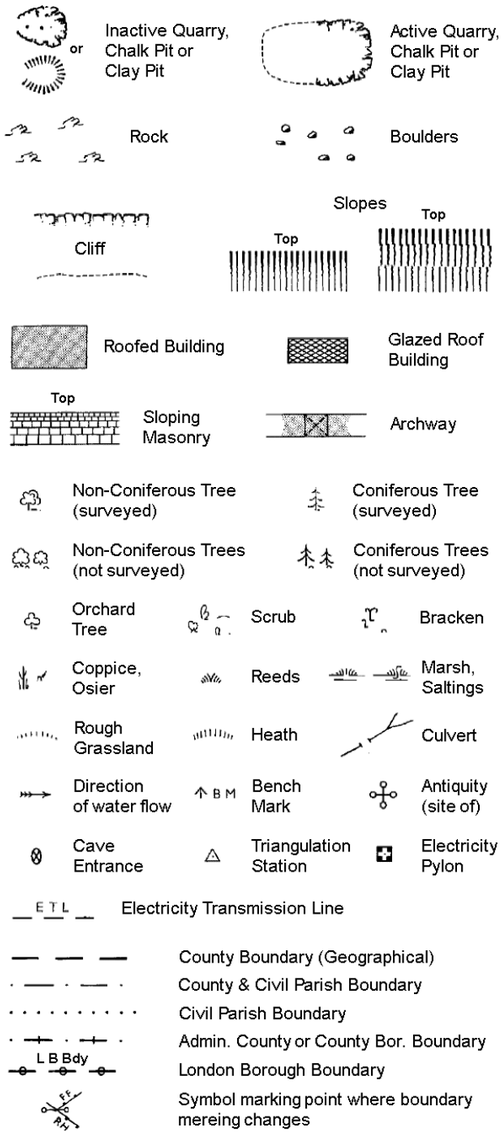
Administrative County & Civil Parish Boundary

Co. Boro. Bdy. County Borough Boundary (England)

Co. Burgh Bdy. County Burgh Boundary (Scotland)

B P B S	Boundary Post or Stone	P.C.B	Police Call Box
B.R.	Bridle Road	P	Pump
E.P	Electricity Pylon	S.P	Signal Post
F.B.	Foot Bridge	St.	Sluice
F.P.	Foot Path	Sp.	Spring
G.P	Guide Post or Board	T.C.B	Telephone Call Box
M.S	Mile Stone	Tr.	Trough
M.P M.R	Mooring Post or Ring	W	Well

Ordnance Survey Plan, Additional SIMs and Supply of Unpublished Survey Information 1:2,500 and 1:1,250



County Boundary (Geographical)

County & Civil Parish Boundary

Civil Parish Boundary

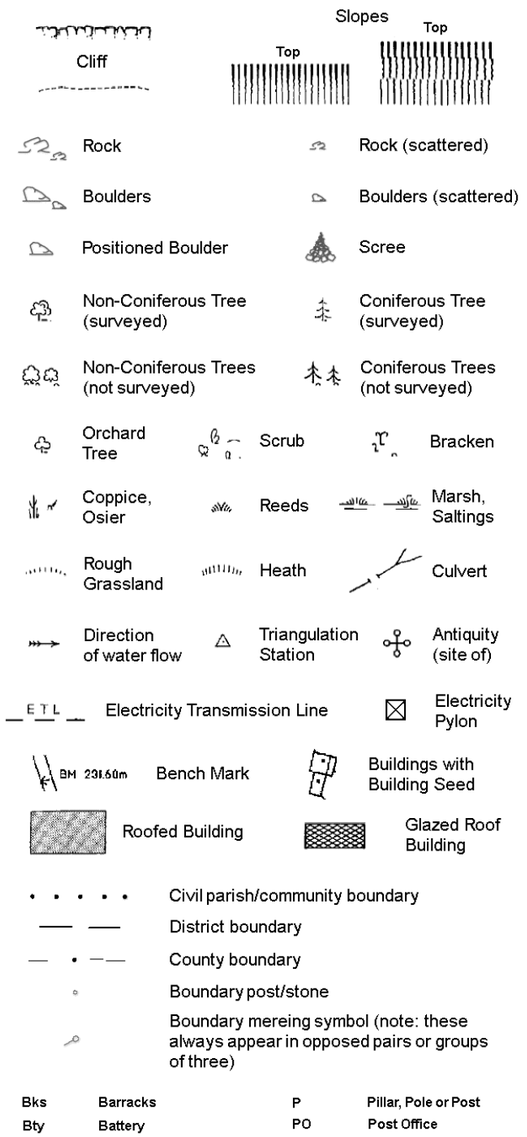
Admin. County or County Bor. Boundary

L B Bdy London Borough Boundary

Symbol marking point where boundary mereing changes

BH	Beer House	P	Pillar, Pole or Post
BP, BS	Boundary Post or Stone	PO	Post Office
Cn, C	Capstan, Crane	PC	Public Convenience
Chy	Chimney	PH	Public House
D Fn	Drinking Fountain	Pp	Pump
El P	Electricity Pillar or Post	SB, S Br	Signal Box or Bridge
FAP	Fire Alarm Pillar	SP, SL	Signal Post or Light
FB	Foot Bridge	Spr	Spring
GP	Guide Post	Tk	Tank or Track
H	Hydrant or Hydraulic	TCB	Telephone Call Box
LC	Level Crossing	TCP	Telephone Call Post
MH	Manhole	Tr	Trough
MP	Mile Post or Mooring Post	Wr Pt, Wr T	Water Point, Water Tap
MS	Mile Stone	W	Well
NTL	Normal Tidal Limit	Wd Pp	Wind Pump

Large-Scale National Grid Data 1:2,500 and 1:1,250



Civil parish/community boundary

District boundary

County boundary

Boundary post/stone

Boundary mereing symbol (note: these always appear in opposed pairs or groups of three)

Bks	Barracks	P	Pillar, Pole or Post
Bty	Battery	PO	Post Office
Cemy	Cemetery	PC	Public Convenience
Chy	Chimney	Pp	Pump
Cis	Cistern	Ppg Sta	Pumping Station
Dismtd Rly	Dismantled Railway	PW	Place of Worship
El Gen Sta	Electricity Generating Station	Sewage Ppg Sta	Sewage Pumping Station
El P	Electricity Pole, Pillar	SB, S Br	Signal Box or Bridge
El Sub Sta	Electricity Sub Station	SP, SL	Signal Post or Light
FB	Filter Bed	Spr	Spring
Fn / D Fn	Fountain / Drinking Ftn.	Tk	Tank or Track
Gas Gov	Gas Valve Compound	Tr	Trough
GVC	Gas Governer	Wd Pp	Wind Pump
GP	Guide Post	Wr Pt, Wr T	Water Point, Water Tap
MH	Manhole	Wks	Works (building or area)
MP, MS	Mile Post or Mile Stone	W	Well

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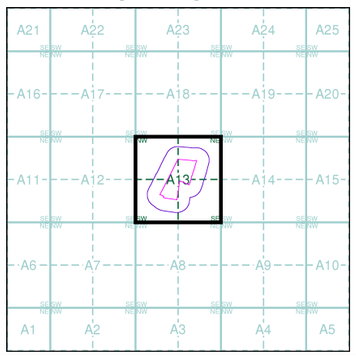
Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Cheshire	1:2,500	1877	2
Lancashire And Furness	1:2,500	1894	3
Cheshire	1:2,500	1898	4
Lancashire And Furness	1:2,500	1907	5
Cheshire	1:2,500	1910	6
Lancashire And Furness	1:2,500	1933	7
Ordnance Survey Plan	1:1,250	1951 - 1955	8
Ordnance Survey Plan	1:2,500	1952 - 1955	9
Additional SIMs	1:1,250	1955 - 1980	10
Ordnance Survey Plan	1:1,250	1963 - 1971	11
Supply of Unpublished Survey Information	1:1,250	1975	12
Additional SIMs	1:1,250	1987	13
Large-Scale National Grid Data	1:1,250	1992	14
Historical Aerial Photography	1:2,500	2000	15

Historical Map - Segment A13



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National Grid Reference:	381090, 394580
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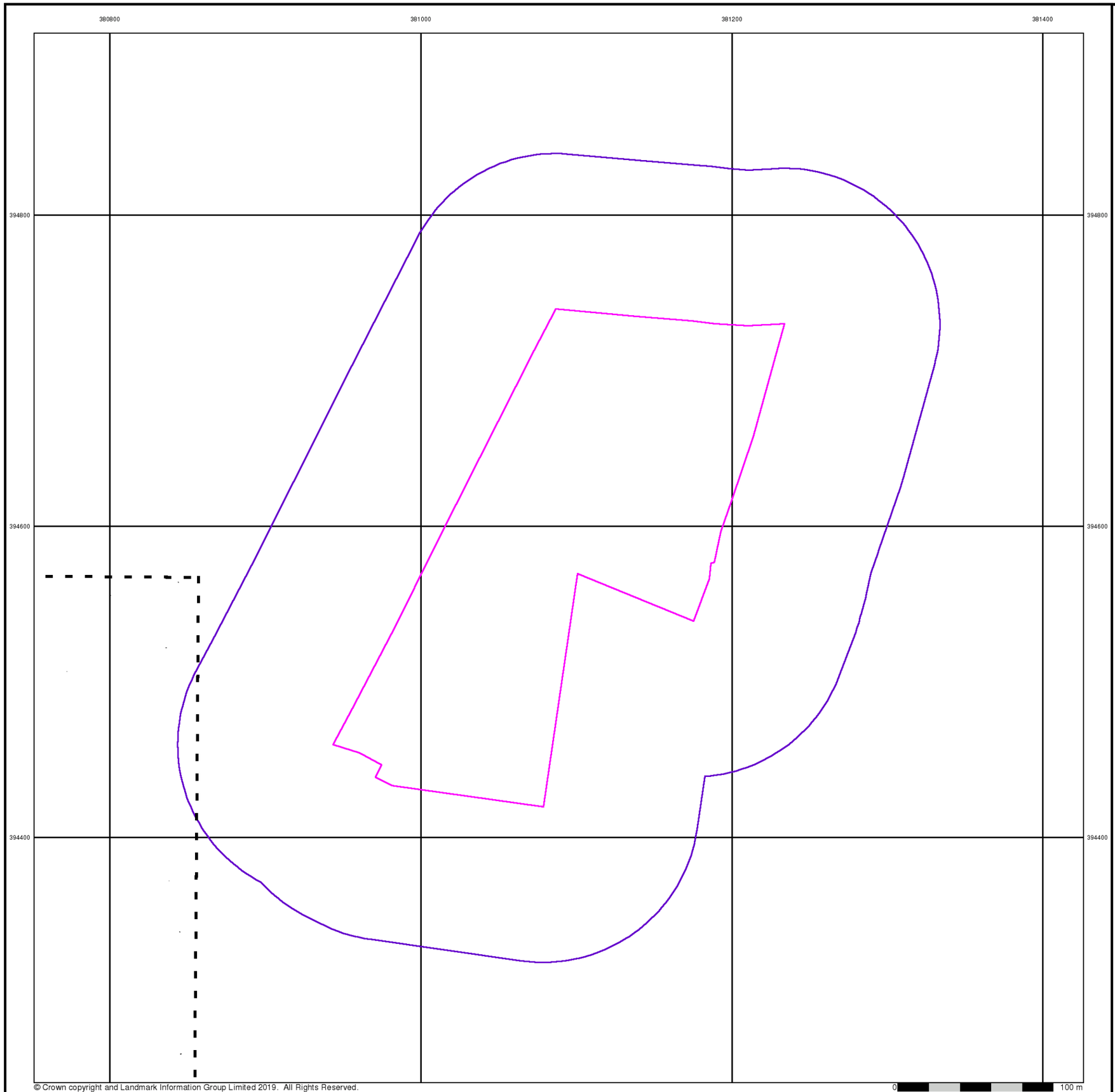
Site Area (Ha):	4.6
Search Buffer (m):	100

Site Details

St. Johns R C Primary School, Chepstow Road, MANCHESTER, M21 9SN

Landmark INFORMATION GROUP

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



e3p

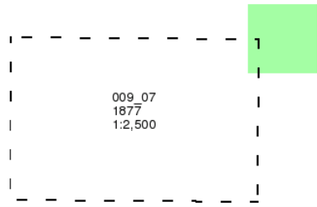
Cheshire

Published 1877

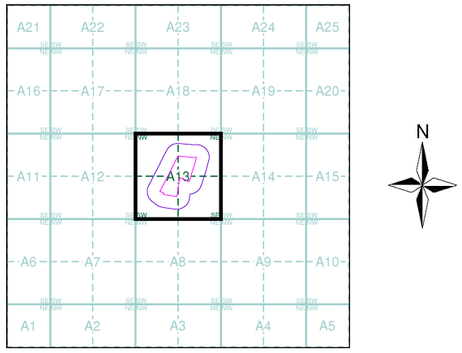
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



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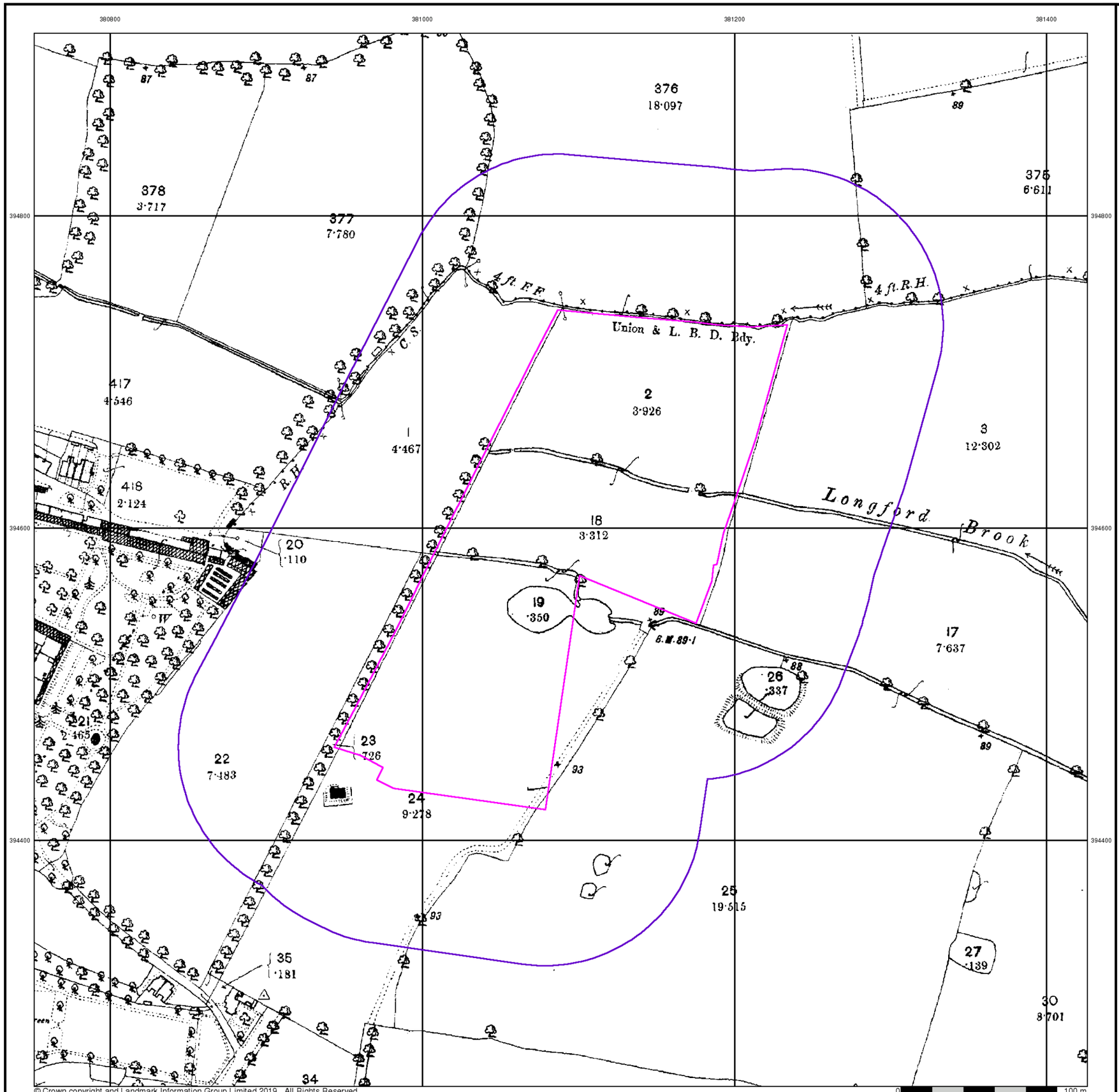

0 100 m

e3p

Lancashire And Furness

Published 1894

Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

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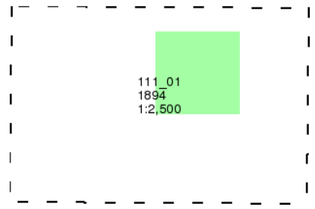
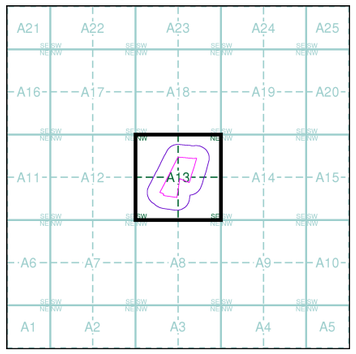


Historical Map - Segment A13



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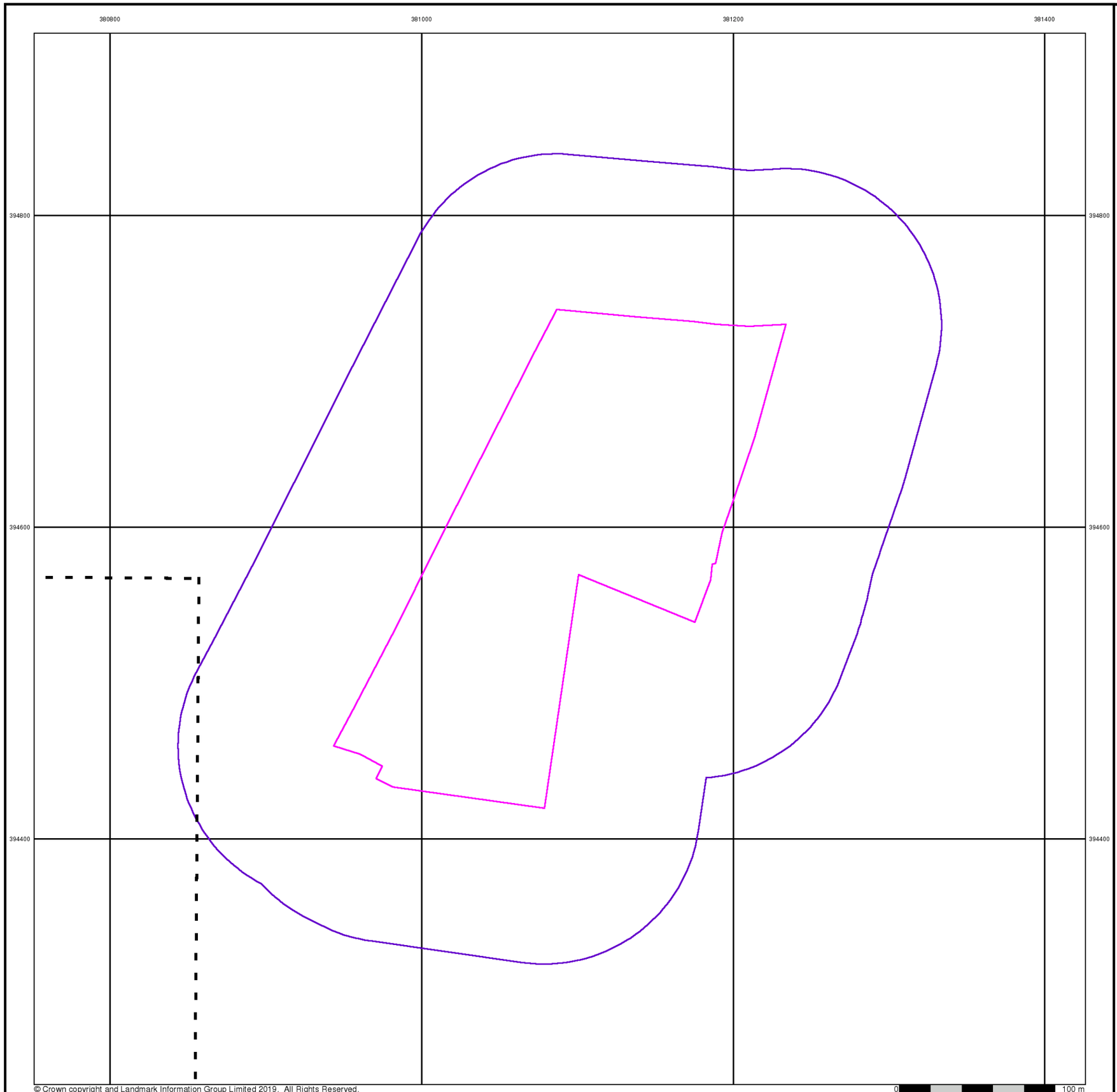

e3p

Cheshire

Published 1898

Source map scale - 1:2,500

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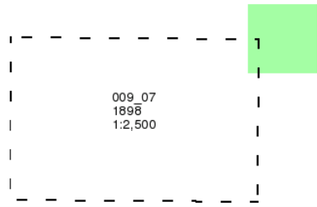
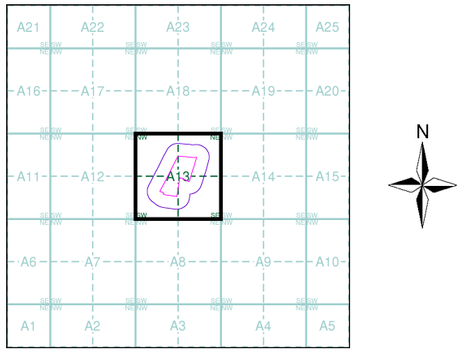


Historical Map - Segment A13



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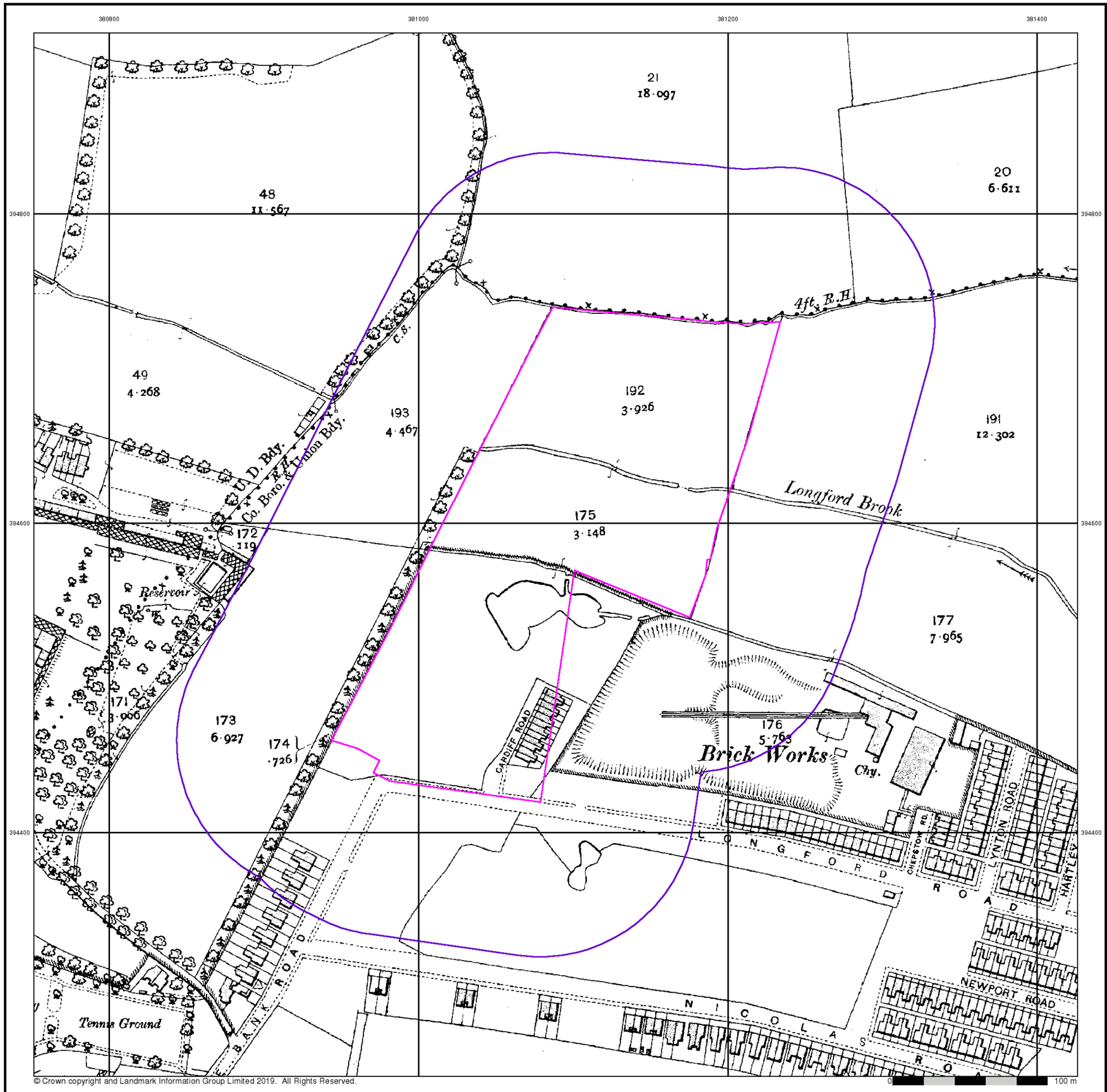


e3p

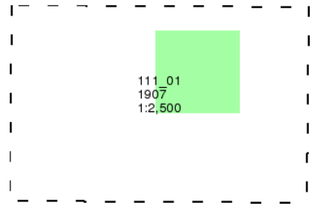
Lancashire And Furness

Published 1907

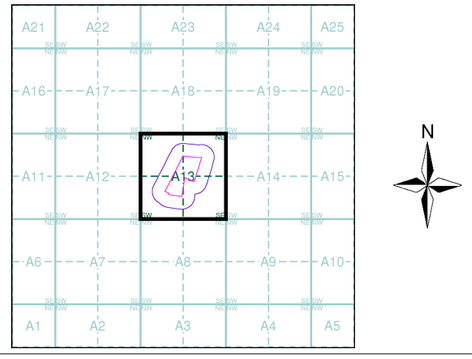
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



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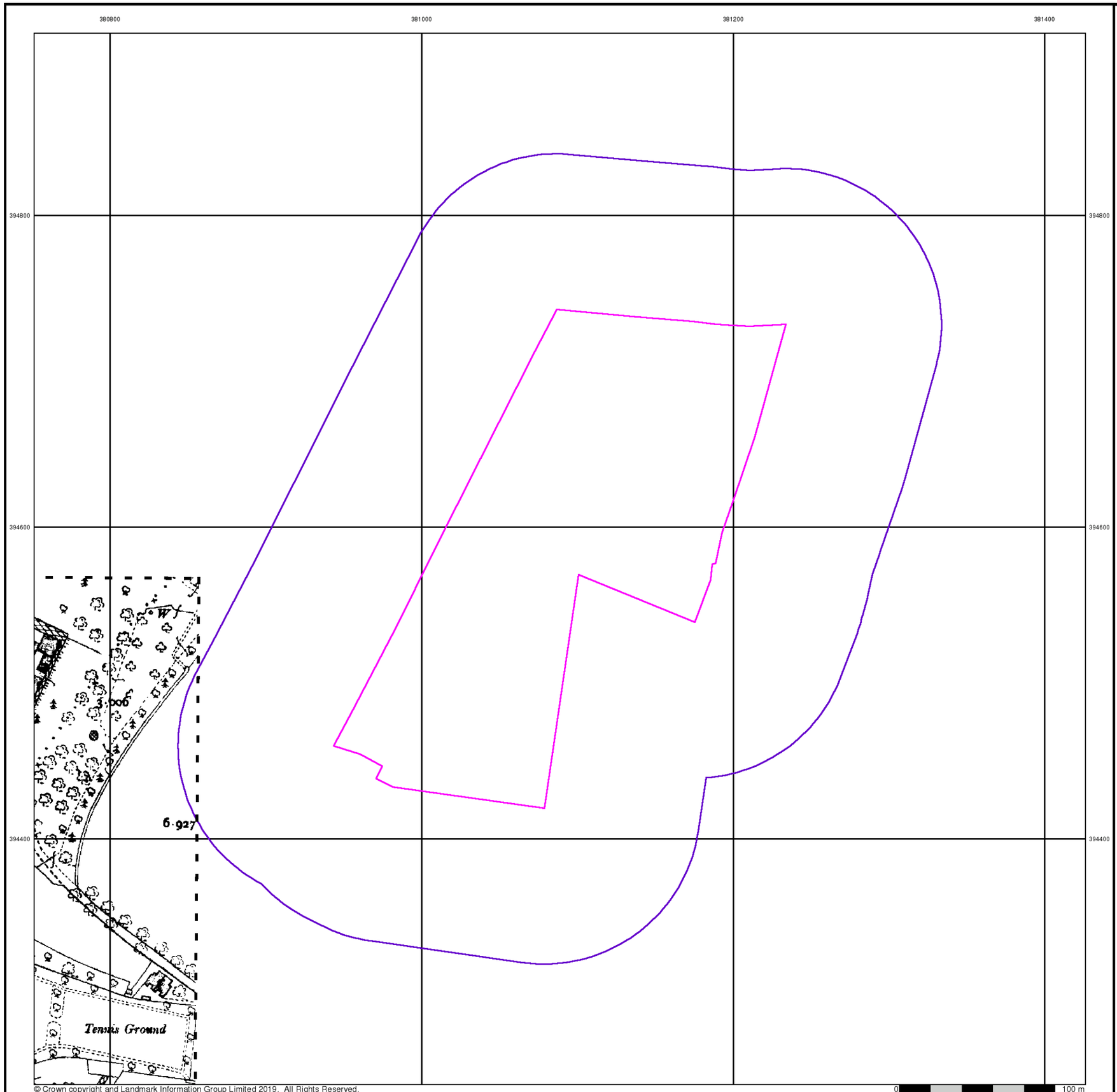

e3p

Cheshire

Published 1910

Source map scale - 1:2,500

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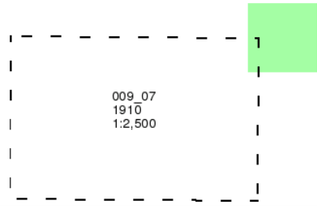
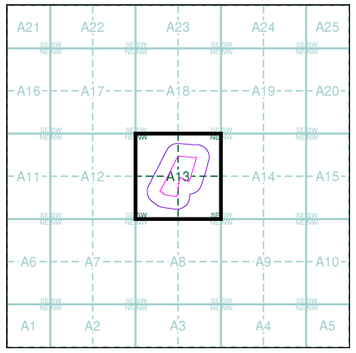


Historical Map - Segment A13



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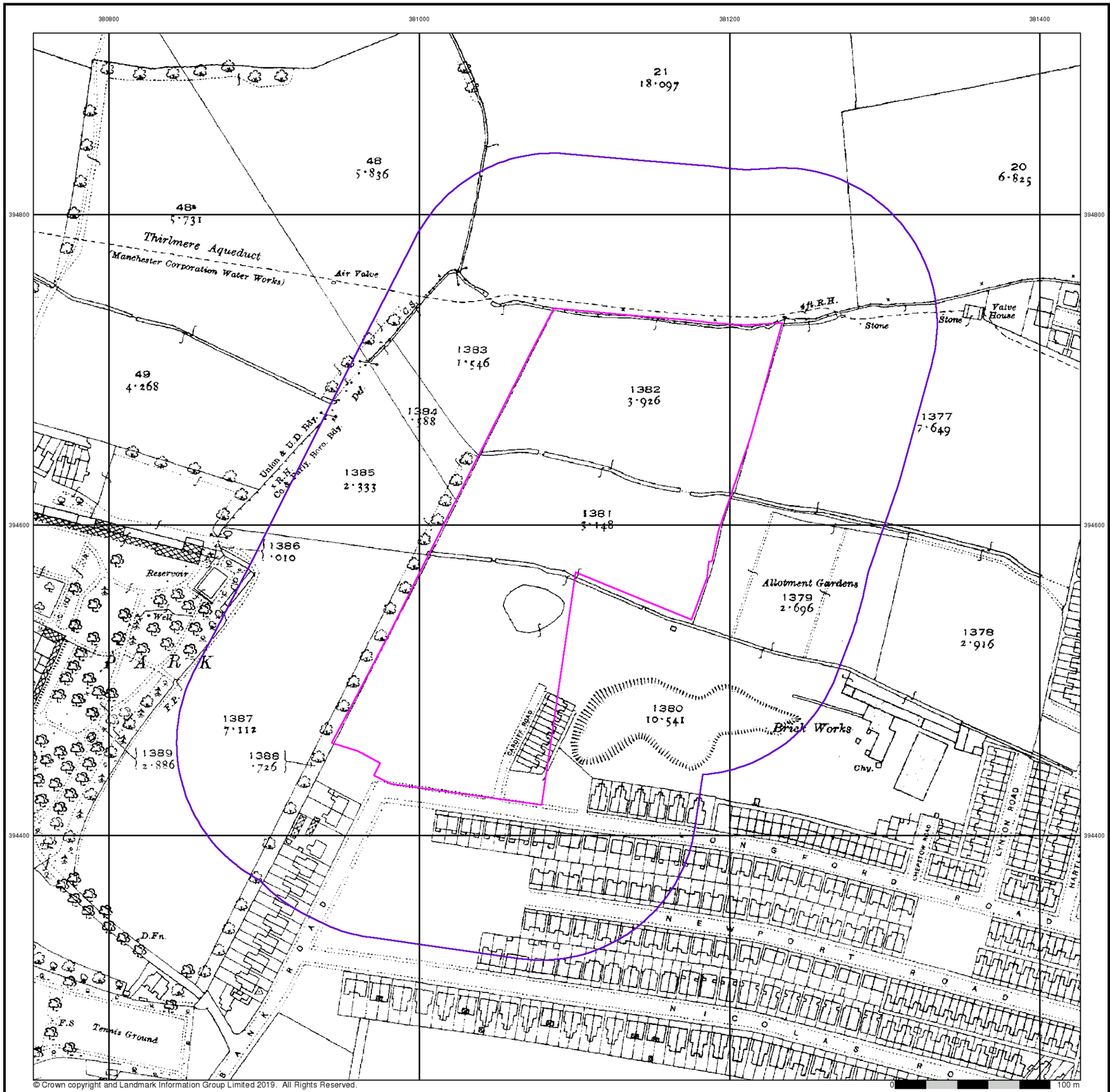

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Lancashire And Furness

Published 1933

Source map scale - 1:2,500

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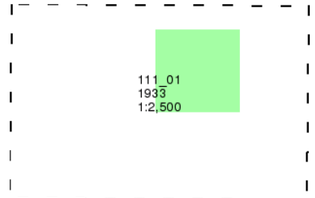
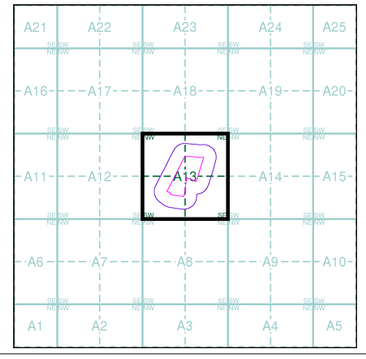
Map Name(s) and Date(s)



Historical Map - Segment A13



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National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
Search Buffer (m):	100

Site Details

St. Johns R C Primary School, Chepstow Road, MANCHESTER, M21 9SN

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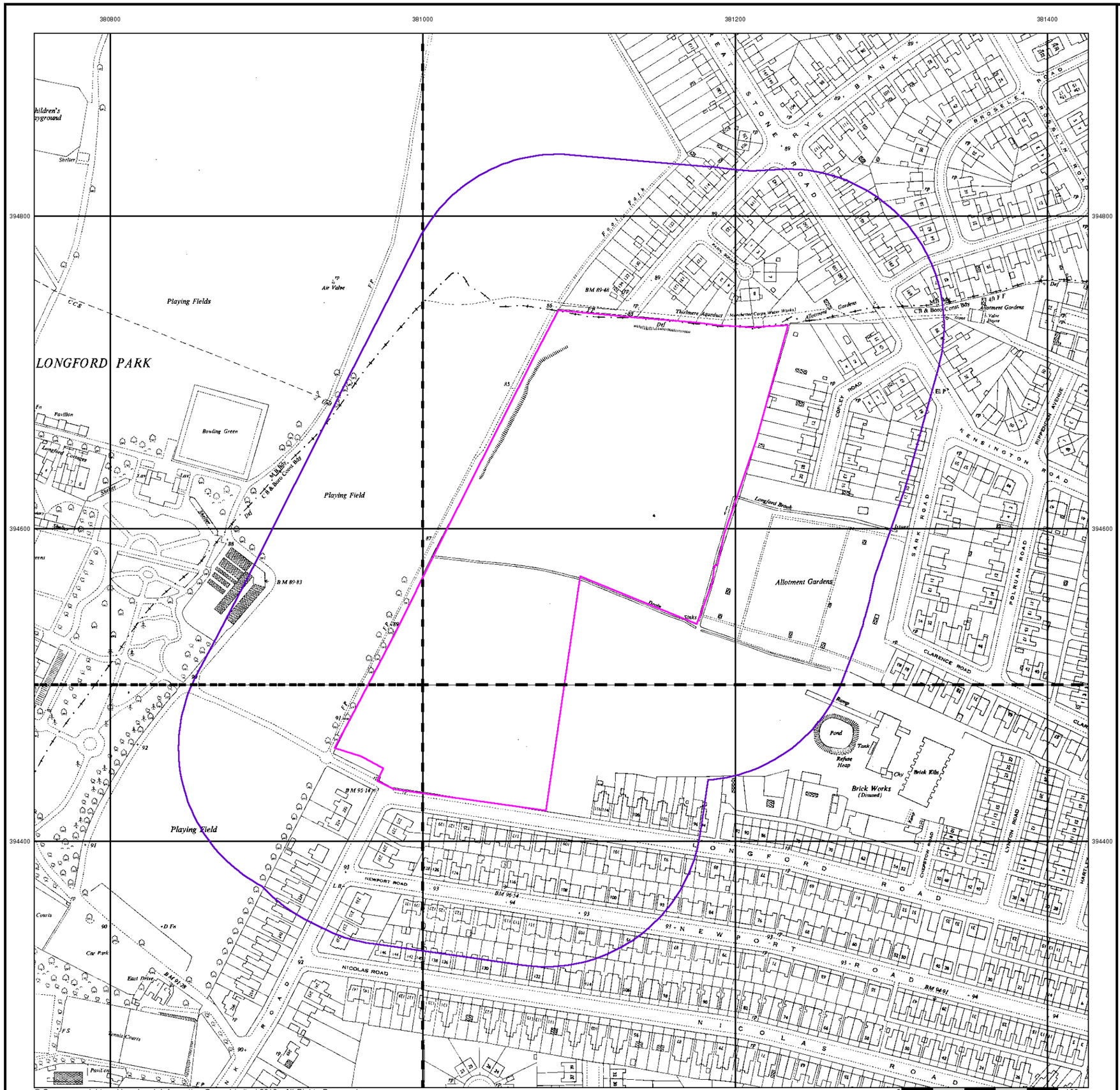


0 100 m

e3p

Ordnance Survey Plan

Published 1951 - 1955

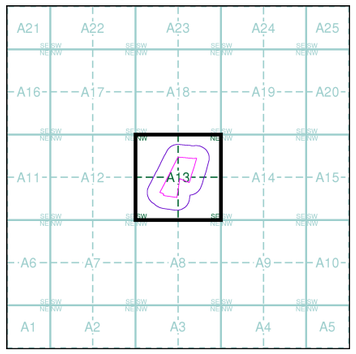
Source map scale - 1:1,250

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)

SJ8094NE 1955 1:1,250	SJ8194NW 1951 1:1,250
SJ8094SE 1955 1:1,250	SJ8194SW 1951 1:1,250

Historical Map - Segment A13



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
Search Buffer (m):	100

Site Details

St. Johns R C Primary School, Chepstow Road, MANCHESTER, M21 9SN

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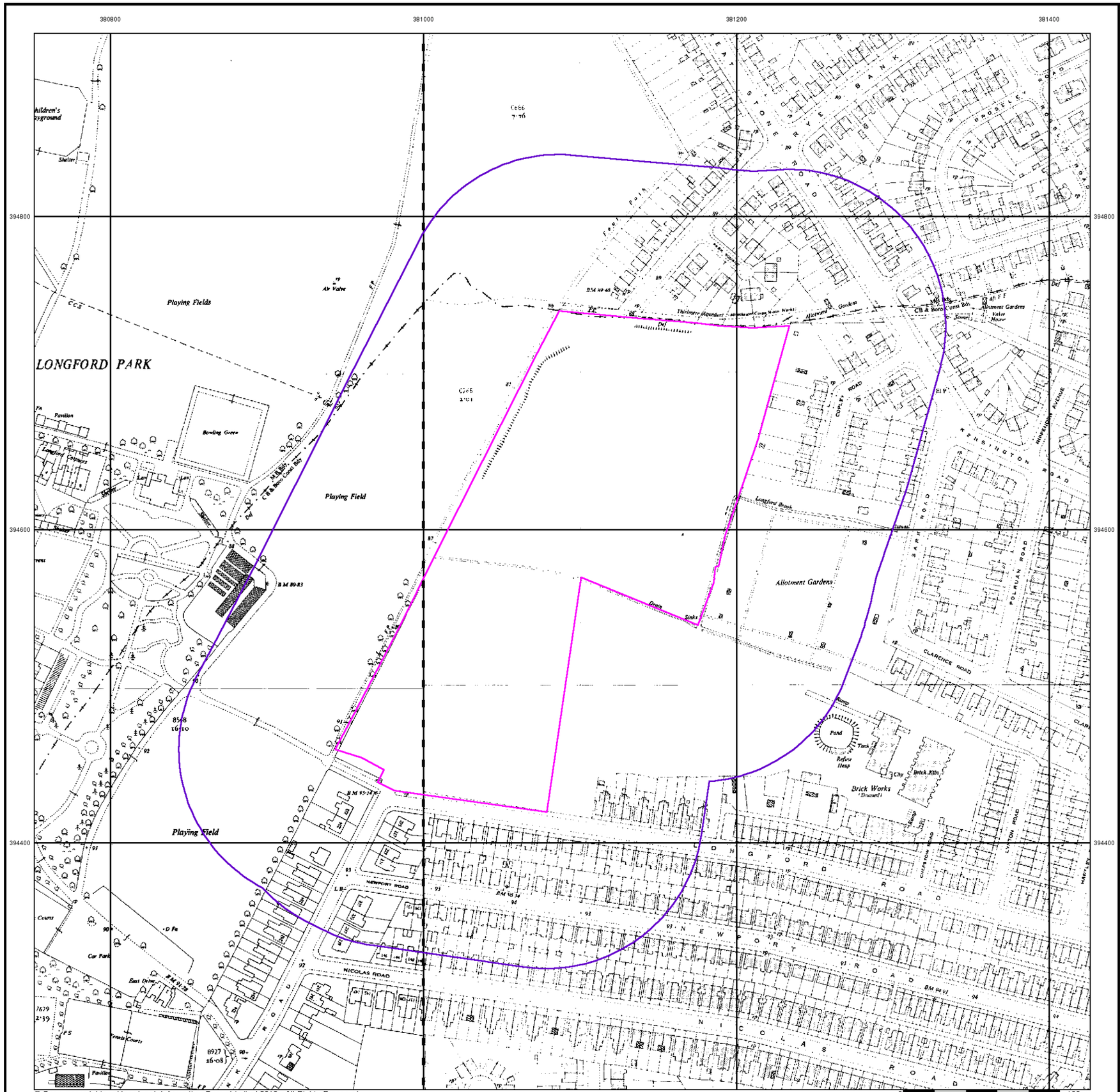


e3p

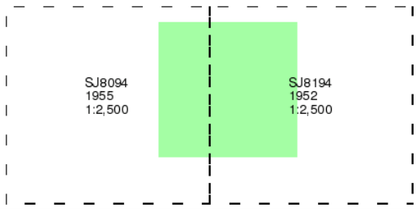
Ordnance Survey Plan

Published 1952 - 1955

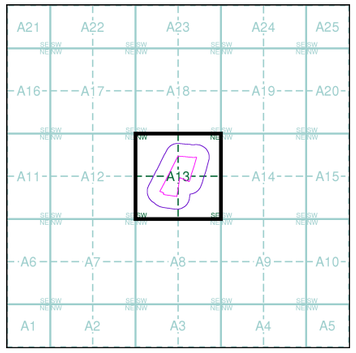
Source map scale - 1:2,500

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
Search Buffer (m):	100

Site Details

St. Johns R C Primary School, Chepstow Road, MANCHESTER, M21 9SN

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

e3p

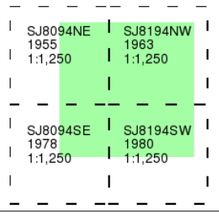
Additional SIMs

Published 1955 - 1980

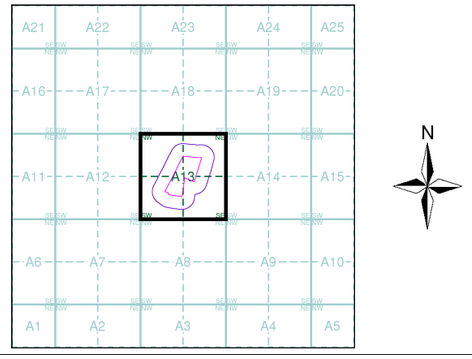
Source map scale - 1:1,250

The SIM cards (Ordnance Survey's `Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
Search Buffer (m):	100

Site Details

St. Johns R C Primary School, Chepstow Road, MANCHESTER, M21 9SN

Landmark INFORMATION GROUP
Tel: 0844 844 9952
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Web: www.envirocheck.co.uk

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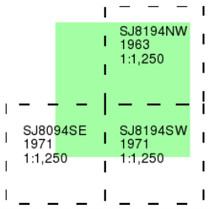
Ordnance Survey Plan

Published 1963 - 1971

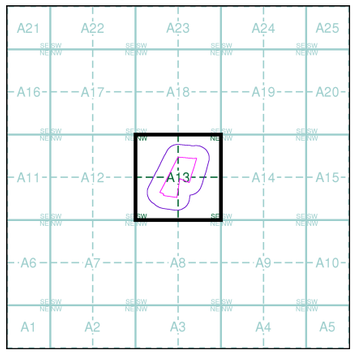
Source map scale - 1:1,250

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
Search Buffer (m):	100

Site Details

St. Johns R C Primary School, Chepstow Road, MANCHESTER, M21 9SN

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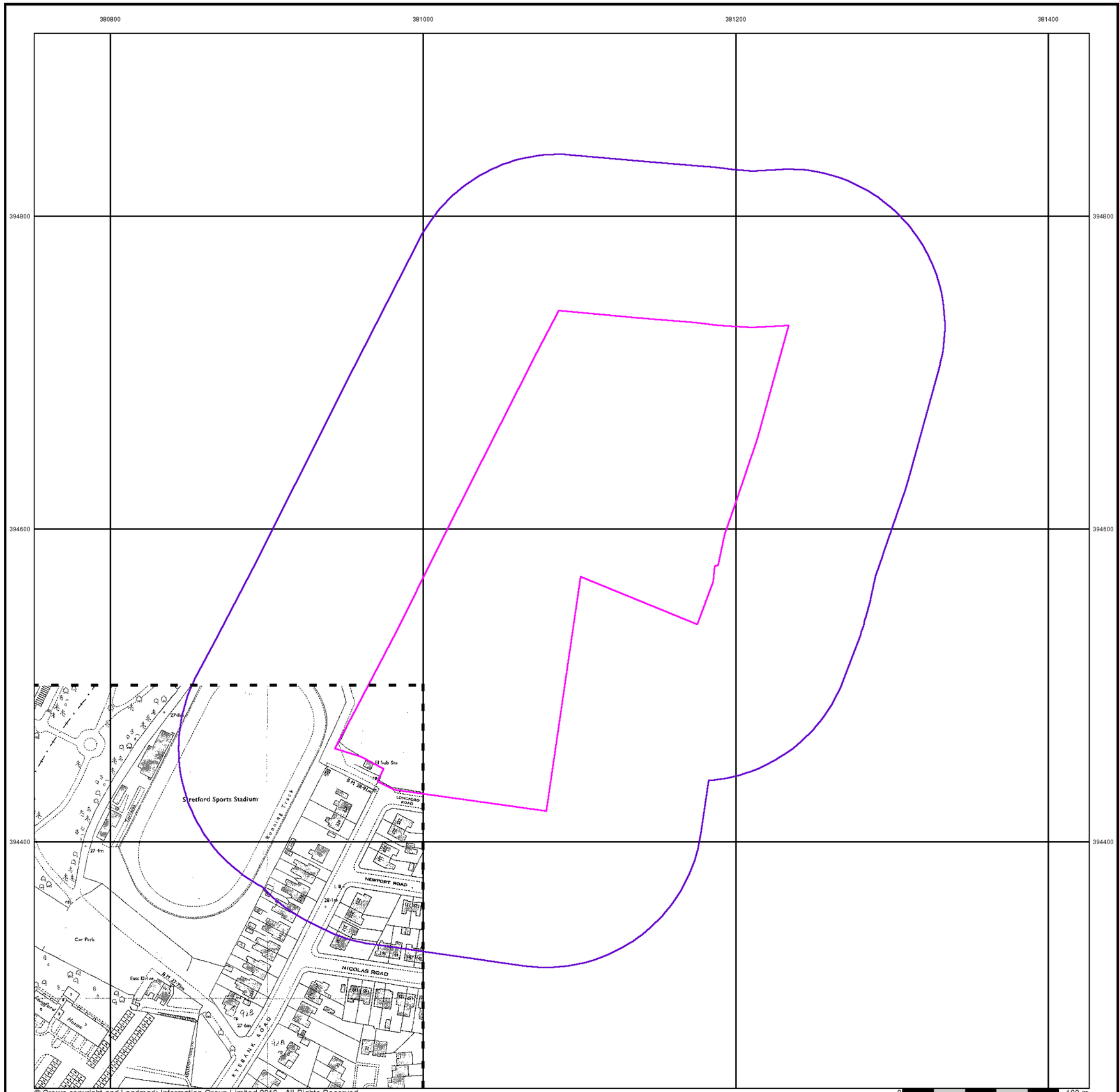


e3p

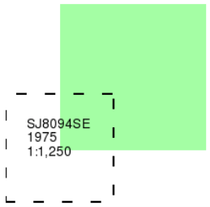
Supply of Unpublished Survey Information

Published 1975

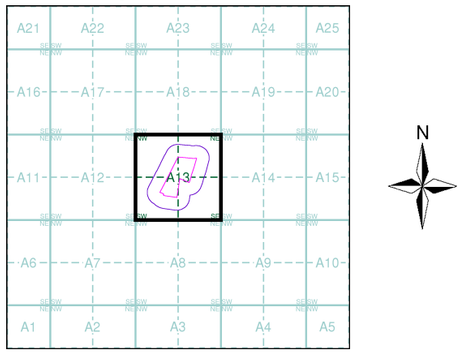
Source map scale - 1:1,250

SUSI maps (Supply of Unpublished Survey Information) were produced between 1972 and 1977, mainly for internal use at Ordnance Survey. These were more of a `work-in-progress' plan as they showed updates of individual areas on a map. These maps were unpublished, and they do not represent a single moment in time. They were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



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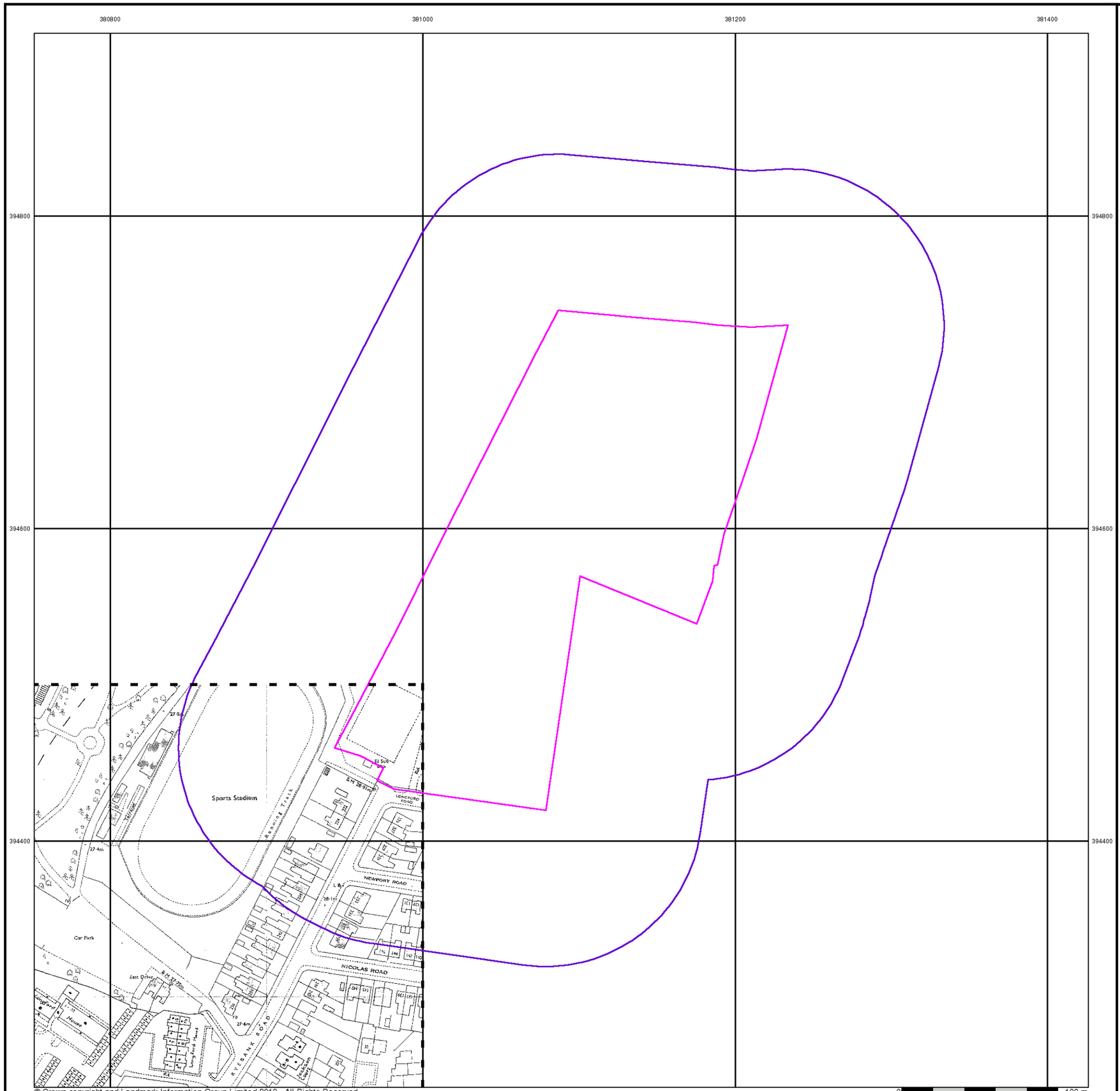


e3p

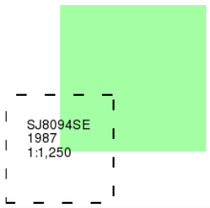
Additional SIMs

Published 1987

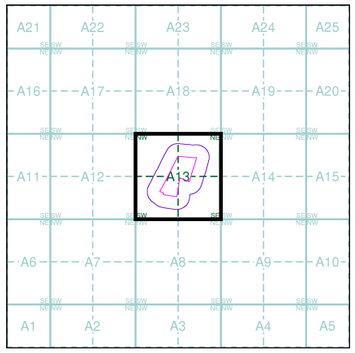
Source map scale - 1:1,250

The SIM cards (Ordnance Survey's `Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



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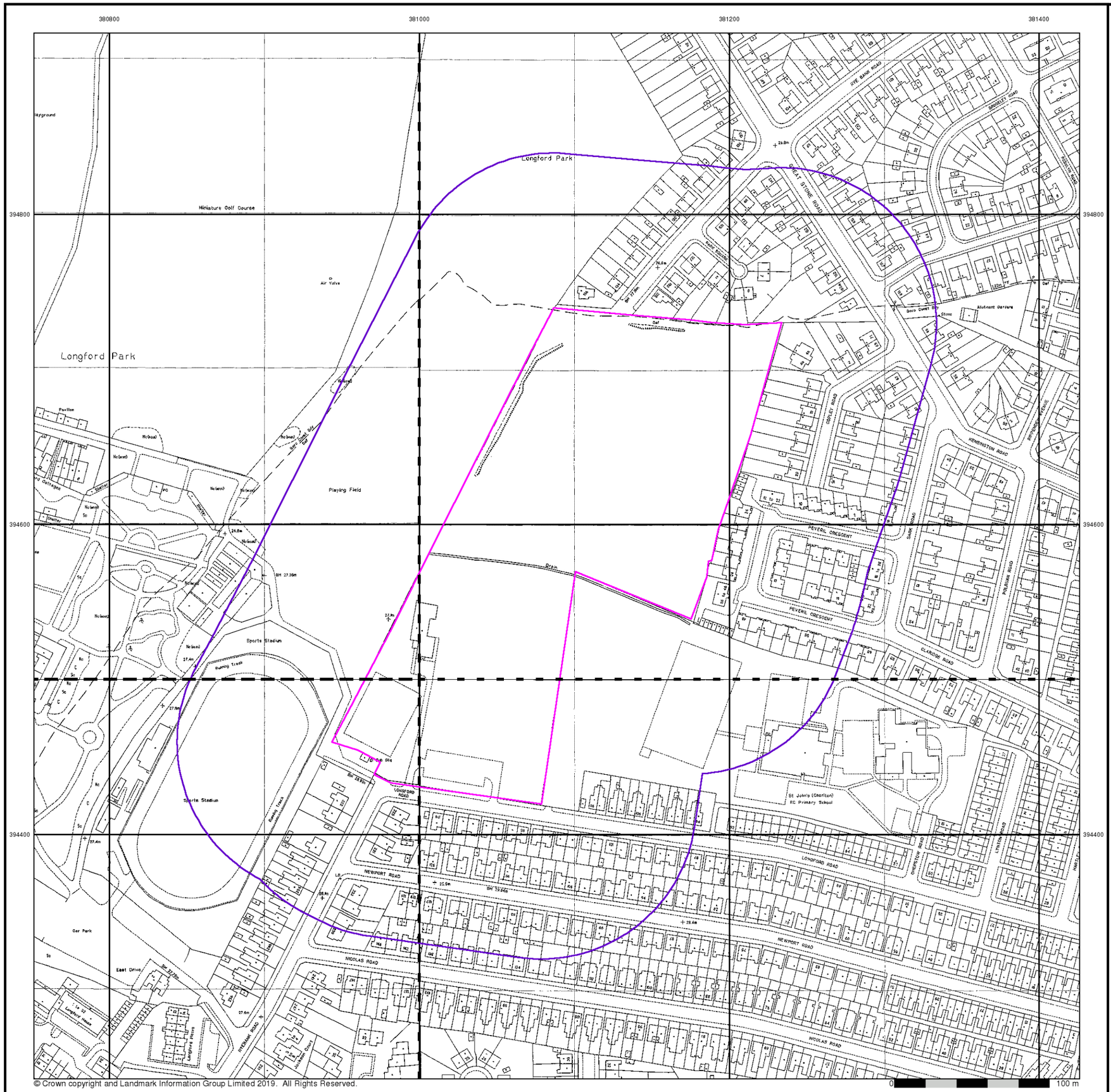


e3p

Large-Scale National Grid Data

Published 1992

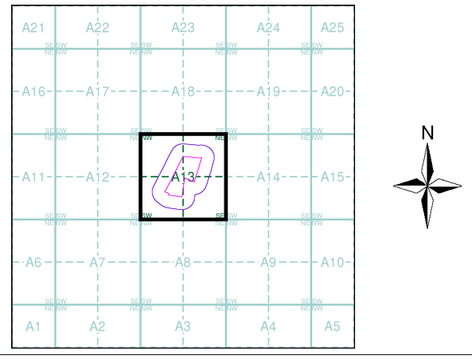
Source map scale - 1:1,250

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)

SJ8094NE 1992 1:1,250	SJ8194NW 1992 1:1,250
SJ8094SE 1992 1:1,250	SJ8194SW 1992 1:1,250

Historical Map - Segment A13



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National Grid Reference:	381090, 394580
Slice:	A
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Search Buffer (m):	100

Site Details

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Web: www.envirocheck.co.uk

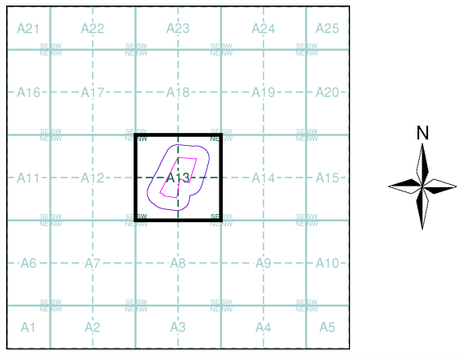
e3p

Historical Aerial Photography

Published 2000

This aerial photography was produced by Getmapping, these vertical aerial photographs provide a seamless, full colour survey of the whole of Great Britain

Historical Aerial Photography - Segment A13



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
Search Buffer (m):	100

Site Details

St. Johns R C Primary School, Chepstow Road,
MANCHESTER, M21 9SN

Landmark INFORMATION GROUP

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Fax: 0844 844 9951
Web: www.envirocheck.co.uk

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

Gravel Pit
Sand Pit
Other Pits
Quarry
Shingle
Orchard
Osiers
Reeds
Marsh
Mixed Wood
Deciduous
Brushwood
Fir
Furze
Rough Pasture
Arrow denotes flow of water
Trigonometrical Station
Site of Antiquities
Bench Mark
Pump, Guide Post, Signal Post
Well, Spring, Boundary Post
285 Surface Level
Sketched Contour
Instrumental Contour
Main Roads
Fenced
Un-Fenced
Minor Roads
Fenced
Un-Fenced
Sunken Road
Raised Road
Road over Railway
Railway over River
Railway over Road
Level Crossing
Road over River or Canal
Road over Stream
Road over Stream
County Boundary (Geographical)
County & Civil Parish Boundary
Administrative County & Civil Parish Boundary
Co. Boro. Bdy.
County Borough Boundary (England)
Co. Burgh Bdy.
County Burgh Boundary (Scotland)
R.D. Bdy.
Rural District Boundary
Civil Parish Boundary

Ordnance Survey Plan 1:10,000

Chalk Pit, Clay Pit or Quarry
Gravel Pit
Sand Pit
Disused Pit or Quarry
Refuse or Slag Heap
Lake, Loch or Pond
Dunes
Boulders
Coniferous Trees
Non-Coniferous Trees
Orchard
Scrub
Coppice
Bracken
Heath
Rough Grassland
Marsh
Reeds
Saltings
Building
Direction of Flow of Water
Shingle
Sand
Glasshouse
Pylon
Pylon
Electricity Transmission Line
Sloping Masonry
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
Standard Gauge Single Track
Siding, Tramway or Mineral Line
Narrow Gauge
Geographical County
Administrative County, County Borough or County of City
Municipal Borough, Urban or Rural District, Burgh or District Council
Borough, Burgh or County Constituency
Shown only when not coincident with other boundaries
Civil Parish
Shown alternately when coincidence of boundaries occurs

BP, BS	Boundary Post or Stone	Pol Sta	Police Station
Ch	Church	PO	Post Office
CH	Club House	PC	Public Convenience
F E Sta	Fire Engine Station	PH	Public House
FB	Foot Bridge	SB	Signal Box
Fn	Fountain	Spr	Spring
GP	Guide Post	TCB	Telephone Call Box
MP	Mile Post	TCP	Telephone Call Post
MS	Mile Stone	W	Well

1:10,000 Raster Mapping

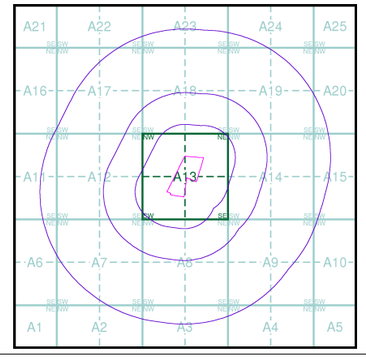
Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Mud
Sand
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or community boundary
District, Unitary, Metropolitan, London Borough boundary
Constituency boundary
Area of wooded vegetation
Non-coniferous trees
Non-coniferous trees (scattered)
Coniferous trees
Coniferous trees (scattered)
Positioned tree
Orchard
Coppice or Osiers
Rough Grassland
Heath
Scrub
Marsh, Salt Marsh or Reeds
Water feature
Flow arrows
MHW(S) Mean high water (springs)
MLW(S) Mean low water (springs)
Telephone line (where shown)
Electricity transmission line (with poles)
BM 123.45 m Bench mark (where shown)
Triangulation station
Point feature (e.g. Guide Post or Mile Stone)
Pylon, flare stack or lighting tower
Site of (antiquity)
Glasshouse
General Building
Important Building

e3p

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Lancashire And Furness	1:10,560	1848	3
Cheshire	1:10,560	1882	4
Lancashire And Furness	1:10,560	1894 - 1896	5
Cheshire	1:10,560	1899	6
Lancashire And Furness	1:10,560	1908 - 1909	7
Cheshire	1:10,560	1911	8
Lancashire And Furness	1:10,560	1923	9
Lancashire And Furness	1:10,560	1932 - 1934	10
Lancashire And Furness	1:10,560	1938	11
Cheshire	1:10,560	1938	12
Ordnance Survey Plan	1:10,000	1954 - 1956	13
Ordnance Survey Plan	1:10,000	1959	14
Ordnance Survey Plan	1:10,000	1965 - 1966	15
Ordnance Survey Plan	1:10,000	1971 - 1979	16
Manchester	1:25,000	1975	17
Ordnance Survey Plan	1:10,000	1980 - 1984	18
Ordnance Survey Plan	1:10,000	1985 - 1989	19
Ordnance Survey Plan	1:10,000	1989	20
Ordnance Survey Plan	1:10,000	1990 - 1994	21
10K Raster Mapping	1:10,000	1999	22
10K Raster Mapping	1:10,000	2006	23
VectorMap Local	1:10,000	2019	24

Historical Map - Slice A



Order Details

Order Number: 222286198_1_1
Customer Ref: 13533-em
National Grid Reference: 381090, 394580
Slice: A
Site Area (Ha): 4.6
Search Buffer (m): 1000

Site Details

St. Johns R C Primary School, Chepstow Road, MANCHESTER, M21 9SN

Landmark INFORMATION GROUP
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Russian Military Mapping Legends

1:5,000 and 1:10,000 mapping

a. Not drawn to scale b. Drawn to scale

- Government and Administrative Buildings
- Military and Industrial Buildings
- Military and Communication Areas
- Subway Entrance
- Fireproof Building
- Prominent Fireproof Building
- Non-fireproof Building
- Non-fireproof Building (non-dwelling)
- Factory, mill, and flour mill, with chimneys
- Factory, mill, and flour mill, without chimneys
- Power Station, drawn to scale (эл.ст.)
- Hydroelectric Power Station (ГЭС)
- Radio Station, drawn to scale
- Telephone Station, drawn to scale
- Abandoned Open-pit Mine or Quarry
- Open-pit Salt Mine (сол.)
- Pit (−1,5)
- Oil Deposit or Well (нефть)
- Oil Seepage (нефть)
- Tailings Pile (+7.0 отвал)
- Fuel Storage Tanks (скл. гор.)
- Natural Gas Tank (газг.)
- Bench Mark (125.4 / 125.1)
- Drill Hole (бур.)
- Burial Mound (+2.0)
- Triangulation Point on Burial Mound (+1.2 67.8)
- Single-track Railroad (Fill, раз., платф., Cut)
- Double-track Railroad and Station Building (Small Bridge, ст., тун., Tunnel, Pipe (Culvert))
- Coniferous Forest (сосна 24 0.30)
- Deciduous Forest (клен 12 0.20)
- Mixed Forest (ель береза 20 0.25)
- Lawns
- Citrus Orchard
- Wet Ground
- Scattered Vegetation

243,8 — Values for prominent elevations

186.0 — Numbers for spot elevations, depth soundings, contour lines, etc.

0,2 — Velocity of the current, width of river bed, depth of river

180/12 180/12 — Fractional terms: length and capacity of bridges; depth of fords and condition of the river bottom; height of forest and the diameter of trees

Russian Alphabet (For reference and phonetic interpretation of map text)

А а (A)	З з (Z)	П п (P)	Ч ч (CH)
Б б (B)	И и (I)	Р р (R)	Ш ш (SH)
В в (V)	Й й (Y)	С с (S)	Щ щ (SHCH)
Г г (G)	К к (K)	Т т (T)	ъ (–)
Д д (D)	Л л (L)	У у (U)	ы (Y)
Е е (E)	М м (M)	Ф ф (F)	ь (')
Ё ё (YO)	Н н (N)	Х х (KH)	Э э (E)
Ж ж (ZH)	О о (O)	Ц ц (TS)	Ю ю (YU or IU)
			Я я (YA or IA)

1:25,000 mapping

a. Not drawn to scale b. Drawn to scale

- Government and Administrative Buildings
- Military and Industrial Buildings
- Military and Communication Areas
- Subway Entrance
- Partly Demolished Buildings
- Demolished Buildings
- Built-Up Area with Fireproof Buildings Predominant
- Built-Up Area with Non-Fireproof Buildings Predominant
- Individual Fireproof Building
- Prominent Industrial Building
- Individual Dwelling, Fireproof
- Ruins of an Individual Dwelling
- Factory or Mill Chimney
- Factory or Mill with Chimney (бум.)
- Factory or Mill without Chimney (скип.)
- Mine or Open Pit Mine (медн.)
- Operating Shaft or Mine (кам. уг.)
- Non-Operating Shaft or Mine
- Salt Mine (сол.)
- Tailings Pile
- Pit (−1.7)
- Stone Quarry (гл. пес. кам.)
- Gas Pump or Service Station
- Fuel Storage or Natural Gas Tank
- Oil or Natural Gas Derrick
- Small Hydroelectric Power Station
- Power Station
- Transformer Station (б.тр.)
- Cemetery
- Burial Mound (height in metres) (+8.1)
- Triangulation Point on Burial Mound (95.7)
- Triangulation Point (92.6)
- Bench Mark (52.1)
- Bench Mark (monumented) (71.1)
- Telegraph Office
- Telephone Station
- Radio Station
- Radio Tower
- Airfield or Seaplane Base
- Landing Strip
- Main Highway (Cut, Fill, Km Post, Plantings, Telegraph/Telephone Lines)
- Highway under Construction
- Improved Dirt Road (former truck road) (Width of Road 6, Steep Grade)
- Double-track Railroad with First Class Station (Small Bridge, ст., Pipe (Culvert), Tunnel)
- Dismantled Railroad
- Railroad Under Construction
- Shore Embankment
- River or Ditch with Embankment (+2.4)
- Direction and velocity of current (0.2, 135.1, Water Gauge, Water Level Mark)
- Well (К. 125.0 гл.8м (г.-сол.))
- Water Reservoir or Rain Water Pit (вдхр.)
- Spring (156.2 кл.)
- Isobath with value (20)
- Heavy (Index) Contour Line
- Contour Line and Value (20)
- Half Contour Line
- Spot Elevation Value (347.1)
- Coniferous
- Deciduous
- Mixed
- Scrub

Key to Numbers on Mapping

SJ89_Manchester

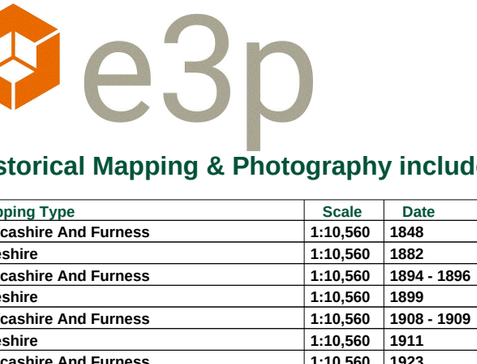
No.	Description
151	Council/Government Buildings/Courts

e3p

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Lancashire And Furness	1:10,560	1848	3
Cheshire	1:10,560	1882	4
Lancashire And Furness	1:10,560	1894 - 1896	5
Cheshire	1:10,560	1899	6
Lancashire And Furness	1:10,560	1908 - 1909	7
Cheshire	1:10,560	1911	8
Lancashire And Furness	1:10,560	1923	9
Lancashire And Furness	1:10,560	1932 - 1934	10
Lancashire And Furness	1:10,560	1938	11
Cheshire	1:10,560	1938	12
Ordnance Survey Plan	1:10,000	1954 - 1956	13
Ordnance Survey Plan	1:10,000	1959	14
Ordnance Survey Plan	1:10,000	1965 - 1966	15
Ordnance Survey Plan	1:10,000	1971 - 1979	16
Manchester	1:25,000	1975	17
Ordnance Survey Plan	1:10,000	1980 - 1984	18
Ordnance Survey Plan	1:10,000	1985 - 1989	19
Ordnance Survey Plan	1:10,000	1989	20
Ordnance Survey Plan	1:10,000	1990 - 1994	21
10K Raster Mapping	1:10,000	1999	22
10K Raster Mapping	1:10,000	2006	23
VectorMap Local	1:10,000	2019	24

Russian Map - Slice A



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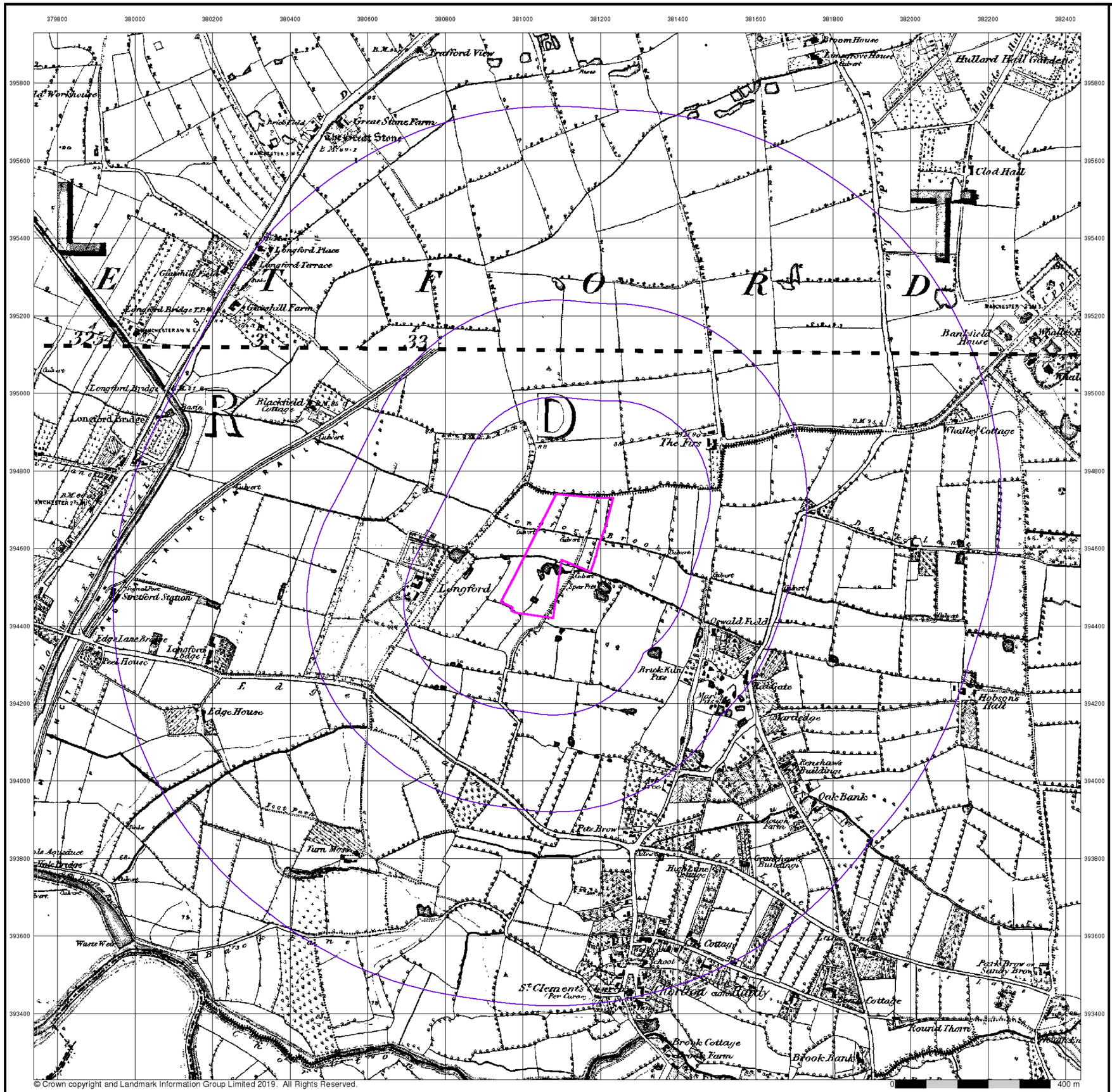

e3p

Lancashire And Furness

Published 1848

Source map scale - 1:10,560

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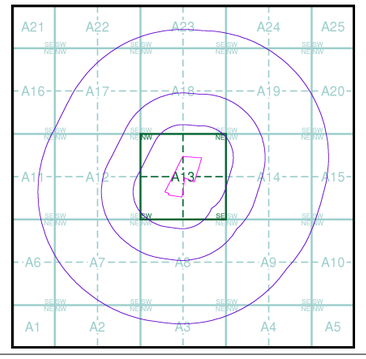
Map Name(s) and Date(s)

10400
1848
1:10,560

11100
1848
1:10,560

Historical Map - Slice A



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Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
Search Buffer (m):	1000

Site Details

St. Johns R C Primary School, Chepstow Road, MANCHESTER, M21 9SN

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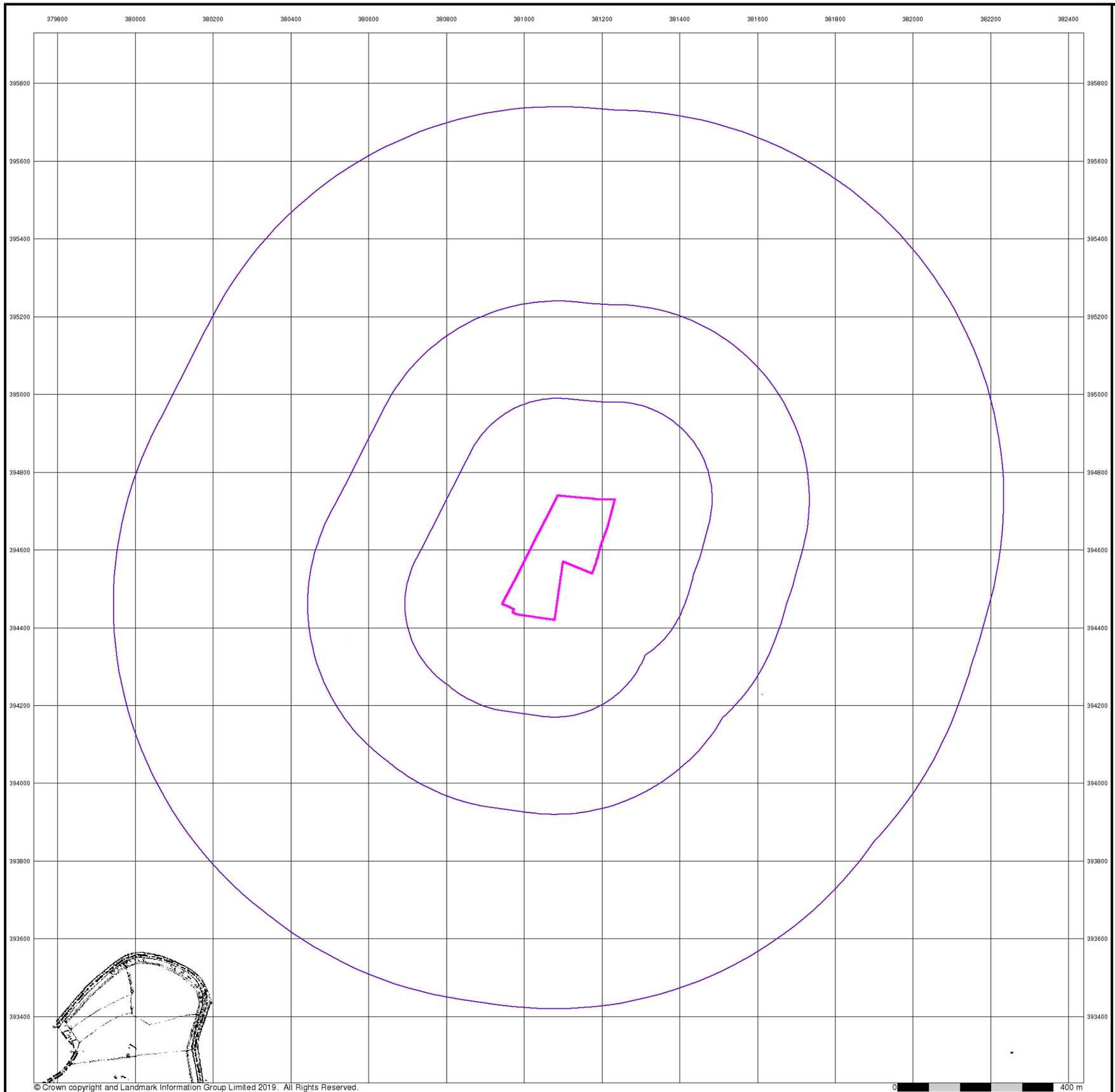
Web: www.envirocheck.co.uk



e3p

Cheshire

Published 1882

Source map scale - 1:10,560

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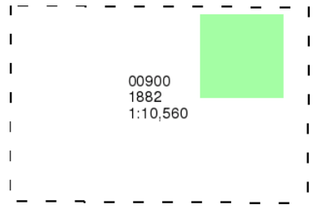
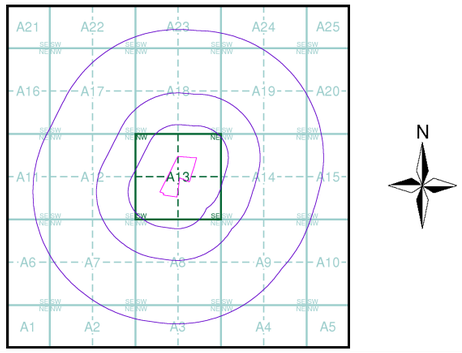
Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

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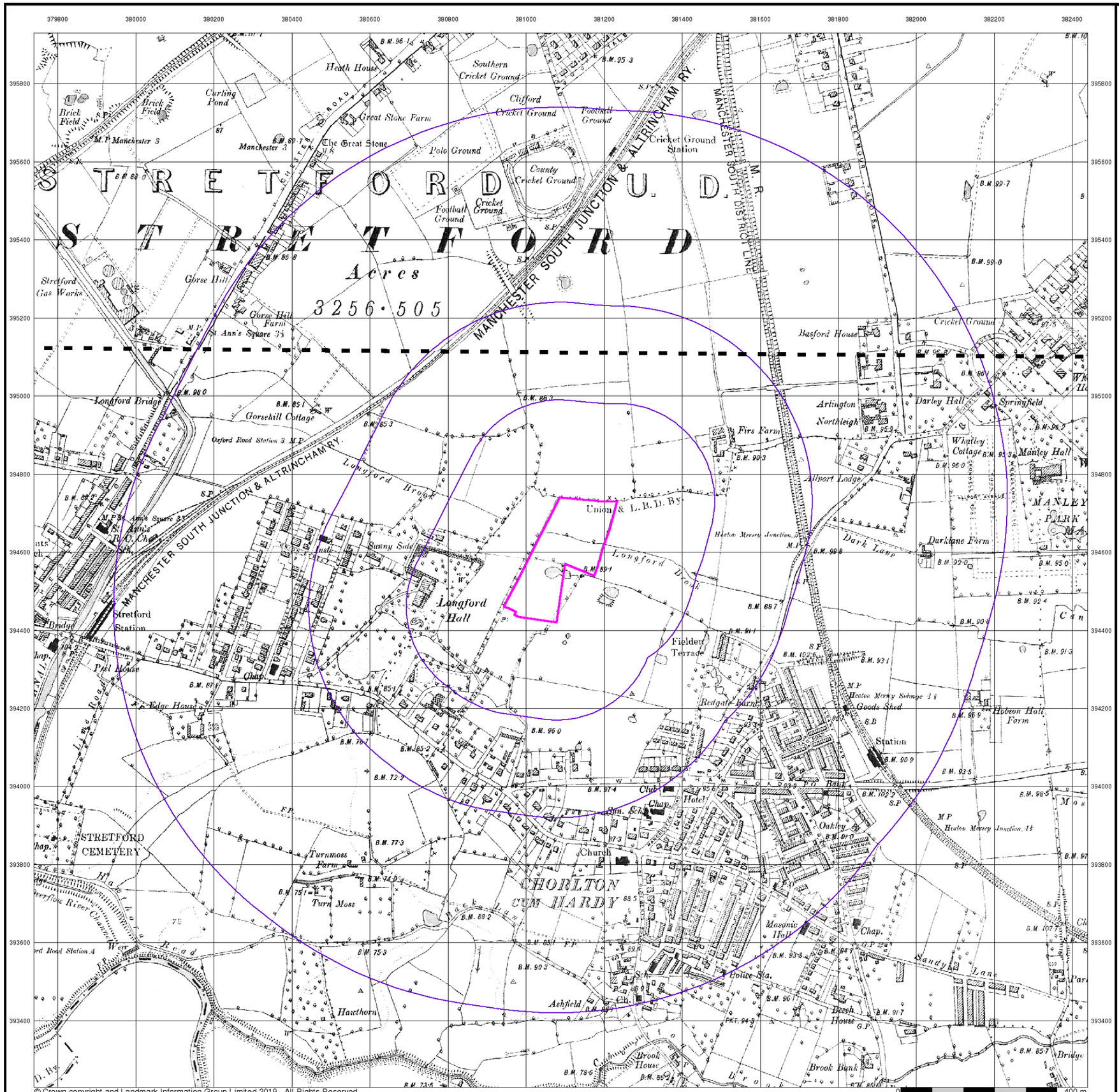


e3p

Lancashire And Furness

Published 1894 - 1896

Source map scale - 1:10,560

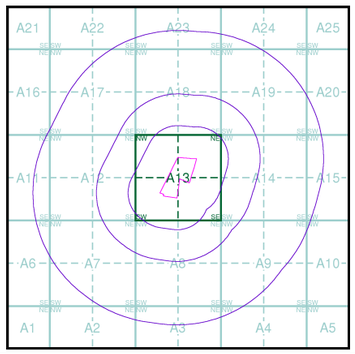
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

104SW
1896
1:10,560

111NW
1894
1:10,560

Historical Map - Slice A



Order Details

Order Number:	222286198_1_1
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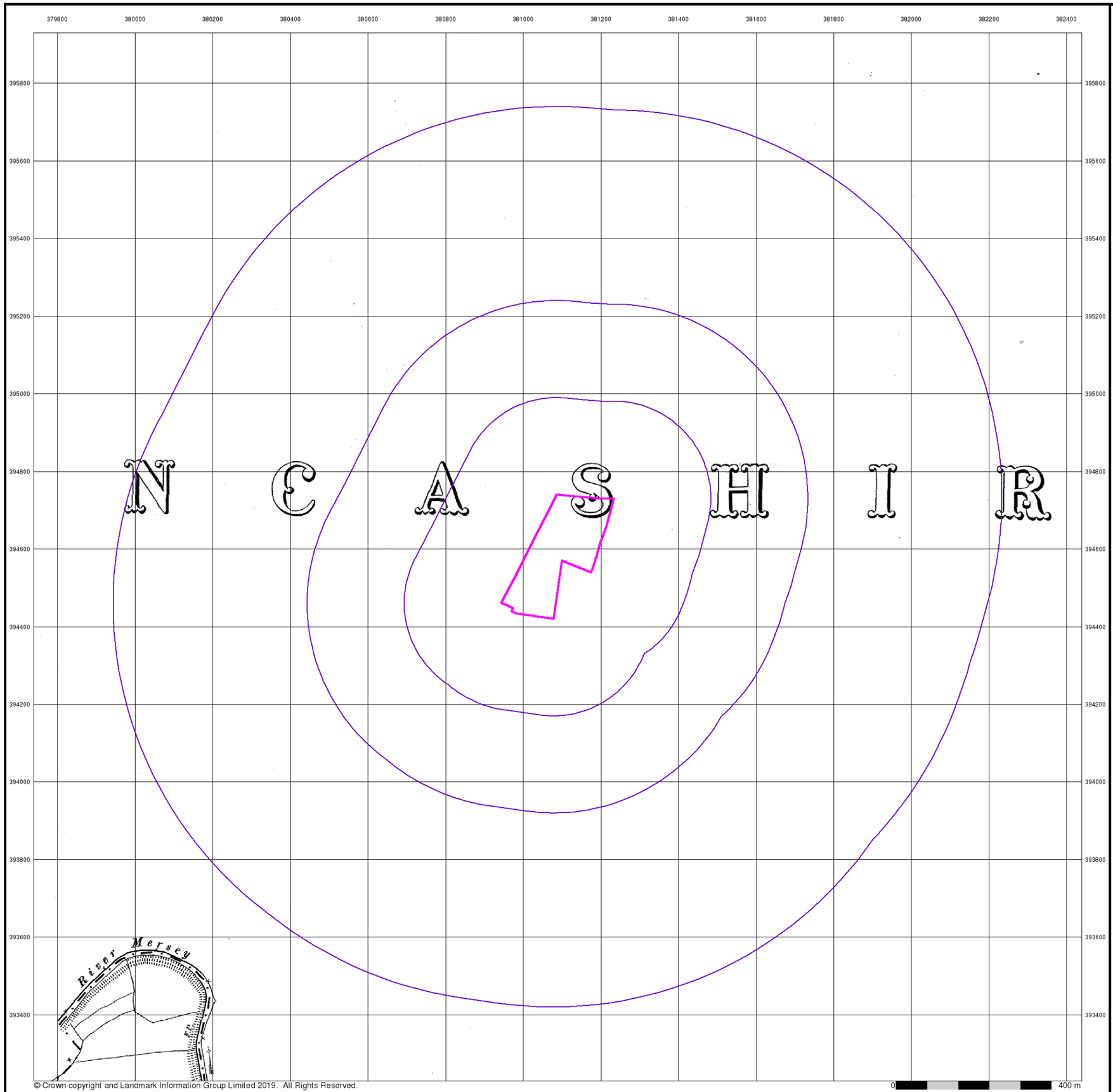

e3p

Cheshire

Published 1899

Source map scale - 1:10,560

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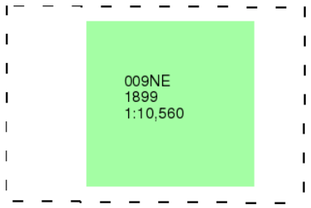
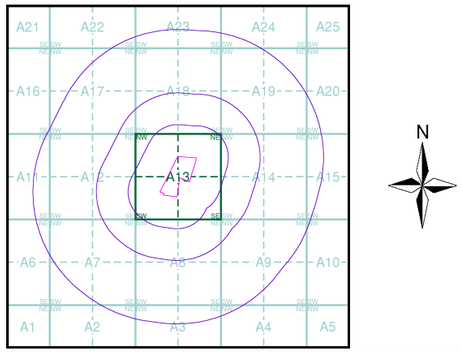
Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

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Lancashire And Furness

Published 1908 - 1909

Source map scale - 1:10,560

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Map Name(s) and Date(s)

Historical Map - Slice A

Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
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Slice:	A
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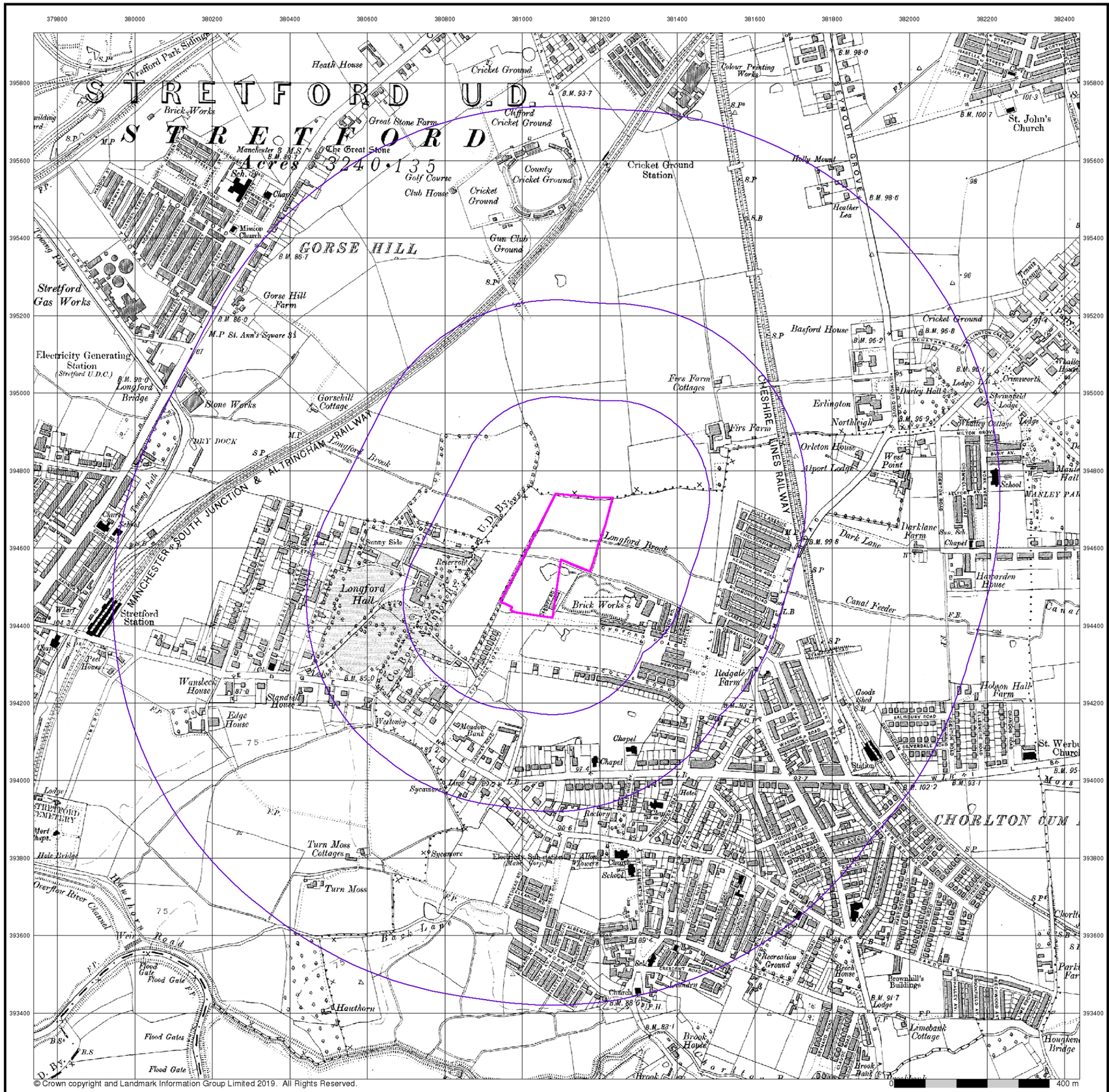

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Cheshire

Published 1911

Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

Historical Map - Slice A

Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
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Lancashire And Furness

Published 1923

Source map scale - 1:10,560

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Map Name(s) and Date(s)

Historical Map - Slice A

Order Details

Order Number: 222286198_1_1
Customer Ref: 13533-em
National Grid Reference: 381090, 394580
Slice: A
Site Area (Ha): 4.6
Search Buffer (m): 1000

Site Details

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MANCHESTER, M21 9SN

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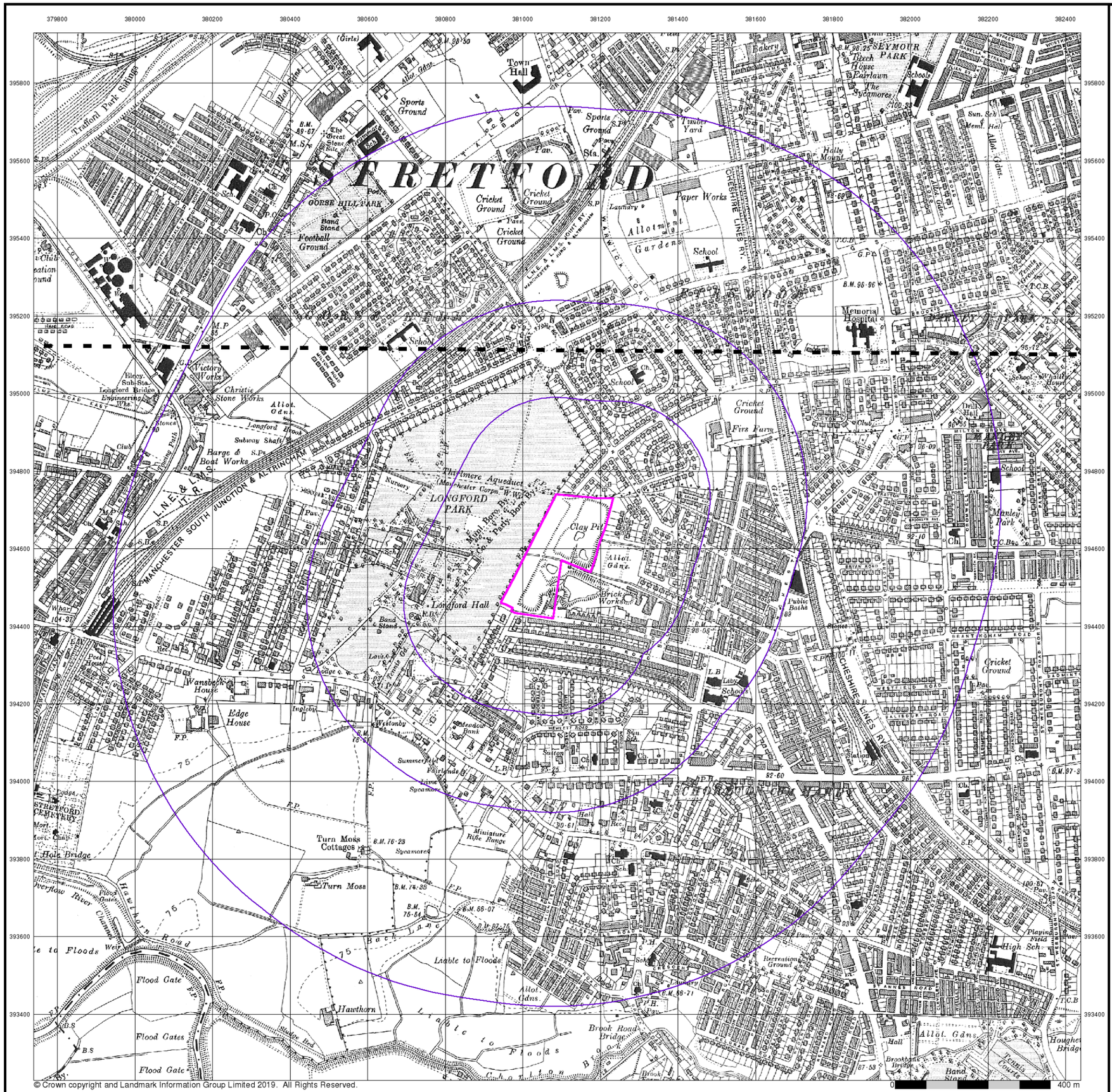

Lancashire And Furness

Published 1932 - 1934

Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

Historical Map - Slice A

Order Details

Order Number:	222286198_1_1
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Slice:	A
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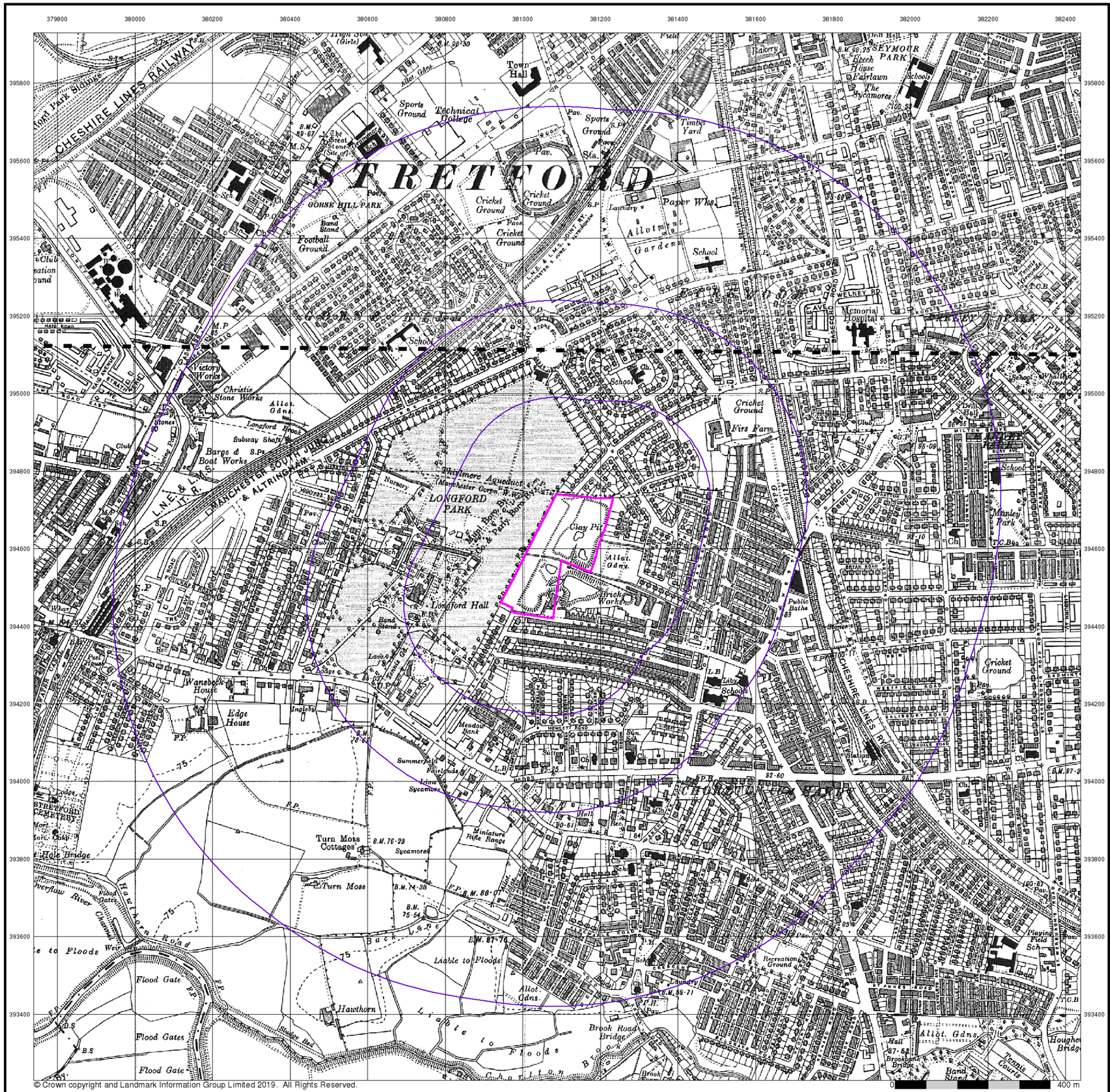

Lancashire And Furness

Published 1938

Source map scale - 1:10,560

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Map Name(s) and Date(s)

Historical Map - Slice A

Order Details

Order Number:	222286198_1_1
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National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
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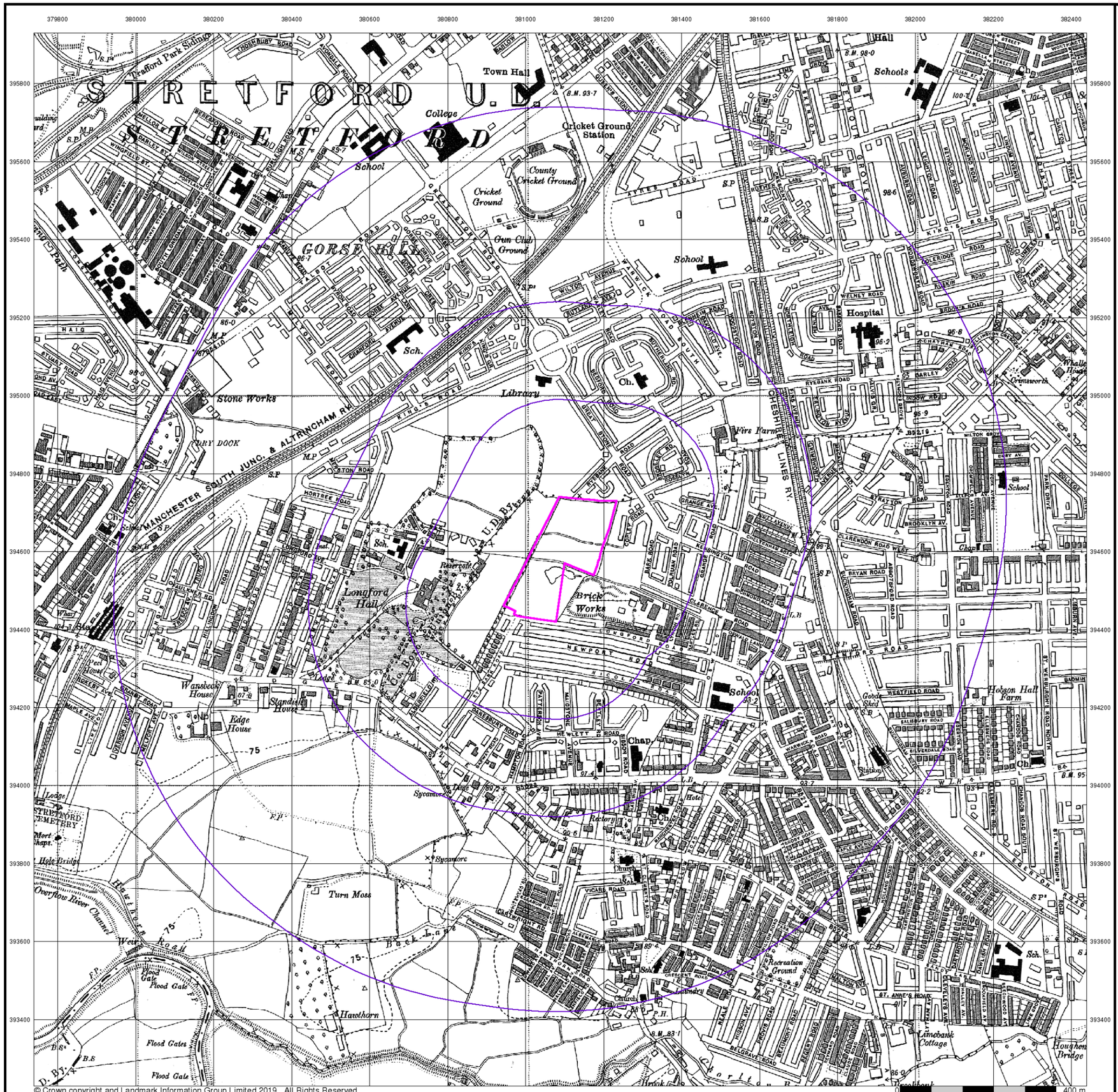

e3p

Cheshire

Published 1938

Source map scale - 1:10,560

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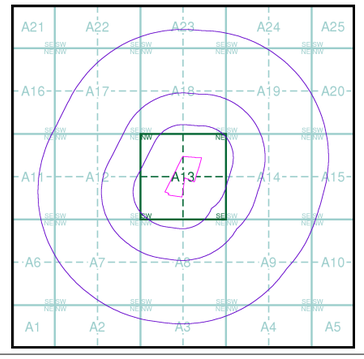
Map Name(s) and Date(s)

009NE
1938
1:10,560

Historical Map - Slice A



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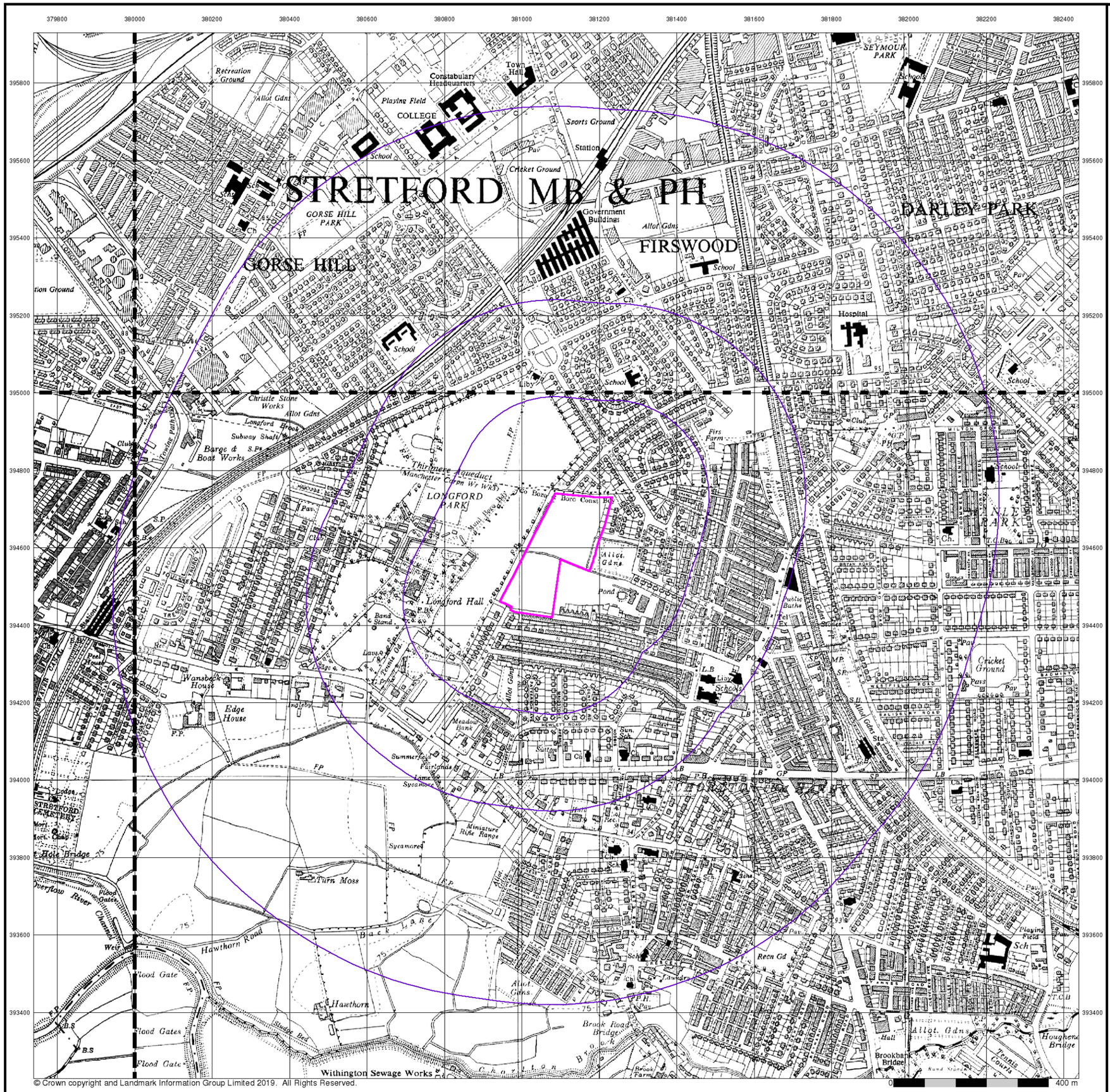


e3p

Ordnance Survey Plan

Published 1954 - 1956

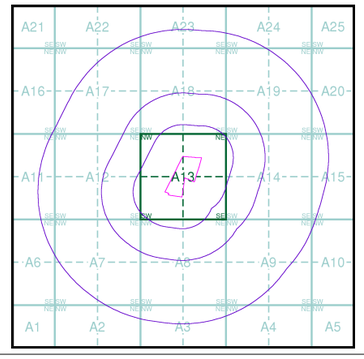
Source map scale - 1:10,000

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

SJ79NE 1956 1:10,560	SJ89NW 1956 1:10,560
SJ79SE 1954 1:10,560	SJ89SW 1955 1:10,560

Historical Map - Slice A



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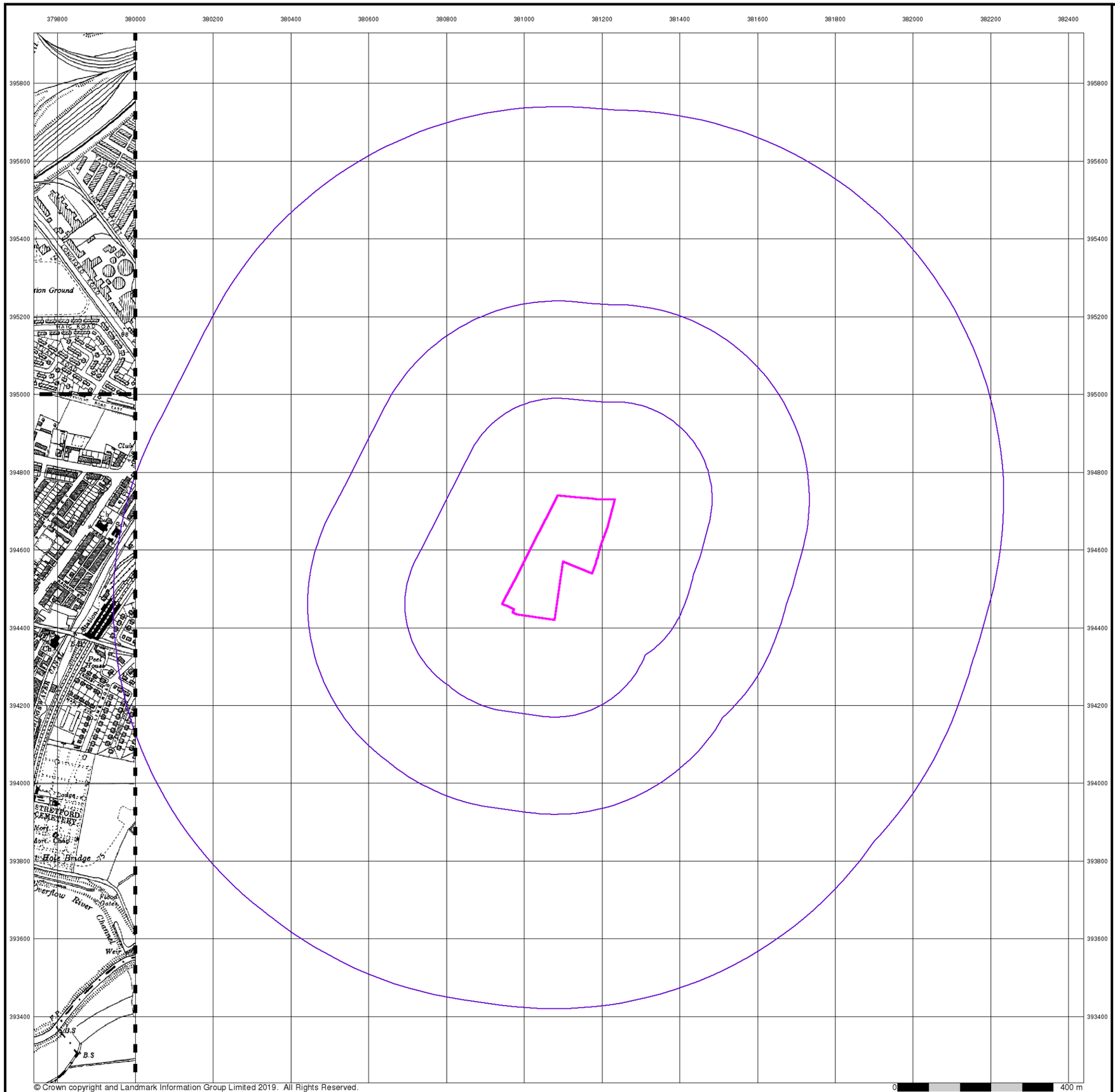


e3p

Ordnance Survey Plan

Published 1959

Source map scale - 1:10,000

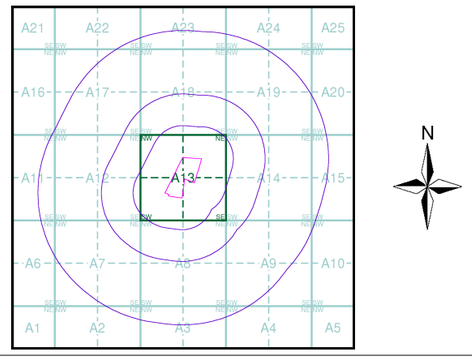
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

SJ79NE
1959
1:10,560

SJ79SE
1959
1:10,560

Historical Map - Slice A



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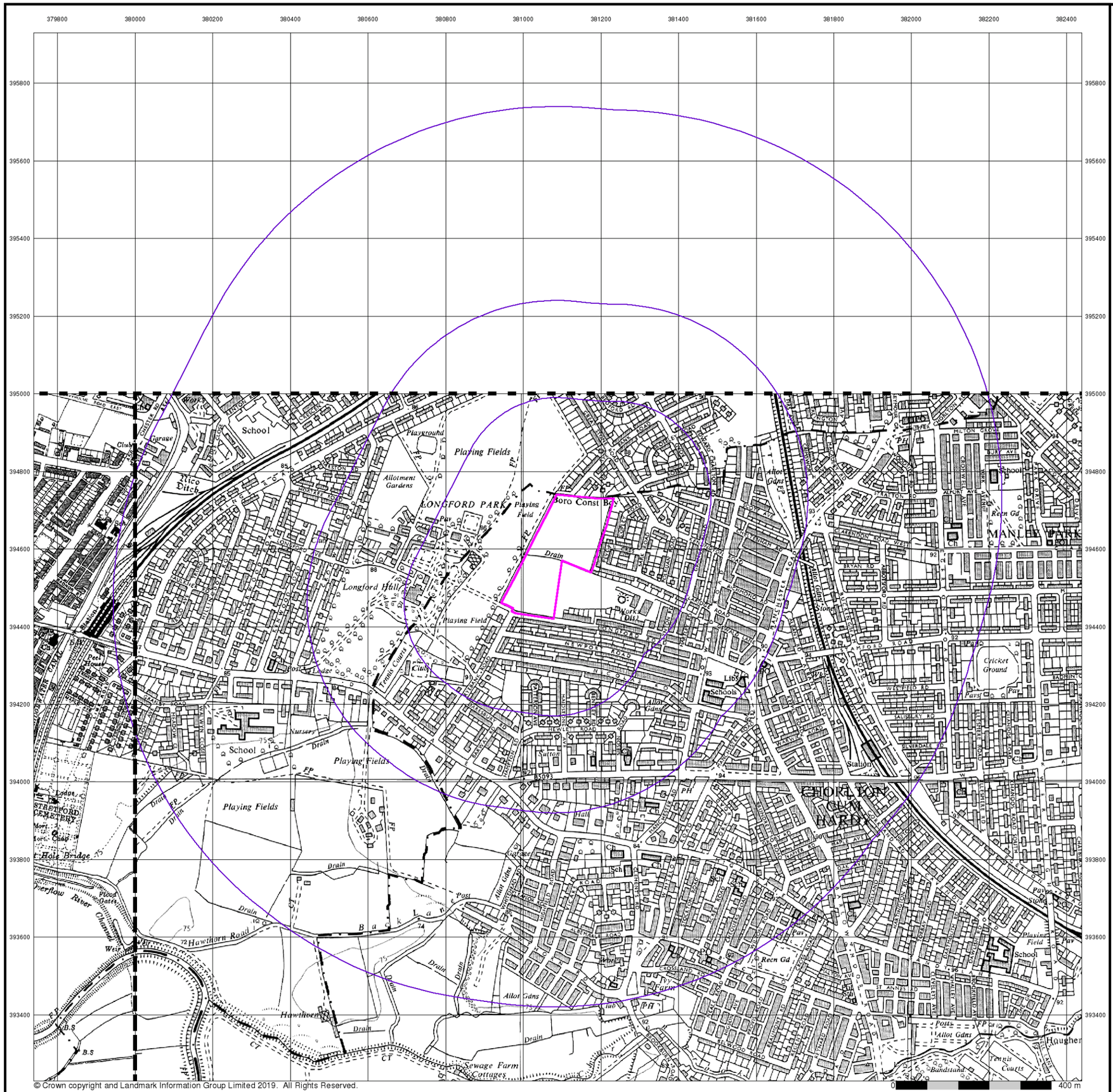

Ordnance Survey Plan

Published 1965 - 1966

Source map scale - 1:10,000

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Map Name(s) and Date(s)

Historical Map - Slice A

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e3p

Ordnance Survey Plan

Published 1971 - 1979

Source map scale - 1:10,000

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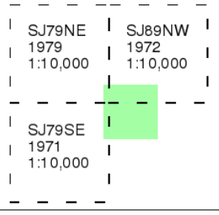
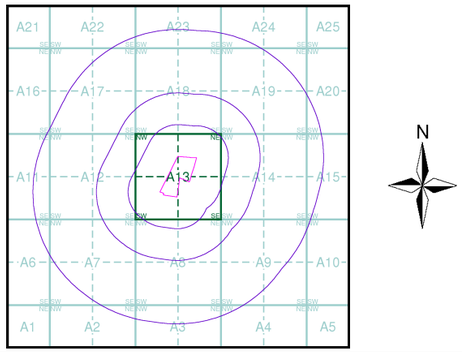
Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
Search Buffer (m):	1000

Site Details

St. Johns R C Primary School, Chepstow Road,
MANCHESTER, M21 9SN

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

e3p

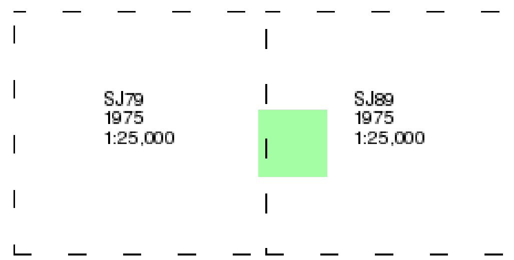
Manchester

Published 1975

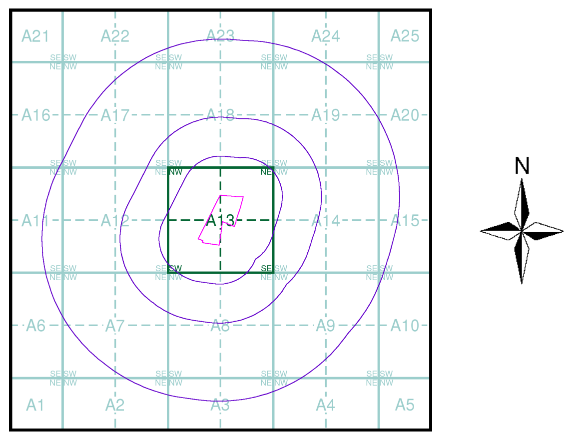
Source map scale - 1:25,000

These maps were produced by the Russian military during the Cold War between 1950 and 1997, and cover 103 towns and cities throughout the U.K. The maps are produced at 1:25,000, 1:10,000 and 1:5,000 scale, and show detailed land use, with colour-coded areas for development, green areas, and non-developed areas. Buildings are coloured black and important building uses (such as hospitals, post offices, factories etc.) are numbered, with a numbered key describing their use.
They were produced by the Russians for the benefit of navigation, as well as strategic military sites and transport hubs, for use if they were to have invaded the U.K. The detailed information provided indicates that the areas were surveyed using land-based personnel, on the ground, in the cities that are mapped.

Map Name(s) and Date(s)



Russian Map - Slice A



Order Details

Order Number: 222286198_1_1
Customer Ref: 13533-em
National Grid Reference: 381090, 394580
Slice: A
Site Area (Ha): 4.6
Search Buffer (m): 1000

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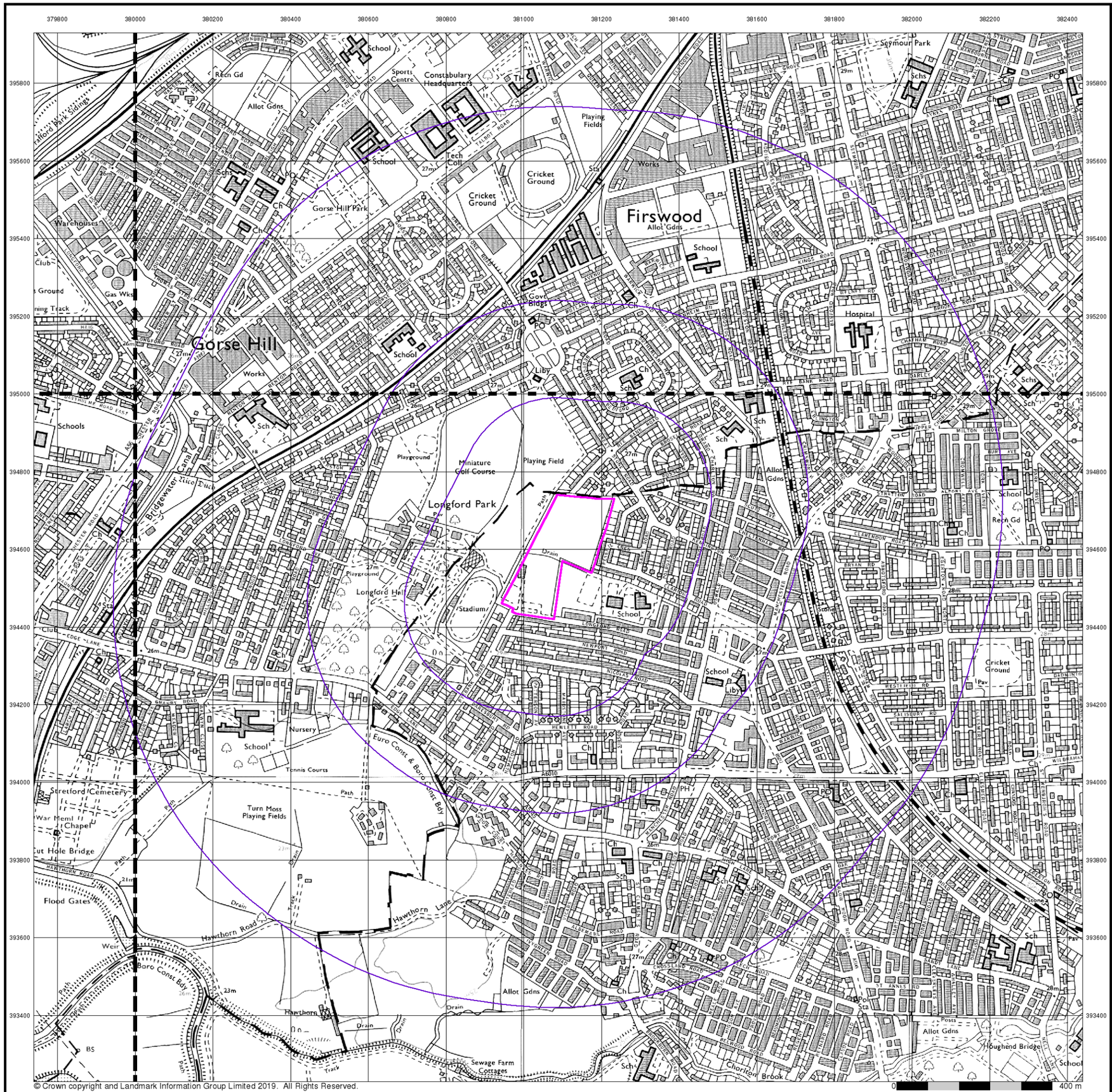


e3p

Ordnance Survey Plan

Published 1980 - 1984

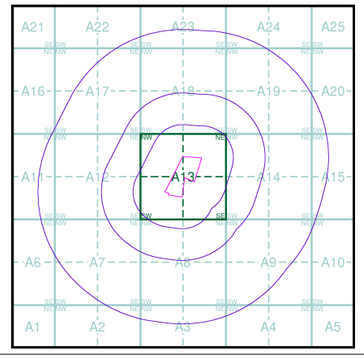
Source map scale - 1:10,000

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

SJ79NE 1984 1:10,000	SJ89NW 1980 1:10,000
SJ79SE 1980 1:10,000	SJ89SW 1981 1:10,000

Historical Map - Slice A



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
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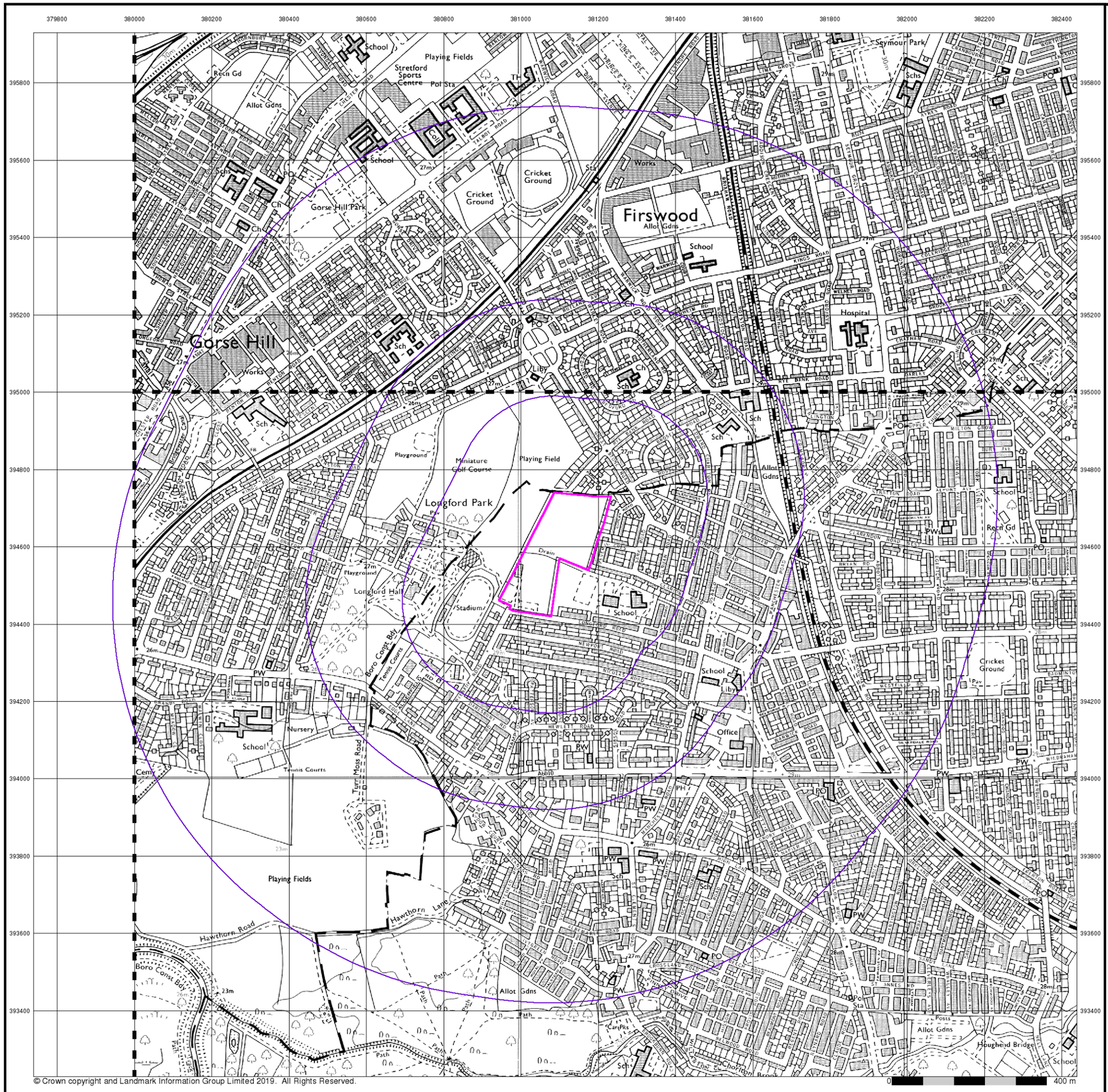


e3p

Ordnance Survey Plan

Published 1985 - 1989

Source map scale - 1:10,000

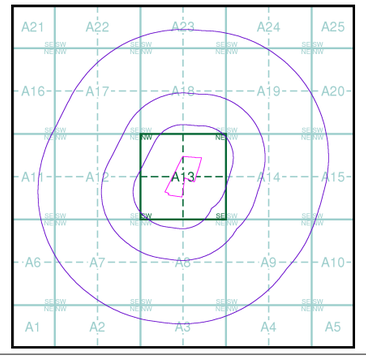
The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

SJ89NW
1985
1:10,000

SJ89SW
1989
1:10,000

Historical Map - Slice A



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
Search Buffer (m):	1000

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e3p

Ordnance Survey Plan

Published 1989

Source map scale - 1:10,000

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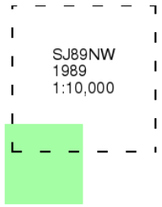
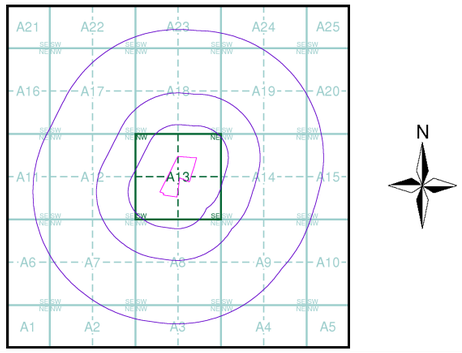


Historical Map - Slice A



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
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Slice:	A
Site Area (Ha):	4.6
Search Buffer (m):	1000

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e3p

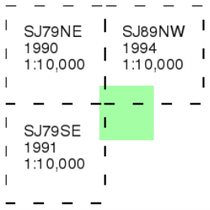
Ordnance Survey Plan

Published 1990 - 1994

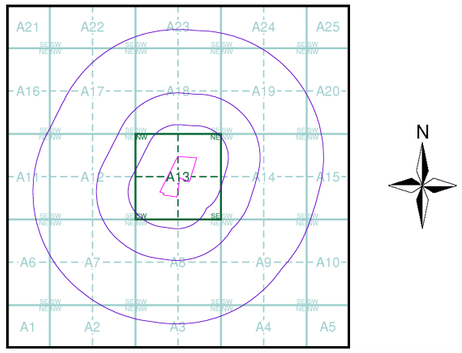
Source map scale - 1:10,000

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
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Site Area (Ha):	4.6
Search Buffer (m):	1000

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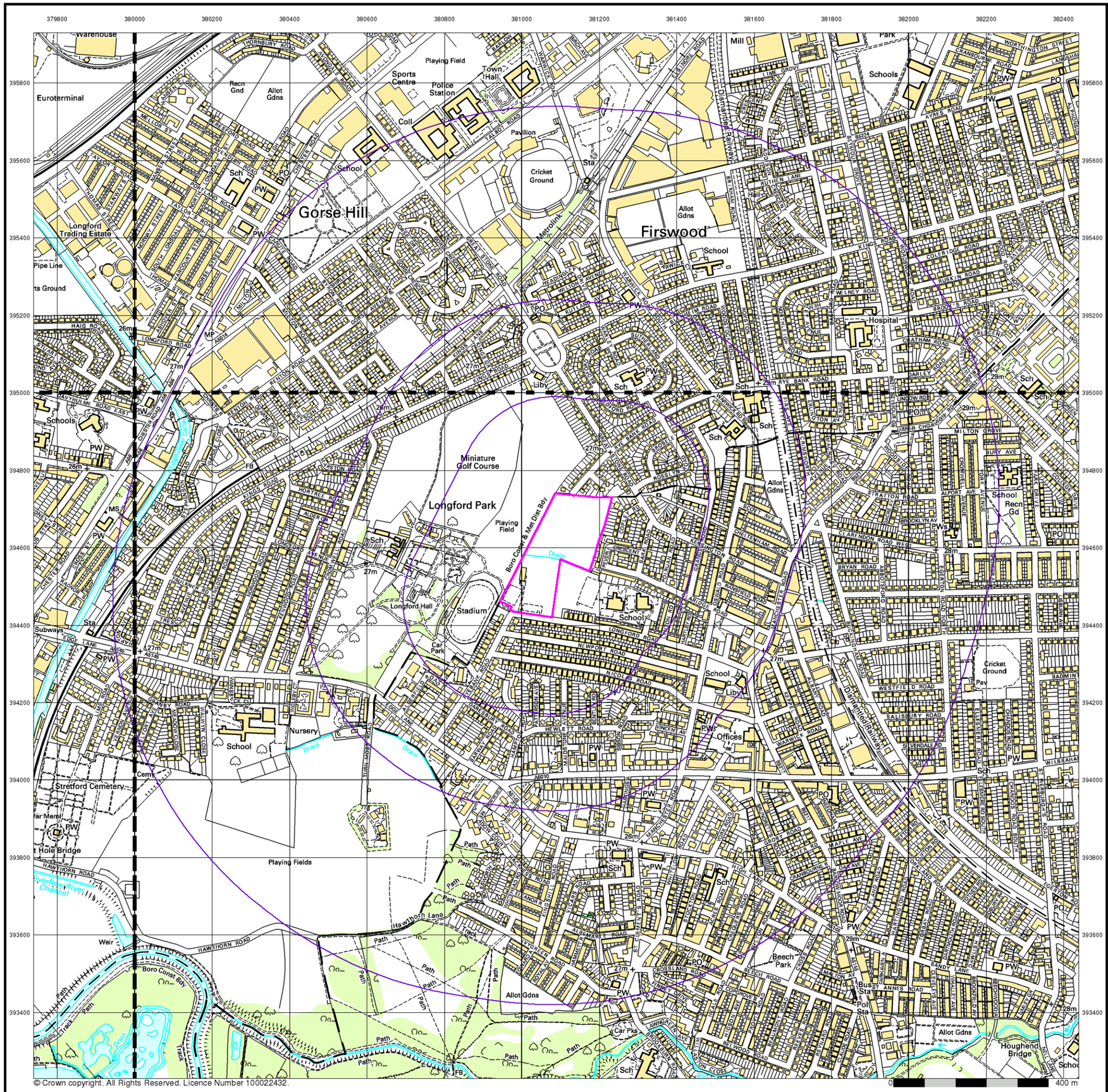


0 400 m

e3p

10k Raster Mapping

Published 1999

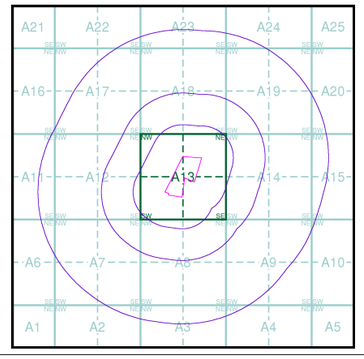
Source map scale - 1:10,000

The historical maps shown were produced from the Ordnance Survey`s 1:10,000 colour raster mapping. These maps are derived from Landplan which replaced the old 1:10,000 maps originally published in 1970. The data is highly detailed showing buildings, fences and field boundaries as well as all roads, tracks and paths. Road names are also included together with the relevant road number and classification. Boundary information depiction includes county, unitary authority, district, civil parish and constituency.

Map Name(s) and Date(s)

SJ79NE 1999 1:10,000	SJ89NW 1999 1:10,000
SJ79SE 1999 1:10,000	SJ89SW 1999 1:10,000

Historical Map - Slice A



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
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Slice:	A
Site Area (Ha):	4.6
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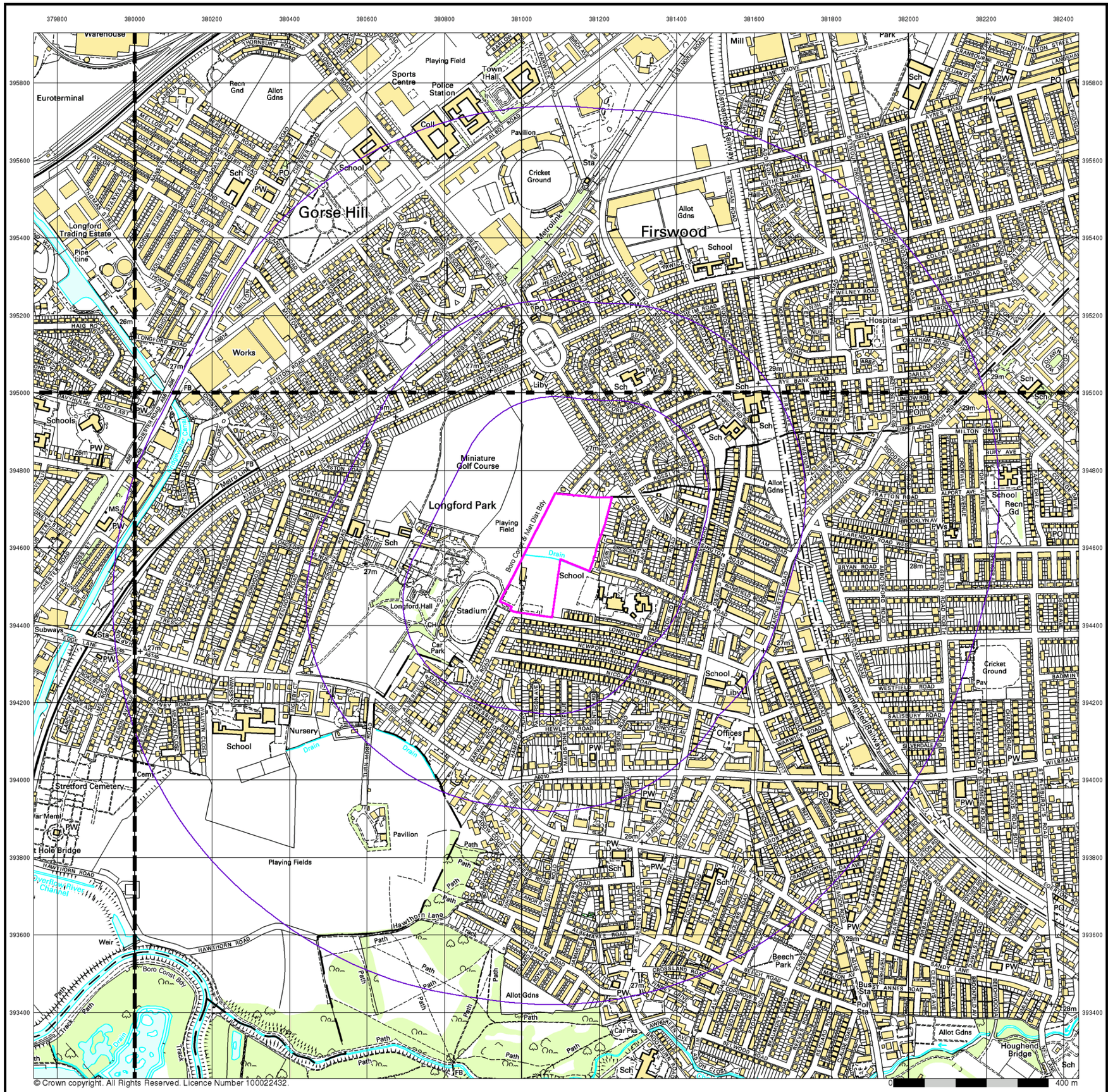


e3p

10k Raster Mapping

Published 2006

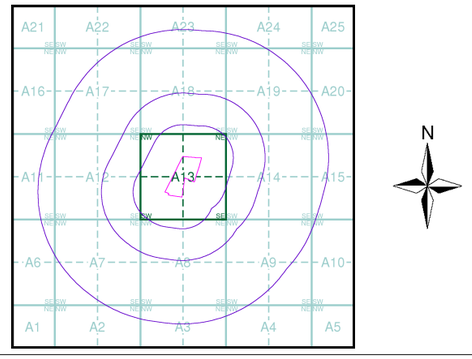
Source map scale - 1:10,000

The historical maps shown were produced from the Ordnance Survey`s 1:10,000 colour raster mapping. These maps are derived from Landplan which replaced the old 1:10,000 maps originally published in 1970. The data is highly detailed showing buildings, fences and field boundaries as well as all roads, tracks and paths. Road names are also included together with the relevant road number and classification. Boundary information depiction includes county, unitary authority, district, civil parish and constituency.

Map Name(s) and Date(s)

SJ79NE 2006 1:10,000	SJ89NW 2006 1:10,000
SJ79SE 2006 1:10,000	SJ89SW 2006 1:10,000

Historical Map - Slice A



Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
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Site Details

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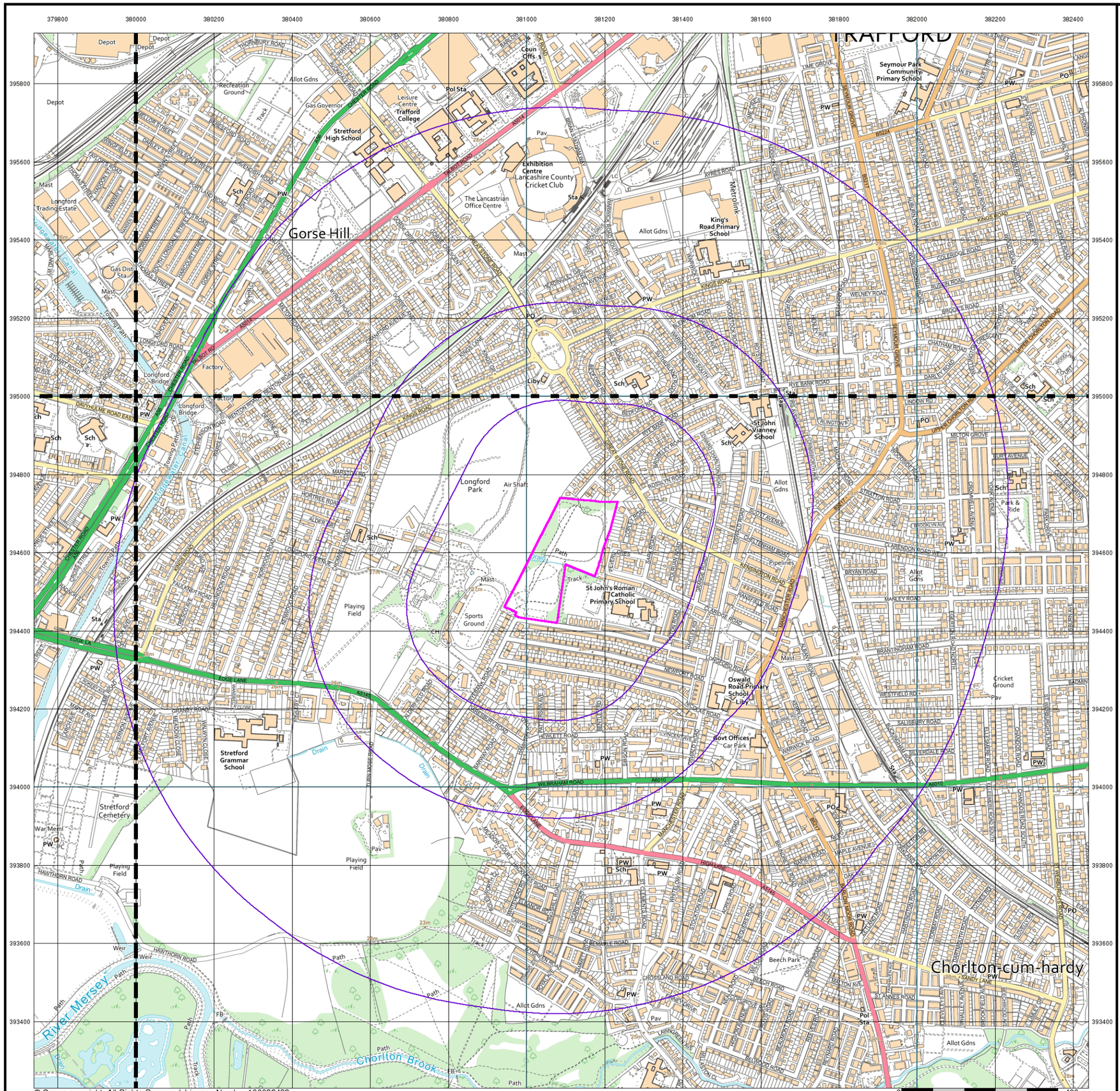

0 400 m

VectorMap Local

Published 2019

Source map scale - 1:10,000

VectorMap Local (Raster) is Ordnance Survey's highest detailed 'backdrop' mapping product. These maps are produced from OS's VectorMap Local, a simple vector dataset at a nominal scale of 1:10,000, covering the whole of Great Britain, that has been designed for creating graphical mapping. OS VectorMap Local is derived from large-scale information surveyed at 1:1250 scale (covering major towns and cities),1:2500 scale (smaller towns, villages and developed rural areas), and 1:10 000 scale (mountain, moorland and river estuary areas).

Map Name(s) and Date(s)

Historical Map - Slice A

Order Details

Order Number:	222286198_1_1
Customer Ref:	13533-em
National Grid Reference:	381090, 394580
Slice:	A
Site Area (Ha):	4.6
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Site Details

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APPENDIX VI
UXO RISK ASSESSMENT

STAGE 1 PRELIMINARY UXO RISK ASSESSMENT

REPORT REF: PRA-19-1156 | Revision: 0

Client: E3P
Project: Ryebank Road, Manchester
Date: 04/11/2019

BRIMSTONE SITE INVESTIGATION
1-3 Manor Road, Chatham, Kent, ME4 6AE
0207 117 2492
www.brimstoneuxo.com

INTRODUCTION

The Stage 1 Preliminary Risk Assessment is an initial screening assessment designed to highlight any sources of unexploded ordnance (UXO) with the potential to contaminate a given site.

The aim of the Stage 1 assessment is to identify or discount the need for further detailed research - a *Stage 2 Detailed UXO Risk Assessment.*

This desktop assessment has been researched and written by a dedicated Researcher / Risk Assessor and produced in accordance with the CIRIA C681Guidelines: Unexploded Ordnance, a Guide for the Construction Industry (published in 2009).

In preparation for this assessment, original WWII bombing figures and the *Brimstone UXO Sources Database* has been searched. The latter incorporates multiple datasets plotting the positions of a variety of domestic military sites and confirmed historic German bombing targets.

The Stage 1 Preliminary Risk Assessment considers the following:

1. The Proposed Works
2. Enemy Action during WWI and WWII
3. British / Allied Military Activity
4. Historic Site Occupancy
5. Risk Mitigating Factors

THE SITE AND PROPOSED WORKS

The Site (centred on Grid Ref: SJ 81086 94587) is located in the Firswood area of Trafford Borough (Greater Manchester), approximately 900m north-west of Chorlton Railway Station. It is bound to the north by Ryebank Road, to the west by Longford Park, to the south by Longford Road, and to the east by residential properties fronting Copley Road and Peveril Crescent. *The Site* is occupied by Ryebank Fields, a large undeveloped plot of unmaintained grassland with dense peripheral vegetation and mature trees. In the south, a narrow hard-surfaced path leads to two areas of hardstanding.

A residential development is proposed, however no details relating to the associated ground works were available at the time of writing. Prior to development, an SI will be conducted. This will comprise window sample boreholes to 5.45m bgl, mechanically excavated trial pits to 3.00 - 4.00m bgl, and cable percussive boreholes to 15.00m bgl (possibly deeper).

ENEMY ACTION DURING WWI AND WWII

Potential Source of UXO	Significant?	Details	
WWI German Bombing	×	Neither Stretford nor Manchester were bombed during WWI.	
WWII German Bombing	✓	British District Bombing Density Statistics	During WWII, *The Site* was located within the WWII-era County Borough of Manchester, however at the boundary with the Municipal Borough of Stretford. These sustained 27.1 bombs / 1,000 acres and 147.3 bombs / 1,000 acres respectively.
		Evidence of bomb strikes	Bombing incident records not currently available. No OS mapped evidence of bomb damage in the vicinity.
		Local German Bombing Targets	An original Luftwaffe target map of the study area highlights two railway targets in the vicinity; Chorley cum Hardy Station to the east and Streford Station (plus infrastructure) to the west.
		Local Bombing Decoy Sites	None within a significant radius of *The Site*. Closest was ~6.3km to the south-west.
WWII German Cross Channel Artillery Shelling	×	n/a	

BRITISH / ALLIED MILITARY ACTIVITY		
Potential Source of UXO	**Significant?**	**Details**
Existing or historic Army or RAF Training Areas / Ranges / Activity	×/✓	Soldiers of the 44th Lancashire (Stretford) or the 46th Lancashire (south Manchester) Home Guard Battalions would have been active within the study area during WWII. At this stage, the possibility cannot be discounted that armed soldiers accessed *The Site*.
Existing or historic Military Bases and Other Installations	×/✓	The possibility that *The Site* was requisitioned by the War Office for temporary WWII use (Civil Defence or military) cannot be discounted at this stage.
Existing or historic Munitions or Explosives Factories	×	n/a
Existing or historic Military Storage Depots	×	n/a
Existing or historic Military Defensive Fortifications	×	n/a
WWII Light and / or Heavy Anti-Aircraft (LAA & HAA) Fire	✓	Numerous (>30 HAA gun batteries) were established within a 15km radius of *The Site*. At least one confirmed Vulnerable Point (defended by LAA guns) was within range of *The Site*. Luftwaffe raids in the region were frequent / heavy and therefore these guns would have expended a vast quantity of ammunition over the wider area.
WWII Pipe Mined Locations and Beach Minefields	×	n/a
HISTORIC SITE OCCUPANCY		
Was *The Site* developed during WWI / WWII?	Like today, *The Site* was undeveloped fields during WWII.	
RISK MITIGATING FACTORS		
Post-Conflict Ground Works	The vast majority of *The Site* has remained undeveloped and is unlikely to have experienced substantial post-war ground disturbance. Any buried UXO is therefore more likely to remain in-situ up to the present day. NB: one small building (since demolished) was constructed in the south post-war.	

CONCLUSIONS

Manchester, Salford and Stretford were subjected to large scale, indiscriminate carpet-bombing during WWII, including four major raids. *The Site* was located relatively close (~2km) to the primary Luftwaffe aiming point (Manchester Docks / Trafford Park / city centre) and therefore would have been vulnerable to bombing. NB: additional individual Luftwaffe targets were situated in closer proximity. Indeed, original wartime figures indicates that the study area was subjected to an elevated (moderate or high) bombing density. As *The Site* likely encompassed soft ground historically, further research is required to elucidate the ground cover of, and analyse the positions of bomb strikes in relation to, *The Site.*

Anecdotal evidence (local residents) has been provided indicating that *The Site* was an unregistered dump post-war with various hazardous items buried on *Site*, including military radios and the remains of WWII bombs. This information is unsubstantiated, however cannot be assumed as inaccurate.

There is currently considered to be a **Moderate-High Risk** to the proposed works from German UXO.

The Site was open ground during WWII, with no apparent use. It could therefore have been a candidate site for temporary War Office requisitioning. It is conceivable that armed soldiers of the Lancashire Home Guard utilised *The Site* for training.

The possibility of an unexploded British AA shell striking soft ground on *Site* and remaining buried in-situ up to the present day cannot be ruled out.

There is currently considered to be a **Low-Moderate Risk** to the proposed works from British / Allied UXO.

RECOMMENDATION:	Brimstone recommends a **Stage 2 Detailed Risk Assessment** is carried out to elucidate the UXO risk to the proposed works. NB: the fee for this Stage 1 assessment will be refunded if the Stage 2 assessment is ordered.

STAGE 2 DETAILED UXO RISK ASSESSMENT

Report Reference: DRA-19-1148

INTEGRITY • PROFESSIONALISM • KNOWLEDGE

STAGE 2 DETAILED UXO RISK ASSESSMENT:

Ryebank Road, Manchester

Prepared For:

E3P

Brimstone Site Investigation

1-3 Manor Road
Chatham
Kent
ME4 6AE

Phone: 0207 117 2492
Web: www.brimstoneuxo.com

REPORT REF: DRA-19-1148 | Revision: 0		
Prepared by:	O. Brown	26/11/2019
Reviewed by:	A. Lane	27/11/2019
Release Authorised by:	A. Florence	27/11/2019
Report Issue Date:		**27/11/2019**

EXECUTIVE SUMMARY

RESULT: Brimstone Site Investigation concludes that UXO poses a ***MODERATE RISK*** and a ***MODERATE-HIGH RISK*** to the proposed works.

THE SITE: The Site (centred on Grid Ref: SJ 81086 94587) is located in the Firswood area of Trafford Borough (Greater Manchester), approximately 900m north-west of Chorlton Railway Station. It is bound to the north by Ryebank Road, to the west by Longford Park, to the south by Longford Road, and to the east by residential properties fronting Copley Road and Peveril Crescent. The Site is occupied by Ryebank Fields, a large undeveloped plot of unmaintained grassland with dense peripheral vegetation and mature trees. In the south, a narrow hard-surfaced path leads to two areas of unused hardstanding.

THE PROPOSED WORKS: A residential development is proposed, however no details relating to the associated ground works were available at the time of writing. Prior to development, an SI will be conducted. This will comprise window sample boreholes to 5.45m bgl, mechanically excavated trial pits to 3.00 - 4.00m bgl, and cable percussive boreholes to 15.00m bgl (possibly deeper).

UXO RISK ASSESSMENT:

German UXO:

- Greater Manchester was the 11th most heavily bombed British conurbation during WWII. Like today, The Site occupied a central location during the Blitz, relatively close to the Luftwaffe's primary target area and a number of smaller individual targets. Consequently, the study area was affected by large scale, indiscriminate bombing and experienced a moderate to high bombing density, as confirmed by wartime records.
- A bomb plot map covering all air raids on Manchester Borough was analysed, as were individual incident reports covering the two heaviest raids on Stretford Borough and a record of civilian fatalities due to enemy action. These confirm that the study area was affected by at least three air raids, resulting in at least 10 x HE bombs and 45 x IB strike locations within 500m of The Site, including a cluster of 20 x IBs within the northern half of The Site and a pair of HE bombs at the western Site boundary.
- The bomb plot map does not cover Streford Borough and the only records available for this borough only cover the two heaviest raids. Therefore, it is considered likely that additional bombs fell locally. Indeed, at least four bomb(s) strike locations in Stretford occurred within 500m of The Site, including a UXB just 70m north of The Site.
- Analysis of the available records indicates that an aircraft flew over The Site whilst dropping their bombloads in the vicinity at least twice, probably three or more times. This raises the possibility of a UXB release over The Site on multiple occasions.
- Records of exploded and unexploded HE bombs dropped during the Manchester Blitz give a failure rate of 16.6%; a significantly higher figure than the widely accepted 10% average for Britain as a whole.
- All bombs dropped locally were part of high-altitude indiscriminate bombing raids carried out at night. The study area was not densely populated during WWII and The Site itself was undeveloped, occupied by clay pits associated with an adjacent brick works. This elevates the chances of any UXB fall on Site occurring unobserved.
- The Site would have been accessed during the bombing campaign, however probably only by a small number of workers and not necessarily frequently. It is quite possible that peripheral areas were neglected for long periods. NB: anecdotal evidence states that the clay pits were in use until the 1950s, however a WWII-era aerial photograph suggests they could have been abandoned during the conflict.
- It is not possible to confirm the exact ground conditions on Site during the WWII bombing campaign, however the 1946 aerial photograph shows the pits on Site to have been flooded. A UXB striking water

would have been immediately lost beneath the waterline and would not have resulted in any persistent observable evidence.

- The Site's peripheries were likely occupied by unmaintained vegetation and bare soil during WWII. A UXB entry hole within such conditions could have been overlooked. NB: the diameter of the smallest German HE bomb (which was also the most commonly deployed over Britain) was 200mm; creating a small, easily obscured entry hole. After a time, environmental conditions would cause the hole to collapse and in-fill, erasing evidence of the UXO strike.
- Anecdotal evidence has been identified suggesting that the remains of WWII bombs were buried on Site. Assuming this is true, it probably refers to local residents and / or Civil Defence personnel dumping unexploded German 1kg / 2kg IBs and / or shrapnel from AA shells and larger HE bombs in disused parts of the clay pits. NB: the former (which are known to have landed locally) were often extinguished by trained locals, Home Guard fire watchers or ARP wardens before they could fully ignite or burnt out. Many unexploded yet potentially still hazardous IBs would have required safe disposal and the flooded clay pits may have been considered an ideal location.
- It should be noted that this anecdotal evidence is less likely to refer to Bomb Disposal units dumping the inert casings of large German HE bombs which they had defused in the local area. Although such activity cannot be ruled out entirely. NB: once defused, the HE content of large bombs was usually steamed-out of the steel casing, which itself was then sent to a metal scrap yard.

British / Allied UXO:

- >30 HAA gun batteries and a number of LAA guns were within range of The Site during WWII. The frequency and intensity of Luftwaffe air raids over the wider area suggests these batteries would have expended a vast quantity of AA ammunition over the city. For the same reasons as above, it is considered quite possible that an unexploded shell could have struck soft ground or standing water on Site unwitnessed and remained undetected / gone unreported. NB: the entry hole of an unexploded AA shell would have been even smaller than a German HE UXB.
- Up to 600 'A' Company soldiers of the local Home Guard battalion were active in the wider area during WWII. Local disused quarries were often requisitioned for temporary Home Guard training and therefore the possibility cannot be completely ruled out that ad-hoc weapons training occurred on Site. However, a detailed account of 'A' Company's activities was reviewed and none of the several training areas / ranges utilised by this unit reference The Site.
- However, as a likely location of historic unauthorised dumping, The Site could now be contaminated with a wide range of refuse and other objects. It is conceivable that an item(s) of British or Allied ammunition was thrown into the clay pits historically.

The Likelihood of UXO Encounter:

- The lack of post-war redevelopment of the vast majority of The Site suggests that any shallow buried UXO is more likely to remain up to the present day. Any deep buried German UXBs on Site will certainly not have been disturbed.
- The footprint of the post-war constructed sports pavilion in the south appears to have been just beyond the edge of the clay pit proper and therefore may have been on a raised area, not requiring post-war fill. As such, this construction would have partly mitigated the risk of any shallow buried UXO. Although it should be noted that undisturbed soil will have persisted in between the foundations at shallow depths and therefore UXO could have remained in-situ beneath this building.
- Between 1946 and 1949, the clay pits on Site were largely in-filled. Any hazardous items in the pits are highly unlikely to have been removed prior to filling. Examples of similar 'out of sight out of mind' dumping of surplus war materials in the aftermath of WWII are not uncommon in the UK. Such behaviour was especially common in bodies of water, e.g a flooded quarry. As such, any UXO or UXO related objects (defused, inert munitions) are more likely to have been simply buried at WWII-era quarry floor level.
- The post-war filling of the clay pits raises the possibility of another source of UXO contamination on Site. After the Blitz, many cities were left with enormous volumes of useless material from numerous

bombsites; broken masonry, timber, glass etc. It is quite possible that Ryebank Fields were identified as a candidate for taking some of Greater Manchester's rubble. If this did occur, The Site could have been inadvertently contaminated with small items of UXO.

- Many bombsites in Greater Manchester will have been struck by subsequent unexploded bombs (HE and IB) and AA shells. A large German HE UXB is highly likely to have passed through the rubble and penetrated below ground level. However, smaller items (German 1kg / 2kg IBs and AA shells) probably would not have achieved penetration. During the process of clearing each bombsite, removing the rubble and redepositing it elsewhere, any smaller devices caught up in the rubble could have been missed during the process. It is conceivable that such UXO could now be present within volumes of fill material at varying burial depths on Site.
- At the time of writing the extent and depth of the future construction works were not known. Consequently, no specific comment can be made regarding the likelihood of a UXO encounter during the development works.
- It can be said however that a large German UXB buried under the former clay pits would reside beyond the reach of shallow traditional foundations for any low-rise housing. However, as the proposed deep boreholes would reach and penetrate the WWII-era quarry floor, these works would be at risk of a UXO encounter. Similarly, if piled foundations extending below WWII-era ground level are required, the likelihood of a UXO encounter will increase.
- Furthermore, a UXB buried under the peripheral parts of The Site could be encountered during more shallow excavations, as WWII-era ground level will exist at a shallow depth here.
- It is possible that the post-war fill material occupying the majority of The Site is UXO contaminated and therefore a UXO encounter during shallow intrusions within this made ground cannot be discounted also.

RECOMMENDED RISK MITIGATION MEASURE: Brimstone has identified an elevated UXO risk on Site. The measures detailed below are recommended to mitigate the UXO risk on Site to ALARP level.

Risk Mitigation Measure	Recommended For?
UXO Safety Awareness Briefings	Prior to all intrusive works
EOD Engineer - On Site Supervision	SI works and open excavations (construction phase)
Intrusive Magnetometer Probe Survey (optional)	All pile positions

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1 INTRODUCTION

1.1 BACKGROUND

E3P, referred to hereon in as *The Client*, has commissioned Brimstone Site Investigation, referred to hereon in as *BSI*, to carry out a Stage 2 Detailed Unexploded Ordnance (UXO) Risk Assessment of the proposed intrusive ground works at the Ryebank Road, Manchester site, referred to hereon in as *The Site*.

1.2 LEGISLATION

1.2.1 Introduction

There is no legal requirement for assessing the risk posed by UXO at UK construction sites, nor is there any specific legislation covering the management and mitigation of UXO risk. However, there are two main pieces of UK legislation that require responsible parties carrying out ground works to undertake comprehensive and robust assessments of potential risks and hazards to their employees.

1.2.2 Construction (Design & Management) Regulations 2015

Construction Design & Management (CDM) Regulations outlines the responsibilities of all involved parties, primarily the Client, the CDM Co-ordinator, the Designer and the Principal Contractor. CDM2015 states that a party has the 'legal responsibility for the way that a construction project is managed and they are accountable for the health and safety of those working on or affected by the project'. All parties are obliged to:

- Provide an appropriate assessment of potential UXO risks at the site or ensure such an assessment is completed by another party.
- 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.

1.2.3 The Health and Safety at Work Act 1974

Section 3 of this legislation covers the general public and other contractors on a site. It states that 'it is the duty of every employer to conduct his/her undertaking in such a way as to ensure,

so far as is reasonably practicable, that persons not in his/her employment who may be affected are not thereby exposed to risks to their health or safety'.

'In such cases as may be prescribed, it shall be the duty of every employer and every self-employed person, in the prescribed circumstances and in the prescribed manner, to give to persons (not being his/her employees) who may be affected by the way in which he/she conducts his/her undertaking, the prescribed information about such aspects of the way in which he /she conducts his/her undertaking as might affect their health or safety'.

1.3 UXO - THE ROLE OF COMMERCIAL CONTRACTORS AND THE AUTHORITIES

1.3.1 Commercial Contractors

If an elevated UXO risk is identified during the Stage 1 and Stage 2 Risk Assessment process, risk mitigation measures will be recommended. Commercial UXO contractors can provide geophysical surveys during the pre-construction phase. Such surveys are designed to identify potential UXO targets which can then be intrusively investigated. Subsequent UXO clearance or avoidance can then be recommended as appropriate.

In addition, EOD Engineers can be deployed to sites before and / or during the construction phase to provide UXO awareness briefings to staff, a watching brief for excavations and reactive response to any suspicious finds.

Having a qualified EOD Engineer on site will avoid unnecessary (potentially costly) call-outs to the authorities when a suspicious item is encountered, as the engineer will be able to identify whether or not the item is UXO and whether or not it is inert or live. If a high risk UXO item is identified the engineer will co-ordinate with the authorities, limiting disruption on site and putting in place safety measures, with immediate effect.

1.3.2 UK Authorities

If a suspected item of UXO is discovered at a UK site where no commercial UXO contractor is in attendance or quickly available, the local Police force will evacuate the site and establish a precautionary safety cordon, which could require the evacuation of neighbouring properties. They will then contact the MOD's Joint Services Explosive Ordnance Disposal (JSEOD) office.

Based on the Police assessment, JSEOD will prioritise the incident based on criteria such as the likely type and size of the item and the site's location / population density in the vicinity. The availability of JSEOD's resources will also be a factor. If an incident is not given high priority, an EOD Engineer may not be made available for up to two days after the find was originally reported. During this period, a Police cordon would likely remain in place.

On assessing the item, the EOD Engineer may need to widen the Police cordon and order an evacuation of a larger area. NB: for German high explosive (HE) UXB finds in urban areas this usually results in the evacuation of thousands of people and the closure of local roads.

At low profile (usually rural) sites where UXO finds are frequent, for example on former military land, JSEOD's limited resources will usually require it to recommend involvement of a commercial UXO contractor to manage the ongoing UXO risk. Most UXO found at such sites is small enough to be covered by the commercial UXO contractor's clearance license, allowing for most, if not all, UXO to be disposed of quickly and safely as and when it is encountered.

1.4 UXO RISK IN THE UK

Fortunately, inadvertent initiations of UXO are rare, however, the legacy of UXO can cause significant delays to construction projects throughout the UK, with associated increases in costs. A list of recent German UXBs finds and examples of WWII UXB detonation incidents can be found at ***APPENDIX 1***. In many cases these unforeseen problems can be avoided if an appropriate risk management procedure has been carried out at the initial stages of the project design process.

Thousands of items of British / Allied UXO and several German UXBs are exhumed by the construction industry and the general public each year, however, the vast majority go unreported in the media due to the potential negative impacts on companies and their projects. NB: the former tends to be smaller in size than German UXBs and therefore pose a relatively smaller threat. In the UK, the origin of buried UXO can be broadly categorised into three families;

1. ***Enemy Action:*** - During WWI and WWII the air forces of Germany, and to a lesser extent Italy, bombed targets throughout the UK. The German Navy bombarded several

coastal targets in eastern England during WWI and then in WWII German long range artillery on the French coast bombarded parts of Kent.

2. ***Allied Military Activity:*** During WWI and WWII several Allied nations used the UK as a staging area for military action in the European Theatre of conflict; most notably the US and Canada.

3. ***UK Military Activity:*** Domestic British Army, Royal Air Force (RAF) and Royal Navy (RN) training activities during peacetime and conflict as well as AA gun and rocket batteries during WWI and WWII.

1.5 UXO DETONATIONS

The effects of a UXO detonation occur extremely quickly and are almost always physically traumatic when personnel are involved. The effects of a detonation are heat, sound, blast and shrapnel. The detonation of a shallow buried 50kg HE bomb would damage masonry up to 16m away and unprotected personnel approximately 70m away. The accepted safety distance for a 500kg WWII HE bomb (with a ~250kg HE fill) is 1,000m.

For a UXO detonation to occur significant stimuli is required; UXO does not spontaneously exploded. WWII-era HE requires a significant quantity of energy to initiate, which is why construction works are particularly vulnerable to UXO. There are three ways in which an item of UXO could initiate:

- ***UXO Body Impact:*** A substantial impact onto the main body of a UXO; borehole rigs, piling rigs, jack hammers and mechanical excavator buckets.
- ***Fuse Impact:*** Environmental conditions during decades of burial can result in the primary explosives located in the fuse pocket to crystallise and become shock sensitive. It would then take a relatively small impact or friction impact to cause the fuse to function and detonate the UXO.
- ***Re-starting a Timer:*** A small proportion of German WWII bombs used clockwork fuses. In 2002 an Army EOD Engineer reported that the clockwork fuse in a UXB re-started. Decades of burial cause substantial corrosion in WWII German UXBs and therefore an incident such as this is extremely rare.

2 ASSESSMENT METHODOLOGY

2.1 INTRODUCTION

This assessment has been produced in accordance with the relevant CIRIA guidelines; *Unexploded Ordnance (UXO) - A Guide for the Construction Industry C681* (published in 2009). CIRIA C681 is designed to provide accurate and authoritative information regarding matters of onshore UK risk in the UK.

2.2 SPRC RISK MODEL

The *Source - Pathway - Receptor - Consequence* (SPRC) risk model can be applied to buried UXO as follows:

Sources: For UK and Allied UXO sources can include; military firing ranges, military bases, military storage depots, munitions factories, wartime anti-aircraft weapons usage, etc. There are a number of ways in which enemy action during WWI and WWII could have resulted in UXO contamination. The source that has produced the most enemy UXO contamination is, by far, Luftwaffe air raids during WWII. This source alone has resulted in a variety of UXO (different types of bombs) each posing a specific hazard.

Pathways: For buried UXO, the pathway describes the activity(s) which results in the hazard (UXO) reaching personnel and / or assets. There are a number of pathways (construction methodologies) which require intrusions into the ground and each has the potential to be a UXO pathway. Common pathways are Ground Investigation (SI) works, Site Enabling Works, Various Excavations (soil stripping, levelling, shallow foundations, services, drainage, etc), pile foundations, etc.

Receptors: On construction sites the receptors are either works specific or external and vary in sensitivity. The former includes site personnel, project specific plant and equipment. The latter incorporates the general public, external structures in the vicinity and environmental receptors (atmosphere, soil, flora and fauna).

Consequence: The consequences of an inadvertent UXO detonation event have the potential to be significant, i.e when they affect human receptors (life or limb). Consequences for non-

human receptors can be wide ranging and also significant. However, in real terms the likelihood of detonating UXO is far lower than that of encountering UXO. NB: a UXO find alone can still have substantial financial consequences due to project delay.

2.3 ASSESSMENT STRUCTURE

In accordance with CIRIA C681 this assessment addresses the following site specific considerations in the appropriate order:

- The risk that the site was contaminated with UXO; site specific history, conflict history and domestic military history.
- The type(s) of UXO that could have contaminated the site and their associated hazards.
- The risk that UXO remains on the site; post-conflict redevelopment / earthworks and military EOD activity.
- Maximum German UXB penetration depth; site specific calculation if required.
- The risk that UXO may be encountered during the proposed works; the extent of the proposed works.
- Risk Rating Assessment; Risk Mapping if required.
- Risk Mitigation Recommendations; if required.

2.4 INFORMATION SOURCES

In order to carry out an informed and accurate risk assessment *BSI* has sought information from a wide range of sources. In preparation for this assessment *BSI*'s Research Team has undertaken detailed historical research, including access of original archived records. The following is a general list of information sources that are consulted during the research process:

- The National Archives, London.
- The London Metropolitan Archive.
- Local Archive Centres.
- The Ministry of Defence.
- The Council for British Archaeology.
- Groundsure Mapping Services.
- Historical Aerial Photography (Historic England, Britain From Above, Bluesky).

- Google open source mapping.
- The British Geological Society.
- Open sources; published book, articles, web resources.
- Site specific information supplied by *The Client*.
- *BSI*'s library and historical database.
- *BSI*'s ex-servicemen employees (including experienced EOD Engineers).

2.5 ALARP PRINCIPLE

The ALARP (as low as reasonably practicable) principle is a risk principle used in the regulation and management of construction industry risks. The term ALARP originated in UK legislation, namely the Health and Safety at Work Act 1974, which states that risks must be averted unless there is a gross disproportion between the costs and benefits of doing so.

The ALARP principle arises from the fact that infinite time, effort and money could be spent attempting to eliminate a risk entirely. It should not be understood as simply a quantitative measure of benefit against detriment. Instead, a best common practice of judgement, balancing risk and societal benefit.

The objective of a *BSI* risk assessment that identifies an elevated UXO risk is to prevent a client unnecessarily spending a grossly disproportionate sum of money reducing that project specific UXO risk. For a risk to be ALARP, it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained.

2.6 RISK TOLERANCES

The *BSI* risk assessment process divides UXO risk into two tolerances:

Tolerable: Negligible Risk or Low Risk ratings are tolerable. However, for some sites, where the risk cannot be completely discounted at the Stage 2 risk assessment stage, it would be prudent to employ relatively low cost proactive risk mitigation measures prior to undertaking ground works. For example, a UXO Tool Box briefing to site personnel.

Intolerable: Moderate Risk or High Risk Ratings are intolerable. Therefore, pro-active risk mitigation measures should be employed prior to undertaking and / or during ground works;

magnetometer survey and EOD engineer attendance on site respectively.

2.7 RELIANCE AND LIMITATIONS

This report has been prepared using published information and information provided by *The Client* which were made available at the time of writing only. *BSI* is not liable for any information which has become subsequently available. No third party liability or duty of care is extended. Third parties using information contained in this assessment do so at their own risk.

3 THE PROJECT

3.1 THE SITE

The Site (centred on Grid Ref: SJ 81086 94587) is located in the Firswood area of Trafford Borough (Greater Manchester), approximately 900m north-west of Chorlton Railway Station. It is bound to the north by Ryebank Road, to the west by Longford Park, to the south by Longford Road, and to the east by residential properties fronting Copley Road and Peveril Crescent.

The Site is occupied by Ryebank Fields, a large undeveloped plot of unmaintained grassland with dense peripheral vegetation and mature trees. In the south, a narrow hard-surfaced path leads to two areas of unused hardstanding.

FIGURE 1: Site Location Maps ***FIGURE 2:*** Recent Aerial Photograph

3.2 THE PROPOSED WORKS

A residential development is proposed, however no details relating to the associated ground works were available at the time of writing. Prior to development, an SI will be conducted. This will comprise window sample boreholes to 5.45m bgl, mechanically excavated trial pits to 3.00 - 4.00m bgl, and cable percussive boreholes to 15.00m bgl (possibly deeper).

4 SITE HISTORY

4.1 INTRODUCTION

Site specific history can be assessed by reviewing historical OS mapping, historical aerial photography and by carrying out additional site specific research where appropriate. Below are descriptions of a selection of records relevant to *The Site*:

4.2 OS MAPPING

Review of OS Mapping			
Period	**Map Date**	**Map Scale**	**Review**
Pre-WWI	**1907**	**1:2,500**	*The Site* is mostly undeveloped with the northern half occupying part of a larger field crossed by Longford Brook. The southern half is mainly open ground with a likely pond. A short row of terraced houses fronting Cardiff Road extends into the south-eastern quarter of *The Site*. Immediately east of *The Site* is a Brick Works and associated quarry pit. Like today *The Site* is bound to the south by Longford Road.
Pre-WWII	**1922**	**1:2,500**	***FIGURE 3.1:*** The likely pond has become smaller and is now fully located within *The Site*.
	1935	**1:2,500**	The northern half of *The Site* is labelled Clay Pit and is occupied by embankment markings indicating a large depression. A tramway extends into this area from the adjacent Brick Works. Two small polygons may represent additional ponds. The southern half of *The Site* is occupied by similar markings and appears to be part of the Brick Works pit immediately to the east.
	1938	**1:10,560**	No significant changes observed either on or immediately adjacent to *The Site*.
Post-WWII	**1952-55**	**1:2,500**	***FIGURE 3.2:*** *The Site* is almost entirely featureless. The varying topography is now level, there are no ponds marked and the row of houses plus Cardiff road have been cleared. NB: demolished pre-war buildings are often indicative of WWII bomb damage on 1950s dated Manchester OS maps. Only a drainage ditch crossing *The Site* remains.
	1955-80	**1:1,250**	The existing ambiguous hard-standing in the south has been laid. In the south-western corner a large rectangle labelled Mat is marked.

Post-WWII	**1992**	**1:1,250**	A medium sized unidentified building has been constructed in the southern part of *The Site*. The aforementioned hardstanding (including an access road) serves this structure.
	2006	**1:10,000**	No significant changes observed either on or immediately adjacent to *The Site*.

4.3 AERIAL PHOTOGRAPHY

Review of Aerial Photography		
Period	**Photo Date**	**Review**
Pre-WWII	**Jun 1932**	***FIGURE 4.1:*** This oblique view photograph (showing *The Site* from the south-east) was taken approximately eight years before the first air raid on Manchester. It shows *The Site* as it appears on the historic pre-war OS mapping; occupied by a quarry and a row of houses. *The Site* level is variable, with a previously worked / excavated area in the east. The pale appearance of the worked part of *The Site,* indicates exposed soil / clay and a lack of vegetation. NB: an excavator is visible within the north-eastern area of *The Site.* The north-western part of *The Site* appears to be undisturbed, beyond the edge of the quarry and has a darker appearance, indicating grass.
Post-WWII	**May 1946**	***FIGURE 4.2:*** This vertical view photograph was taken approximately one year after the end of WWII. Significant change has occurred on *Site*. The majority of *The Site* has now been excavated leaving just the north, west and south peripheries at street level. The houses and Cardiff Road have been demolished. The quarry appears to have been abandoned and is now waterlogged. *The Site* peripheries appear to have experienced disturbance, likely occupied by spoil, disturbed soil and unmaintained vegetation. A cluster of >18 houses approximately 170m south-east of *The Site* has been demolished. This is likely the result of a large WWII HE bomb strike.
	Apr 1949	***FIGURE 4.3:*** the northern half of *The Site* appears to have been in-filled and levelled. It is now likely occupied by unmaintained vegetation. The southern half appears to have been partly in-filled. The dark polygon is likely a shadow cast by a quarry wall encroaching into *The Site*.
	Dec 2000	*The Site* appears as it does on the 1955-80 OS map. The aforementioned mat is an overgrown sports pitch with two opposing rows of four floodlights. The building on *Site* is a redbrick single or two storey structure with several single pitch rooves. It is likely to be sports / recreation related.

4.4 ADDITIONAL SITE-SPECIFIC HISTORY

Some sites will have been occupied by landmarks or significant buildings historically and in such cases specific written histories including significant wartime details are occasionally available in the public domain.

The Client has provided anecdotal evidence (from local residents) stating that *The Site* was previously used as an unregistered dump with various items buried there during the 1950s and 1960s. These are believed to include military radios, a dumper truck, a plane and the remains of WWII bombs. Although this information is unsubstantiated, *The Site* was indeed a pre-war quarry which was filled in post-war and therefore this evidence cannot be assumed to be inaccurate.

Further information gleaned from a local residents' webpage states that Ryebank Fields (also known locally as the 'Clay Pits') was given to Manchester Metropolitan University by the local council after WWII, to be used for sports and recreation. It goes on to suggest that WWII air-raid shelters may be buried on *Site*.

In addition, a local historian's webpage discussing the history of Ryebank Fields states that the adjacent brickworks was in operation from the beginning of the 20th Century until the 1950s. Sometime after closure, the pits were filled and capped with top soil. Ryebank Road Playing Fields were then used as a sports facility by the university until 1996.

5 UXO RISK - GERMAN BOMBING

5.1 WWII BOMBING HISTORY OF THE SITE

5.1.1 Greater Manchester

Greater Manchester was home to a number of vital wartime industries during WWII, many of which were located in Trafford Park. Infrastructure of strategic importance was also present in the form of Manchester Docks and the Manchester Ship Canal.

Between 29th July 1940 and 30th July 1942, Greater Manchester experienced 41 individual air raids during 30 days, most of which were small in scale, often executed by a solitary bomber.

At least nine relatively insignificant raids were carried out during the autumn of 1940, with the first medium scale raid affecting a wide area, occurring on the 28th August. Then on the 1st October, a medium to heavy raid was executed.

The Luftwaffe mounted consecutive major attacks on the nights of the 22/23rd and 23/24th December 1940 (the 'Christmas Blitz'). These left large areas of Manchester, Salford and Stretford devastated. NB: a major attack was a Luftwaffe designation for a raid delivering >100 tonnes of HE (in addition to incendiaries) to a target area.

In total these two attacks involved 441 German bombers dropping 272 tonnes of HE on the first night and 195 tonnes of HE on the second night. Seven conflagrations and 600 smaller fires were reported, the result of tens of thousands of small incendiary bombs (IBs). The Christmas Blitz caused the total destruction of >4,000 houses as well as serious damage to a further 12,000. 805 HE bombs were reported across Manchester, Salford, Stretford and Manchester Docks, including 134 UXBs.

During 1941, two additional major* raids was launched on the 9th January and 1st June. Although each involved half as many aircraft as the 22nd December 1940 raid, they still delivered a further 208 tonnes of HE bombs and numerous IBs onto the city and surrounding area. Three medium scale raids were also mounted in 1941, during the spring.

*The fourth and final major raid actually only delivered 97 tonnes of HE, however is close enough to 100 tonnes to be considered 'major'.

5.1.2 Site Specific History

The Luftwaffe's primary aiming point for raids on the wider Greater Manchester conurbation was the Trafford Park / Port of Manchester / Manchester city centre area, >1.5km north of *The Site*. A collection of original German maps highlighting potential bombing targets in the region was reviewed. One map highlights two railway targets in the wider study area; Chorley cum Hardy Station and Streford Station, approximately 650m east and 800m west of *The Site* respectively. Consequently, the study area would have been vulnerable to inaccurate overspill bombing.

The Site was located at the border between Manchester County Borough and Stretford Municipal Borough during WWII. As a result of the Christmas Blitz alone, Manchester Borough suffered 1,546 casualties and 6,388 houses either totally destroyed or rendered uninhabitable. For Stretford there were 358 casualties and 1,679 houses either totally destroyed or rendered uninhabitable.

5.2 BOMBING DECOY SITES:

In mid-1940 the War Office began developing a number of Bombing Decoys with the intention of diverting a proportion of Luftwaffe bombs away from the real civilian and military targets. The decoys used either;

- A system of lighting to simulate an urban area or a military airfield's runway
- Deliberately started fires to simulate a previously bombed target
- Dummy buildings and vehicles to simulate a military facility

Some 792 static decoy sites were built at 593 locations in Britain. They were estimated to have drawn at least 5% of the total weight of bombs away from their intended targets. By the end of 1941, airfield decoy sites had received 359 attacks compared with 358 raids carried out against the real airfields and by June 1944 approximately 730 attacks had been recorded on all decoy site types. As *The Site* was located within an urban area during WWII, no bombing decoys were installed in the vicinity. The closest decoy was sited approximately 6.3km to the south-west.

5.3 WWII BOMBING RECORDS

5.3.1 Introduction

The Bomb Census was undertaken by the Ministry of Home Security during WWII to try to provide a greater understanding of the effects the Luftwaffe bombing campaign was having upon Britain and to provide intelligence relating to bombing raid patterns, types of munitions used and consequent damage. The Bomb Census was compiled using information recorded by ARP wardens based in every bombed location throughout the UK.

Bombing incidents were reported to ARP wardens who kept a written record for their area of responsibility in the form of individual incident reports. In larger urban areas (mainly cities)

these reports were used to compile bomb census / plot maps. ARP bombing records were gathered by the Ministry of Home Security and used to calculate bombing density statistics for every administrative area in the UK.

The detail and quality of information recorded by the Bomb Census was inconsistent for the early stages of the war, however, by 1941 procedures had been standardised. The quality of Bomb Census information also varied greatly depending on where in the UK the records were produced.

5.3.2 ARP Bombing Density Statistics

The table below records the Ministry of Home Security's bombing density calculation for Manchester County Borough and Stretford Municipal Borough. It gives a breakdown of the types of large German bombs reported. These figures were sourced from the National Archives, London.

Record of German Air-Delivered Ordnance		
Administrative Area	**M.CB**	**S.MB**
Area Acreage	**27,255**	**3,530**
High Explosive Bombs (all types/weights)	712	456
High Explosive Parachute Mines	18	64
Flam (Oil) Bombs	17	15
40kg Phosphorus Incendiary Bombs	0	0
40kg 'Fire Pot' Incendiary Bombs	0	0
V1 Flying Bomb	1	0
V2 Long Range Rocket	0	0
Total (excluding V-Weapons and 1kg IBs)	737	520
Bombs Per 1,000 Acres	**27.0**	**147.3**

The overall bombing density figure for Manchester is not high because the Luftwaffe's primary target area was positioned near the boundaries of Manchester County Borough, Salford County Borough (to the west) and Stretford Municipal Borough (to the south-west). Consequently, the weight of Luftwaffe ordnance dropped locally was divided between these

three districts. Furthermore, Manchester County Borough covered a very large area, most of which was far from the primary Luftwaffe aiming point.

1kg / 2kg IBs and 2kg anti-personnel (AP) bombs were often too numerous to record accurately and therefore are usually not included in the Ministry of Home Security records. However, additional original data (*Cooper. G, 2018*) states that during the first major air raid alone (22nd December 1940) some 37,000 small IBs were dropped on Manchester. Luftwaffe records state the total number of IB canisters dropped during the four heaviest raids on the city as 1,925. The smallest Luftwaffe canister held just 36 x 1kg IBs and therefore it can be said that at least 70,000 x 1kg IBs were delivered, in addition to the many small and medium scale raids. NB: this number is likely far greater, as larger canister types were used.

5.3.3 Manchester Consolidated Bomb Plot Maps

These original WWII-era maps were produced by Manchester City Council's Architect's Department (Building Surveyor's Division) during the war and were updated throughout the conflict to reflect all raids on the county borough. No original legend / key accompanies the maps, however a contemporary description does confirm most of the symbols. No symbol for UXBs was identified. Any IB strike symbol with a number written within it represents the number of individual IBs falling at that location. Sections of the maps covering the study area have been combined and are displayed at ***FIGURE 5***.

- The study area (500m radius around *The Site*) was bombed during at least two separate air raids; 7th October 1940 and 22nd December 1940.
- Within a 500m radius of *The Site*, 10 x HE bombs and 45 x IB strike locations are plotted. Two of the IB locations saw 20 x IBs reported.
- One of these two 20 x IB clusters is plotted within the northern half of *The Site*. 2 x HE bombs are plotted at the western *Site* boundary and 1 x IB is plotted at the eastern *Site* boundary.
- The Stretford Borough boundary (the northern *Site* boundary) marks the edge of bomb plot map coverage. Therefore, as the 500m radius extends 500m into this adjacent borough, it is considered highly likely that additional bombs fell within 500m of *The Site*.

NB: the base map is the 1935 OS edition, illustrating the varying levels of the clay pits.

5.3.4 Manchester and Stretford Bombing Incident Reports

Neither the Greater Manchester County Record Office nor the National Archives holds a complete collection of (ARP or Police) reports of individual bombing incidents reports for the two boroughs.

A log of bombing incidents from the Manchester Emergency Committee's records (held at Trafford Archive) is contained within a local history publication (*Pythian. G, 2015*). However, this log only covers the two-night Christmas Blitz; the heaviest two raids. No original ARP reports covering all other air raids on the county borough are understood to have survived. No reference to a bombing incident specifically on *Site* or in the vicinity was found.

A list of Stretford's 'serious bombing incidents' reported during the two Christmas Blitz raids is included within a local history publication (*Smith. P, J, C, 2003*). This diary was reviewed and the following entries of interest were identified within 500m of *The Site* boundary. This dairy was compiled using original ARP records. Four local incidents were included, however this record is incomplete and therefore additional incidents in the vicinity could have occurred.

- **22nd / 23rd December:** Royston Road, HE bomb(s) - 490m to 670m north-east of *The Site*.
- **22nd / 23rd December:** No.118 Ryebank Road, unexploded Parachute Mine - 70m north of *The Site*.
- **22nd / 23rd December:** Ryebank Road / Royston Road, HE bomb(s) - 0m to 670m north and / or north-east of *The Site*.
- **23rd / 24th December:** No.78 Cromwell Road, HE bomb(s) - 430m west of *The Site*. NB: this entry confirms that a third air raid affected the study area.

5.3.5 Manchester Civilian Fatalities Map

A map of Greater Manchester showing the locations of civilian fatalities as a result of enemy action during the two consecutive major air raids of 1940 was reviewed. This map was compiled using official data from the Commonwealth & War Graves Commission, with corroboration from a number of other historical information sources. It plots the positions of bombing incidents that caused one or more fatalities and is therefore not a complete record of all bombing incidents.

Two incidents are plotted locally, both of which correspond to plotted HE bomb strikes on the aforementioned map: No.18 - 20 Cheltenham Road (six fatalities) and No.66 - 68 Newport Street (6 fatalities).

5.3.6 Abandoned Bombs Register

Evidence of suspected UXB strikes was reported to an ARP warden who in turn reported its location to the local BDU. Occasionally, a combination of factors meant that the BDU had to simply record its location on an Abandoned Bomb Register and leave it buried in situ. The reasons for abandoning a UXB could be; a relatively safe location / position, access problems or a likely extreme depth of burial. Furthermore, BDUs in the most heavily bombed areas were constantly overstretched during WWII and therefore had limited resources available.

The Archive Office of the British Army's 33rd Engineer EOD Regiment holds an Abandoned Bomb Register for Britain, a copy of which *BSI* has obtained. Considering the inaccuracy of WWII records the locations included in this register cannot be considered definitive, nor the list exhaustive and some of these Abandoned Bombs are known to have been since recovered or discounted. The Department of Communities & Local Government also holds an Abandoned Bomb Register for the UK. No Abandoned Bombs are noted either on or adjacent to *The Site*.

5.4 LIKELIHOOD OF UXB CONTAMINATION

Several factors govern the likelihood of a UXB actually striking a specific site during WWII. In parts of the UK where detailed bombing records exist it is possible to accurately predict whether any UXBs could have actually contaminated the area of the proposed works. These factors are discussed in the following table:

Density of Bombing	
Number of Air Raids in the Vicinity:	Three air raids affected the wider study area.
Intensity of these Air Raids:	The bombs dropped locally occurred during one medium scale bombing raid and two major raids, all carried out at night.
Bomb Strike Positions	
Closest Bomb Strikes to *The Site*:	1kg / 2kg IBs within *The Site* boundary and HE bombs at *The Site* boundary.

Alignment of recorded Bomb Strikes:	Assuming that the two adjacent pairs of HE bombs next to *The Site* are from the same bombload, it is considered likely that the aircraft was travelling in a north-west / south-east orientation. If so, it probably passed over the southern half of *The Site.* NB: it is possible that these bombs were dropped by two aircraft. Small IBs were dispersed from containers at a predetermined height, with the sub-munitions then spreading out over a wide area. As such, the locations of individual IB strikes at ground level does not give an indication of the aircraft's flightpath, unlike HE bomb bombloads which usually formed linear bomb-sticks. However, it can be said that the presence of IB strikes on *Site* indicates a high probability that an aircraft passed over *The Site*. Furthermore, the close proximity of IB strikes to *The Site* during a second air raid, indicates a high probability that a second aircraft passed over *The Site.*
Bomb Failure Rate	
Evidence to suggest that the generally accepted failure rate of 10% differs in the vicinity of *The Site*:	During the two Christmas Blitz raids, 148 HE bombs (including 24 UXBs) were dropped on Stretford and six of 27 Parachute Mines also fell as UXBs. Records of exploded and unexploded HE bombs dropped on Manchester, Salford and Stretford during the Christmas Blitz give a failure rate of 16.6% (*Smith. P, J, C, 2003*). This is higher than the national average.
UXBs recorded in close proximity to *The Site*:	The closest known UXB strike is an unexploded parachute mine which landed within 70m of *The Site* boundary.

5.5 LIKELIHOOD OF SUBSEQUENT UXB DETECTION

Many factors govern the likelihood of a UXB strike being observed either during its occurrence or subsequently. These are discussed in the following table. NB: it should be noted that assessing the precise conditions that existed on a site >70 years ago can be problematic, especially in urban environments where the number of variables is great.

Historic Site Access
A UXB falling on a site which was frequently accessed would have had a greater chance of being observed during its descent or subsequently. In frequently bombed residential areas, ARP Wardens carried out post-raid searches for UXBs. The importance of a site or facility is an important consideration. Many factories, gas works, power stations, docks, etc had teams of Fire Watchers tasked with extinguishing 1kg IBs and reporting UXBs.
The Site occupied a wider urban area historically, however was undeveloped and therefore it is possible that a UXB dropping within *The Site* boundary could have done so unnoticed, especially during one of the night time raids that affected the study area. Assuming that the clay quarry / pit was operational during WWII, *The Site* would have been accessed during the bombing campaign, however probably only by a small number of workers and not

necessarily frequently. Furthermore, some peripheral areas could have been neglected for long periods. Consequently, it is quite possible that a UXB entry hole could have remained undiscovered on *Site* for a significant period of time.

The Site was undeveloped, isolated and insignificant. Therefore, it would not have been subject to specific post-raid searches for delayed action bombs / UXBs, carried out by ARP wardens.

Home Guard 'Fire Pickets' (groups of fire watchers) were mounted in Chorlton from January 1941, in response to the intense fire bombing of the Manchester Blitz. However, these were stood down by March 1941. Any bombs dropping within the study area during this period are more likely to have been witnessed. However, it appears that *The Site* was not bombed during these raids.

Bomb Damage
A type of WWII specific ground cover, substantial bomb damage to a site will have resulted in conditions that would make the identification of a subsequent UXB strike extremely difficult. A HE bomb striking soft ground will have thrown up a large quantity of soil, as well as producing a crater. If this ground disturbance was not immediately repaired, any subsequent UXB strike could have been overlooked.
No evidence of HE bomb cratering was identified on *Site*. It is not known exactly when the houses on *Site* were demolished. However, analysis of the 1946 aerial photograph suggests a higher probability that the houses were cleared during the 1930s to make way for further clay extraction, as opposed to being destroyed by WWII bombing.

Ground Cover Type
The type of ground cover at a site during WWII is significant as differing types will have had differing effects on the visual evidence of a UXB entry hole. Evidence of a UXB strike to manmade structures and hard-standing will have been long lasting and easily identifiable. A UXB strike to dense vegetation or very soft ground (marshland) could have easily been overlooked. In the extreme, a UXB landing in a body of water would have been immediately obscured from view and is highly unlikely to have been accurately reported and therefore recovered.
It is not possible to confirm the exact ground conditions on *Site* during the WWII bombing campaign, however the 1946 aerial photograph shows the pits on *Site* to have been flooded. A UXB striking water would have been immediately lost beneath the waterline and would not have resulted in any persistent observable evidence. *The Site*'s peripheries were likely occupied by various unmaintained vegetation and bare soil during WWII. A UXB entry hole within such conditions could have been overlooked. NB: the diameter of the smallest German HE bomb (which was also the most commonly deployed over Britain) was 200mm; creating a small, easily obscured entry hole. After a time, environmental conditions would cause the hole to collapse and in-fill, erasing evidence of the UXO strike.

5.6 BOMBING DURING WWI

During WWI, an estimated 9,000 German bombs were dropped on London, Eastern England and South-Eastern England during some 51 Zeppelin airship raids and 52 fixed-wing aircraft raids. London suffered the worst of the bombing with an estimated 250 tonnes of HE and

incendiary bombs recorded across the Capital, over half of which fell on the City of London district. The first raid on the Capital took place on the 31st May 1915.

The WWI bombing campaign waged by Germany was on a far smaller scale than the WWII campaign, in terms of the number of raids, the weight of ordnance dropped during each attack and the size of the bombs used. When coupled with the fact that most WWI bombed locations have since been redeveloped, German WWI UXB finds are extremely rare. Furthermore, most air raids took place during daylight hours and as it was the first time Britain had experienced strategic aerial bombardment, the raids often attracted public interest and even spectators, increasing the chances of any UXBs being reported.

A small scale WWI air raids plot map of Britain and collection of written records of air raids were reviewed. These confirm that neither Manchester nor Stretford experienced any bombing during WWI. Consequently, there is no risk associated with WWI German UXO.

5.7 WWII GERMAN MUNITIONS

5.7.1 Bombs Dropped on the UK

The Luftwaffe deployed a wide variety of ordnance against the UK during WWII. The design and specific usage of the various air-delivered munitions differs greatly. Some bombs achieved significant ground penetration and are therefore more likely to remain buried in the ground today. The design of each weapon allows an informed assessment of the hazards posed by a UXB. Data sheets on those bombs most likely to be encountered today are included at ***APPENDIX 2***. Descriptions of the various families of bombs are presented below:

NB: the Italian Air Force's CAI participated in air raids against targets in Essex and Kent during the Battle of Britain in 1940. However, the CAI was a small force, dropping a fraction of the ordnance that the Luftwaffe deployed.

- ***HE Bombs*** - ***Moderate charge / weight ratio:*** The most common type of HE bombs dropped were the SC (general purpose) and SD (semi-armour piercing) series of bombs. The charge / weight ratios were between 30% and 50% allowing for penetration through multiple floors / basements of buildings and fragmentation of the thick steel shell to create

an AP shrapnel hazard. The most common weights were 50kg, 250kg and 500kg. Although six additional models between 1,000kg and 2,500kg were also deployed, ~70% of HE bombs dropped on the UK were of the 50kg type.

- ***HE Bombs - High charge / weight ratio:*** Blast Bombs, Parachute Mines or Land Mines had thin steel walls allowing for larger HE charges which detonated above ground, producing a far greater blast effect than general purpose bombs. These large weapons were parachute retarded with a ~40 mph rate of descent resulting in very limited or no ground penetration, depending on the ground cover. Therefore, it is highly unlikely that any unexploded blast bombs remain buried underground in the UK today.
- ***HE Bombs - Low charge / weight ratio:*** The PC series of bombs (500kg and 1,000kg) were armour piercing bombs used against heavily fortified defences and deep buried, reinforced bunkers, as such they were not commonly used over the UK. Charge / weight ratios were approximately 15%.
- ***Small Incendiary Bombs - sub-munitions:*** The B1E (1kg) and B2E (2kg) series of sub-munitions were the most commonly dropped bomb of all types. Up to 620 x 1kg incendiaries could be packed into the largest 'AB' series cluster bomb canisters, which opened at a pre-determined height scattering the incendiaries over a wide area. These small bombs could fully penetrate soft ground due to their small diameter. The longer 2kg model incorporated an additional HE hazard, in the form of a small anti-tampering charge with a delay fuse. Over 100,000 were dropped on London alone during the Blitz.
- ***Large Incendiary Bombs - Thick skinned:*** The Brand C50 A had a thick steel body similar to an SC 50 but contained a mixture of incendiary liquids and Phosphorus. The C50 B was the same size but incorporated mostly White Phosphorus as its fill. The Sprengbrand C50 Firepot bomb also had an SC 50 shell but contained both Thermite incendiary containers (Firepots) and a small HE charge.
- ***Large Incendiary Bombs - Thin skinned:*** The Flam 250 and Flam 500 (Oil bomb) models had thin steel bodies enabling them to break up on impact and spread their oil incendiary mixture across the ground. As such they are unlikely to remain buried today. Furthermore, their unreliability resulted in them being withdrawn from frontline use by January 1941.

- ***Anti-Personnel (AP) Bombs***: The SD2 'Butterfly' bomb was a 2kg sub-munition dropped on several British cities and towns. It contained 225grams of Amatol however, had no ground penetration ability and therefore any unexploded SD2s would have been recovered during WWII, unless they fell into water.
- ***V1 Flying Bombs and V2 Long Range Rockets:*** In the final year of WWII Germany began using pilotless weapons against England, launched from sites in occupied Europe. Both V Weapons had 1,000kg HE warheads however, were thin-skinned constructions and therefore any that failed to detonate would have broken up on impact, resulting in a large debris field of incontrovertible evidence. As such, there is no risk from unexploded V Weapons today. Thousands landed in south-east England causing widespread damage in London especially.

5.7.2 Bomb Failures

Original War Office statistics record a daily average of 84 large German UXBs (not including 1kg and 2kg sub-munitions) dropped on civilian targets throughout Britain between 21st September 1940 and 5th July 1941. 1 in 12 of these were Delayed Action (time delay fuses) bombs and therefore exploded sometime later, with the remainder being unintentional UXBs.

By the end of WWII empirical evidence indicated a (generally accepted) 10% failure rate for German HE bombs dropped on the UK as whole. However, it should be noted that this estimate is based on BDU figures collected during the war and therefore will not have taken account of the unknown numbers of UXBs that went unreported, i.e the German UXBs that are found every year by the construction industry. UXBs occur for one of the following four reasons:

- Failure of the aircraft's crew to properly arm the bombs (charging the electrical condensers) due to human error or equipment defect.
- Failure of the clockwork mechanism in the fuses of Delayed Action bombs.
- Jettisoning the bomb from a very low altitude. Most likely if the bomber was under attack or crashing.
- Fuse malfunction due to a fault during the manufacturing process. This could be the result

of accidental faulty installation or sabotage by POWs put to work in German factories.

5.8 WWII UXB GROUND PENETRATION

5.8.1 Introduction

During WWII the Research & Experiments Department of the Ministry of Home Security was tasked with analysing the varying penetration depths achieved by the Luftwaffe's HE bombs. The Army's Bomb Disposal Headquarters provided details of 1,304 UXB clearance tasks carried out on bombs which had penetrated undeveloped land (soil). In addition, the Research & Experiments Department carried out their own tests; 24 bombs were dropped into Chalk, under controlled conditions.

Records held at the National Archive include the results of this analysis. Once a pattern was ascertained from the 1,304 datasets, each bomb weight was amplified to produce a table of anticipated bomb penetration depths (below), including both average maximums and probable maximums.

Bomb weight (kg)	SANDSTONE		SAND		GRAVEL		CHALK		CLAY	
	Average (m)	Max (m)	Average (m)	Max (m)	Average (m)	Max (m)	Average (m)	Max (m)	Average (m)	Max (m)
50	2.7	6.0	2.8	7.8	2.8	7.8	3.5	7.7	4.0	9.1
250	4.6	10.3	4.8	13.7	4.8	13.7	6.0	13.1	6.8	15.8
500	5.8	13.1	6.0	17.3	6.0	17.3	7.6	16.4	8.7	19.8
1,000	7.3	16.4	7.6	21.9	7.6	21.9	9.6	20.7	10.9	24.9

As the 1,304 datasets involved broadly homogenous geologies, the penetration depths given above are likely to be different for situations where a bomb firstly penetrates through superficial deposits or made ground and then through bedrock, as would be the case for many locations in the UK which were bombed. Furthermore, some locations in the UK are underlain by geology not included in the table above and therefore informed calculations of bomb penetration cannot be made.

In both cases, the above WWII-era data should be coupled with knowledge of the strength of various rock types to make inferences on likely maximum bomb penetration depths. To calculate a maximum bomb penetration depth for a specific site, one must use a number of

assumptions based on the most likely WWII German bombing scenario:

- ***UXB Impact Velocity:*** The majority of German HE bombs dropped over the UK resulted from mass carpet bombing raids. These attacks were carried out at altitudes in excess of 5,000m which would have resulted in a 500kg HE UXB impacting the ground at an approximate velocity of 260m/s.
- ***UXB Impact Angle:*** Luftwaffe high altitude bombing resulted in strike angles of 10 to 15 degrees to the vertical. It must be assumed that the bomb was stable at the moment of ground penetration.
- ***Bomb Design:*** Some larger German bombs were occasionally fitted with "Kopfrings"; a metal ring, triangular in cross section, fitted around the nose of the bomb to limit ground penetration. It must be assumed that no such retarder units were fitted to the bomb.

5.8.2 The 'J-Curve' Effect

During WWII, BDUs reported that most deep buried German HE UXBs were found to be in a horizontal or up-turned orientation. This observation confirmed the presence of the J-Curve Effect. As a HE bomb penetrates the ground, slightly offset from the vertical, its trajectory through the underlying geology curves towards the surface.

This phenomenon can be significant to a risk assessment as the J-Curve Effect results in a horizontal offset from the point of UXB entry. This is typically a distance of about one third of the bomb's penetration depth. In the extreme, a low altitude attack resulting in a low angle UXB strike could produce even greater horizontal offset, up to 15m.

5.8.1 Site Specific Geology

WWII-era Site Geology		
British Geological Survey (BGS) 1:50,000 scale Mapping:	***Superficial Deposits:*** Glacial Till (Diamicton)	***Bedrock:*** Wilmslow Sandstone Formation (Sandstone)
Previous SI Data:	No recent SI data was provided by *The Client* and no historic BGS borehole logs for *The Site* were available. The nearest BGS borehole log (through the same mapped geology as *The Site*) is 300m to the east. It encountered the following:	

	- 0.3m of Made Ground - 0.6m of soil - 0.6m of sand - 0.6m of yellow sand - 1.5m of gravel - 3.6 of brown clay

5.8.2 Site Specific Maximum Bomb Penetration Depth

During WWII the Luftwaffe dropped many different types of HE bomb. The SC (general purpose) series was by far the most numerous and of this series, the SC 500 model (weighing 500kg) was the largest of the most commonly deployed and therefore this will be used as the benchmark weapon for the Maximum Bomb Penetration Depth assessment.

The presence of two natural deposits under *The Site* during WWII complicates the estimation of bomb burial depth. NB: the empirical 1940s evidence appears to record UXBs travelling through geology of only one type. Each lithology will have had a differing decelerating effect on a HE UXB, both individually and in combination, thereby complicating the estimation of burial depth. In addition, the depth of Sandstone rockhead on *Site* is not known. Furthermore, *The Site* was in use as a quarry during WWII, with significant variations in ground level and an unknown depth of standing water likely existed in some parts. These factors mean it has not been possible to calculate an accurate *Site*-specific maximum bomb penetration depth.

Taking this into account, it has been conservatively assessed that a 500kg HE bomb would have had a maximum bomb penetration depth of ***12m*** below WWII ground level and the average depth of HE UXBs would be approximately ***5m*** below WWII ground level.

Theoretically penetration depths could be greater if the UXB was larger, however, War Office statistics confirm that between October 1940 and May 1941 the majority of HE UXBs (>90%) were either 50kg or 250kg, with the 500kg bombs making up most of the remaining 10%.

The northern, western and southern extents of *The Site* appear to have been at a higher ground level to the remainder of *The Site* during WWII and therefore any UXB remaining here up to the present day would be at a shallower depth to the same sized UXB buried within the central part of *The Site.* The fill deposited on *Site* post-war will have affectively buried any UXO

there to a greater depth. However, as the thickness of this fill is not known, the maximum depth of German UXB contamination is not known.

6 UXO RISK - BRITISH / ALLIED MILITARY ACTIVITY

6.1 INTRODUCTION

The table below lists all the modern and historical facilities and activities that could have potentially resulted in localised British / Allied UXO contamination in the UK. Those which are relevant to *The Site* have been discussed in the subsequent section(s).

POTENTIAL UXO SOURCE	DOES THE SOURCE HAVE THE POTENTIAL TO AFFECT THE SITE IN QUESTION?
Existing or historic Army or RAF Training Areas / Ranges	✗
Existing or historic Military Bases and Other Installations	✗
Existing or historic Munitions or Explosives Factories	✗
Existing or historic Military Storage Depots	✗
Existing or historic Military Defensive Fortifications	✗
Sites requisitioned by the military during conflict	✗
WWII Pipe Mined Locations and Beach Minefields	✗
WWII Home Guard activity	✓
WWII Light and / or Heavy Anti-Aircraft Fire	✓

6.2 POTENTIAL SOURCES OF UXO

6.2.1 Introduction

Research has not located any evidence of British or Allied army, RAF or Royal Navy activity specifically on *Site.* Unused open ground within Britain's vulnerable cities was often used for temporary AA gun batteries, searchlight batteries or barrage balloon sites during WWII and therefore *The Site* could have been considered a candidate for such use. However, its uneven ground level and tendency to flood, likely made it unsuitable. Furthermore, a secondary source record of the locations of such sites (*Smith. P, J, C, 2003*) does not list *The Site*.

The most likely potential sources of UXO contamination on *Site* are WWII Home Guard activity and AA fire, as discussed below.

6.2.2 WWII Home Guard Activity

The Home Guard, originally the Local Defence Volunteers, was formed in the summer of 1940. It was a volunteer force comprising men who were either too young, too old, or in reserved occupations (those jobs vital to the war effort). Battalions were established in most urban areas and some large organisations (such as railway networks) created their own platoons.

Their main purpose was to bolster regular Army units in the event of German invasion. By the end of June 1940, over one million had signed up. Initially, only shotguns, old hunting rifles, bayonets, knives and an array of improvised weapons were available, however by mid WWII, conventional weapons were available and some were even designed specifically for the Home Guard; such as SIP grenades (Molotov Cocktails) and the Northover anti-tank Projector. Furthermore, ammunition in very short supply during 1940 became more readily available.

Home Guard units had a variety of responsibilities; road patrols, manning Observation Posts at commanding points, reporting on enemy airborne landings, delaying the enemy at specified road-blocks, and organising mobile fighting patrols to harry the enemy.

Soldiers of 'A' Company (Chorlton-cum-Hardy) of the 46th Lancaster (south Manchester) Home Guard Battalion, were responsible for and active within the study area during WWII. By mid-June 1940, 'A' Company already had a strength of 600 troops and was headquartered at No.14 Edge Lane.

A publication describing the activities of 'A' Company was reviewed (*The Naval & Military Press, 2015*). This book includes a list of the unit's 'Posts' which were established within Chorlton-cum-Hardy during 1940. Ryebank Fields or the Clay Pits are not listed. The Company is said to have used Crowden Range and the South Manchester Rifle Club miniature range for training with small arms (rifles and pistols) during 1940.

Training became a lot more frequent and intense during 1941. With new weapons, came the opportunity for Platoons to form specialist Sections, e.g with anti-tank weapons, such as the

Smith Gun or Spigot Mortar.

As well as Crowden, visits to the ranges at Stalybridge, Diggle, Brushes, Facit and Holcombe Brook were frequent during early 1942. This allowed all troops to become familiar with all the weapons available to the Company by 1943. The local Golf Course was also used for training, however it is not known whether weapons training was authorised here.

In May 1942, the first Company Camp took place at Devisdale and Stamford Park. All Platoons spent a week camped out in tents carrying out hard training every day. Mobberley, Marple and Carrington Camp hosted subsequent week-long camps. In March 1944, Parrs Wood Range was opened which provided a more local firing range for the Company. In September 1944, the last of the local urban exercises took place, when three attacking Platoons of 'A' Company attacked troops of the 44th Battalion in the Stretford area.

Although no specific evidence of Home Guard activity on *Site* has been identified, it is known that troops often carried out manoeuvres in open ground on the outskirts of urban areas, sometimes within close proximity to civilian life. Unused quarries were often requisitioned as they were ideal for small scale ad-hoc training with weapons and explosives. However, no such evidence of the clay pits on *Site* being used as such was found. Even if they weren't, it is conceivable that armed Home Guard soldiers could have accessed *The Site* whilst on patrol.

Recent WWII land service and small arms ammunition finds in the England indicate an ill disciplined 'out of sight out of mind' culture in the armed forces during WWII. It would appear that faulty or partially spent ammunition was sometimes discarded on civilian land, in seemingly random locations. Any such UXO could then become buried over time. Similarly, there are examples of surplus (boxed) ammunition buried as a hassle-free means of disposal, likely when the Home Guard was disbanded in 1944. Such a scenario on *Site* can therefore not be completely discounted, although is considered unlikely.

6.2.3 WWII Anti-Aircraft Batteries

Anti-Aircraft (AA) Command was a British Army command established in 1939 to defend the UK during the anticipated German bombing campaign. It controlled the Territorial Army AA artillery and searchlight units. From 1940 to 1945 BDUs dealt with some 7,000 UX AA shells in

Britain. There were three main types of AA battery used for home defence (see below). Data sheets on these AA defences are included at ***APPENDIX 3***.

1. ***Heavy Anti-Aircraft (HAA)*** **-** Large calibre guns (3.7" and 4.5") for engaging high altitude bomber formations. Hundreds of permanent batteries were constructed in and around major cities and military bases during the 1930s. Some 2,000 of these guns were available during the Blitz. Each gun could fire between 10 and 20 rounds per minute and consequently HAA batteries could expend large quantities of shells during each engagement.

   British time fuses were poorly manufactured during WWII and this led to high failure rate for HAA shells, up to 30%. Unexploded HAA shells had the potential to land up to 27km from their battery, although more typically landed within a 15km radius.

2. ***Light Anti-Aircraft (LAA)*** **-** smaller calibre guns for engaging dive bombers and low altitude intruders. As such they were mostly used to defend specific industrial and military targets which were subject to precision bomber attack. LAA guns were either .303" calibre machine guns or 20mm and 40mm calibre cannon. The latter were fitted with simply impact fuses and small incendiary or HE bursting charges.

   The 40mm Bofors gun could fire 120 x HE shells / minute to a ceiling of 1,800m. Each shell was designed to self-destruct if it didn't strike an aircraft, however, inevitably some failed and fell back to earth.

3. ***Z (Rocket) Batteries*** - A Z-Battery comprised a grid formation of 64 rocket projectors which fired 2" and later 3" Unrotated Projectile (UP) rockets to a maximum altitude of 5,800m; a ground range of some 9,000m. They were deployed in cities all around the UK from 1941 and proved to be an effective addition to the existing AA guns.

   The rockets measured 0.9m (2") and 1.8m (3") in length with four stabilising fins at the base and were fitted with 3.5kg or 8.2kg HE warheads. The larger warhead had an effective airborne blast radius of up to 20m. Some variants deployed a form of aerial mine described as a "small yellow bomb" which was designed to detach from the rocket at height and descend on a parachute with the objective of becoming snagged

on target aircraft and then detonating.

Unlike bombs which were designed to strike the ground nose first, AA shells and rockets were not designed to hit the ground and therefore unexploded AA munitions do not necessarily land nose first. This coupled with the lower mass of AA UXO resulted in shallower ground penetration depths. Although, in very soft conditions, unexploded WWII AA munitions were observed to penetrate to >1.5m bgl.

The 70th and 98th HAA Regiments of the 44th AA Brigade manned >30 static HAA batteries within a 15km radius of *The Site*. The 81st AA Regiment deployed LAA guns to at least one confirmed Vulnerable Point within range of *The Site*; the Metropolitan-Vickers factory at Trafford Park.

The frequency and intensity of Luftwaffe air raids over Greater Manchester suggests these batteries would have expended a large quantity of AA ammunition and it is quite possible that an unexploded AA shell struck *The Site*.

NB: a Home Guard manned Z Rocket battery (No.135 Battery, 4th ZAA Regiment) was established in Alexandra Park during July 1942, however the heaviest bombing had ceased by this time and therefore it is considered unlikely that any AA rockets were ever fired in anger over the city.

6.3 LAND SERVICE AMMUNITION (LSA)

6.3.1 General

Land Service Ammunition (LSA) is a broad military term relating to a wide variety of weapons primarily deployed for land use. NB: Similar weapons (particularly artillery guns) were also deployed on naval platforms historically. LSA encompasses those types of ammunition that can be placed, thrown or propelled and as such is broken down into five main munitions families; Grenades, mortar bombs, artillery projectiles, anti-tank rockets and landmines.

The former three (detailed below) were produced / deployed in the greatest numbers historically and therefore are more likely to be encountered on UK sites today.

Anti-tank rockets were portable infantry weapons, however saw only limited service in the latter years of WWII. As such, the US made Bazooka and British made PIAT were deployed in relatively small numbers.

Landmines (both anti-personnel and anti-tank) were used by the British Army to fortify English beaches against an anticipated German invasion during WWII. However, as expected, each minefield was well documented and subsequently cleared during the 1940s.

Like German UXBs, LSA does not lose its effectiveness with age. Decades of burial can cause ammunition to become less stable and more sensitive. The potentially fragile state of expended, yet unexploded LSA, coupled with the relatively shallow burial state of such items, makes for a particularly hazardous scenario as LSA is more likely to be encountered and tampered with by unqualified personnel.

Data sheets on the most likely types to be encountered today and / or the most hazardous are included at ***APPENDIX 4***.

6.3.2 Grenades

A grenade is a short-range infantry weapon, essentially a small bomb, typically thrown by hand or launched from rifles or dedicated grenade launchers. A wide variety of grenades have been deployed in the UK historically, the most common being explosive (fragmentation or blast / concussion) grenades designed to detonate after impact or after a set amount of time.

They are divided into two categories; HE and Carrier (chiefly smoke for signalling and white phosphorus). Grenades were designed for both anti-personnel and anti-tank roles.

The Mills Bomb was the first modern fragmentation grenade produced for the British Army, and was used in the WWI trenches from 1915. Updated Mills models were the mainstay of the Army throughout WWII and into the post-war period.

The striker of a Grenade (found buried on site today) may either be in contact with the detonator or still be retained by a spring under tension. As a result, any shock or vibration may cause it to function.

One primitive incendiary grenade produced in vast number during WWII was the SIP grenade. Unlike most grenades, these had no explosive element, relying instead on a chemical reaction between phosphorus and air to produce an intense incendiary effect and resulting burns hazard.

6.3.3 Mortars

A mortar is a simple infantry weapon that fires a projectile (mortar bomb) in a high-arcing ballistic trajectory, at low velocity, to a relatively short range. It is a compact, easily transportable weapons system used by British and Allied armies since WWI, when the British Stokes Trench Mortar became the first truly portable infantry mortar.

During WWII British mortars had a rate of fire of 30 bombs per minute with ranges in excess of 2km. The 2" and 3" mortars were the most common types used by the British Army.

Ammunition for mortars generally comes in two main varieties: fin-stabilized and spin-stabilized. Examples of the former have short fins on their posterior portion, which control the path of the bomb in flight. Spin-stabilized mortar bombs rotate as they travel along and leave the mortar tube, which stabilizes them in much the same way as a rifle bullet. Both types of bomb come in a variety of types; high explosive, smoke, parachute illumination, inert practice.

The mortar bomb is almost always nose fused with the tail piece comprising a 'spigot tube' (housing the propellant charge) screwed or welded to the rear end of the main body. A mortar relies on a striker hitting a detonator for explosion to occur. Like grenades, the striker of an expended but unexploded mortar bomb may now be in a very fragile state, after decades exposed to environmental conditions.

6.3.4 Artillery Projectiles

Anti-tank guns and Howitzers have been in use with the British Army for over a hundred years. The former ranged from the Ordnance QF 2 Pounder (40mm) to the Ordnance QF 17 Pounder (76mm) in calibre. The latter ranged from the Ordnance QF 25 Pounder (87.6mm) to the BL 60 Pounder (127mm).

A wide variety of artillery projectiles have been deployed in the UK historically, by British and

Allied Armies. In general, projectiles fall into two categories; Shot and Shell. The former are inert; solid metal projectiles containing no hazardous element, whereas the latter are hollow (like bombs), containing a variety of potentially hazardous fills.

Solid shot falls into four categories, mainly for gun proofing and target practice, however as they are inert they are relatively irrelevant with regards to present day UXO risk. Historically, there were three types of WWII-era British artillery shell:

- ***Bursting Type*** - The filling (or part of it) caused the shell to burst. The most common filling was HE where the shell caused damage to material by the force of the burst or to personnel and aircraft by fragmentation of the shell casing producing shrapnel. NB: bursting shells were also used with chemical fillings.
- ***Shrapnel Type*** - These usually burst in the air and projected their 'payload' forwards acting like a shotgun. The usual payload was shrapnel bullets however Thermite 'pots' were used during WWI. By the start of WWII shrapnel shells were obsolete for field artillery.
- ***Carrier Type*** - These also burst in the air, however ejected their payload backwards after blowing the base plate off the shell. The most common fills used were smoke, star and flare shells. The latter two being designed to illuminate an area or target. Smoke shells were used to produce smoke screens and used various fillings (the common being white Phosphorus).

  Artillery projectiles were always painted, this protected the steel from rust but was also used to indicate the nature of the ammunition. The basic body colours for artillery were; Yellow (HE), Light Green (smoke), Black (Flare / Star) and Grey (chemical).

Most artillery shells have a similar appearance and therefore the 3.7” AA shell shown in *Appendix 3* is a good example of a WWII-era artillery projectile.

NB: artillery shell fuses found on their own do not represent a significant hazard. A fuse from an unspent shell will only contain a very small quantity of gunpowder in the detonator.

6.4 20MM AUTOCANNON AMMUNITION

During WWII, a number of RAF and USAAF fighters were fitted with 20mm autocannons;

manufactured by the Swiss company Oerlikon and the French company Hispano-Suiza. These weapons were also used by UK based Army and Navy units in the LAA role. An autocannon is essentially a larger calibre machine gun utilising fused (not solid shot) ammunition.

Although cannon ammunition looks very similar to SAA, some projectiles incorporate a small, simple impact fuse and an approximately 4gram HE and / or incendiary fill. Although small, when compared with artillery shells, each bursting charge still has the potential to cause serious injury.

During WWII, Hispano-Suiza and Oerlikon produced a variety of 20mm ammunition types; High Explosive, High Explosive Incendiary, Armour-Piercing, Armour Piercing Incendiary, Target Practice (inert), Target Practice Tracer (inert). Each type was distinguished by the painted colour of the projectile head and colours varied between the two manufactures.

On some projectiles, the tracer became a self-destruct mechanism, detonating the bullet if no impact occurred after five seconds. This resulted in the potential for less collateral damage and far less unexploded 20mm rounds falling back to earth.

A data sheet on 20mm ammunition is included at ***APPENDIX 5***.

6.5 SMALL ARMS AMMUNITION (SAA)

Small arms ammunition is primarily cartridge-based, solid shot ammunition with a calibre <20mm. It covers ammunition used for side arms, rifles and light to heavy machine guns. Each 'round' of ammunition comprises a cartridge case, solid shot projectile (bullet), propellant and primer.

The most common types of SAA to be encountered in the UK are 0.303” calibre (the standard British and Commonwealth military cartridge from 1889 until the 1950s), 0.30” calibre (the standard American cartridge used during WWII) and 0.5” calibre (used by machine guns deployed on USAAF bombers based in Britain during WWII).

As solid shot, spent SAA rounds do not pose a hazard. Unspent rounds comprise a small propellant charge within the cartridge, however SAA is generally stable and relatively safe to handle. NB: Unspent rounds can function if subjected to high heat, such as fire. Any detonation

however would not be contained within a barrel and would only result in local, minor overpressure.

7 UXO RISK MITIGATING CIRCUMSTANCES

7.1 INTRODUCTION

Subsequent works on a UXO contaminated site could have resulted in the partial or complete removal of this UXO risk. Various construction works or earthworks could have uncovered UXO which would then have been reported and removed by the authorities. Alternatively, a site may have been subject to a military Explosive Ordnance Clearance (EOC) task, involving surveying, subsequent target investigation and removal.

7.2 EXPLOSIVE ORDNANCE CLEARANCE TASKS

The British Army, RAF and Royal Navy all have EOD units that are responsible for carrying out UXO clearance on their own bases and training areas. UXO found on civilian land is dealt with by whichever EOD unit is local and available.

BSI has access to a database of historic EOC tasks carried out by the British Army's Royal Engineer EOD unit; the 29th Regiment. NB: this database is only complete up until the early 2000s and therefore does not include recent EOC tasks. No such database for the RAF and Royal Navy EOD units is easily accessible. A search of this database has not resulted in any Army EOC tasks resulting in UXO finds in the vicinity of *The Site*.

UXO encounters on civilian land are often reported in the media and therefore a web search of local media outlets was also carried out. No evidence of recent UXO finds within the immediate vicinity of *The Site* was found. The closest UXO incident occurred in Trafford Park where a wartime artillery shell was found during works in Hadfield Street in June 2015.

7.3 GROUND WORKS

There appears to have been one phase of post-WWII development on *Site*; the university sports building / pavilion (since demolished) within the southern half of *The Site*. This was a low-rise construction (with associated hardstanding) only occupying a small part of the

southern half of *The Site*. The type of footings utilised is not known. It is considered unlikely that substantial earthworks were undertaken as a result of this development.

The vast majority of *The Site* has remained undeveloped and is unlikely to have experienced substantial post-war intrusive ground disturbance.

7.4 DEDUCTIONS

The lack of post-war redevelopment of the vast majority of *The Site* suggests that any shallow buried UXO is more likely to remain up to the present day. Any deep buried German UXBs on *Site* will certainly not have been disturbed.

The footprint of the post-war constructed sports pavilion in the south appears to have been just beyond the edge of the clay pit proper and therefore may have been on a raised area, not requiring post-war fill. As such, this construction would have partly mitigated the risk of any shallow buried UXO. Although it should be noted that undisturbed soil will have persisted in between the foundations at shallow depths and therefore UXO could have remained in-situ beneath this building.

Between 1946 and 1949, the clay pits on *Site* were largely in-filled. Any hazardous items in the pits are highly unlikely to have been removed prior to filling. Examples of similar 'out of sight out of mind' dumping of surplus war materials in the aftermath of WWII are not uncommon in the UK. Such behaviour was especially common in bodies of water, e.g a flooded quarry. As such, any UXO or UXO related objects (defused, inert munitions) are more likely to have been simply buried at WWII-era quarry floor level.

The post-war filling of the clay pits raises the possibility of another source of UXO contamination on *Site*. After the Blitz, many cities were left with enormous volumes of useless material from numerous bombsites; broken masonry, timber, glass etc. It is quite possible that Ryebank Fields were identified as a candidate for taking some of Greater Manchester's rubble. If this did occur, *The Site* could have been inadvertently contaminated with small items of UXO.

Many bombsites in Greater Manchester will have been struck by subsequent unexploded

bombs (HE and IB) and AA shells. A large German HE UXB is highly likely to have passed through the rubble and penetrated below ground level. However, smaller items (German 1kg / 2kg IBs and AA shells) probably would not have achieved penetration. During the process of clearing each bombsite, removing the rubble and redepositing it elsewhere, any smaller devices caught up in the rubble could have been missed during the process. It is conceivable that such UXO could now be present within volumes of fill material at varying burial depths on *Site*.

8 CONCLUSION

8.1 ACCURACY OF THE HISTORICAL RECORDS

Occasionally, the accuracy of some historical records can be proven to be poor, when compared with other records. One significant consequence of this can be the possibility of unrecorded German bomb strikes in the vicinity of a study area. A review of the records gathered for this assessment has not highlighted any significant inconsistencies.

8.2 THE RISK OF UXO CONTAMINATION ON SITE

8.2.1 Key Findings - German UXO Risk

- Greater Manchester was the 11th most heavily bombed British conurbation during WWII. Like today, *The Site* occupied a central location during the Blitz, relatively close to the Luftwaffe's primary target area and a number of smaller individual targets. Consequently, the study area was affected by large scale, indiscriminate bombing and experienced a moderate to high bombing density, as confirmed by wartime records.
- A bomb plot map covering all air raids on Manchester Borough was analysed, as were individual incident reports covering the two heaviest raids on Stretford Borough and a record of civilian fatalities due to enemy action. These confirm that the study area was affected by at least three air raids, resulting in at least 10 x HE bombs and 45 x IB strike locations within 500m of *The Site*, including a cluster of 20 x IBs within the northern half of *The Site* and a pair of HE bombs at the western *Site* boundary.
- The bomb plot map does not cover Streford Borough and the only records available for this borough only cover the two heaviest raids. Therefore, it is considered likely that

additional bombs fell locally. Indeed, at least four bomb(s) strike locations in Stretford occurred within 500m of *The Site*, including a UXB just 70m north of *The Site*.

- Analysis of the available records indicates that an aircraft flew over *The Site* whilst dropping their bombloads in the vicinity at least twice, probably three or more times. This raises the possibility of a UXB release over *The Site* on multiple occasions.
- Records of exploded and unexploded HE bombs dropped during the Manchester Blitz give a failure rate of 16.6%; a significantly higher figure than the widely accepted 10% average for Britain as a whole.
- All bombs dropped locally were part of high-altitude indiscriminate bombing raids carried out at night. The study area was not densely populated during WWII and *The Site* itself was undeveloped, occupied by clay pits associated with an adjacent brick works. This elevates the chances of any UXB fall on *Site* occurring unobserved.
- *The Site* would have been accessed during the bombing campaign, however probably only by a small number of workers and not necessarily frequently. It is quite possible that peripheral areas were neglected for long periods. NB: anecdotal evidence states that the clay pits were in use until the 1950s, however a WWII-era aerial photograph suggests they could have been abandoned during the conflict.
- It is not possible to confirm the exact ground conditions on *Site* during the WWII bombing campaign, however the 1946 aerial photograph shows the pits on *Site* to have been flooded. A UXB striking water would have been immediately lost beneath the waterline and would not have resulted in any persistent observable evidence.
- *The Site*'s peripheries were likely occupied by unmaintained vegetation and bare soil during WWII. A UXB entry hole within such conditions could have been overlooked. NB: the diameter of the smallest German HE bomb (which was also the most commonly deployed over Britain) was 200mm; creating a small, easily obscured entry hole. After a time, environmental conditions would cause the hole to collapse and in-fill, erasing evidence of the UXO strike.
- Anecdotal evidence has been identified suggesting that the remains of WWII bombs were buried on *Site*. Assuming this is true, it probably refers to local residents and / or Civil Defence personnel dumping unexploded German 1kg / 2kg IBs and / or shrapnel from AA shells and larger HE bombs in disused parts of the clay pits. NB: the former (which are

known to have landed locally) were often extinguished by trained locals, Home Guard fire watchers or ARP wardens before they could fully ignite or burnt out. Many unexploded yet potentially still hazardous IBs would have required safe disposal and the flooded clay pits may have been considered an ideal location.

- It should be noted that this anecdotal evidence is less likely to refer to Bomb Disposal units dumping the inert casings of large German HE bombs which they had defused in the local area. Although such activity cannot be ruled out entirely. NB: once defused, the HE content of large bombs was usually steamed-out of the steel casing, which itself was then sent to a metal scrap yard.

8.2.2 Key Findings - British UXO Risk

- >30 HAA gun batteries and a number of LAA guns were within range of *The Site* during WWII. The frequency and intensity of Luftwaffe air raids over the wider area suggests these batteries would have expended a vast quantity of AA ammunition over the city. For the same reasons as above, it is considered quite possible that an unexploded shell could have struck soft ground or standing water on *Site* unwitnessed and remained undetected / gone unreported. NB: the entry hole of an unexploded AA shell would have been even smaller than a German HE UXB.
- Up to 600 'A' Company soldiers of the local Home Guard battalion were active in the wider area during WWII. Local disused quarries were often requisitioned for temporary Home Guard training and therefore the possibility cannot be completely ruled out that ad-hoc weapons training occurred on *Site*. However, a detailed account of 'A' Company's activities was reviewed and none of the several training areas / ranges utilised by this unit reference *The Site.*
- However, as a likely location of historic unauthorised dumping, *The Site* could now be contaminated with a wide range of refuse and other objects. It is conceivable that an item(s) of British or Allied ammunition was thrown into the clay pits historically.

8.3 SITE SPECIFIC UXO HAZARDS

Different types of UXO pose differing types of hazard, depending on their structural design, Net Explosive Quantity (NEQ), fill type and likely contamination depth. The table below lists

the main types of UXO most often encountered on urban UK sites and their relative hazard levels.

UXO Type	NEQ (NEQ Range)	Likely Burial Depth	Hazard Posed
WWII German General Purpose HE Bombs	25kg - 220kg (most commonly deployed bomb weights)	Likely deep burial (>3m)	HIGH RISK
WWII British Heavy Anti-Aircraft Shells	1.1kg - 1.7kg	Shallow burial (<1.5m)	MODERATE-HIGH RISK
WWII British Land Service Ammunition	<2kg	Shallow burial (<1.5m)	
WWII German 2kg Incendiary / HE Bombs	680g incendiary hazard + ~500g explosive hazard	Shallow burial (<1.5m)	
WWII German 1kg IBs	680g (incendiary, not explosive hazard)	Shallow burial (<1.5m)	MODERATE RISK
WWII British Light Anti-Aircraft Shells	4g - 70g	Very shallow burial (<1m)	LOW-MODERATE RISK

8.4 THE LIKELIHOOD OF UXO ENCOUNTER

8.4.1 Introduction

This report assesses the risk of UXO in relation to the proposed works, not simply the risk that UXO remains buried on site. The likelihood of UXO encounter during intrusive ground works will vary depending on the type of UXO and the type of construction methods employed during the project. Naturally, the greater the number, volume and depth of intrusions, the greater the likelihood of UXO being encountered, assuming UXO resides on site.

Within an area of elevated UXO contamination risk (delineated at ground level), the sub-surface volume of potential UXO contamination will comprise the natural soil / geology in between WWII ground level and the maximum bomb penetration depth. Therefore, any intrusions into this layer will be at risk of UXO encounter.

Any post-WWII fill material deposited on a site is unlikely to be contaminated with UXO and therefore the risk of encountering UXO on such a site could vary with depth. NB: the origin of post-war fill material is not always known and therefore it cannot be assumed to be UXO free.

In the wake of the initial nine-month Blitz, many cities and towns were left with vast quantities of bomb site rubble that required removal and relocation. This material was put to use for in a variety of ways, for example >750,000 tons of London's rubble was used to build runways for new RAF and USAAF airfields and much of Liverpool's rubble was used to create and maintain sea / flood defences throughout Merseyside.

It is quite possible that unexploded British AA projectiles and German 1kg incendiaries were overlooked during removal, resulting in UXO contaminated fill material ending up on otherwise low UXO risk sites, possibly many miles from any high bombing density areas.

8.4.2 German UXBs

Although most German HE UXBs came to rest several metres below WWII ground level, these weapons can be found at any level between just below WWII ground level and the maximum bomb penetration depth. There are a number of reasons why these heavy bombs might be found at surprisingly shallow depths;

- ***Tip and Run:*** When enemy aircraft had to take evasive action to escape RAF fighter interception and / or AA defences, they often dropped their bomb loads from a reduced height, potentially resulting in extreme J-Curve Effect.
- ***Deflection:*** The shape of German HE bomb nosecones meant they were susceptible to deflection when striking surface or shallow sub-surface obstacles, occasionally resulting in shallow burial or even UXBs skidding across hard-standing, roads, etc.
- ***Aircraft Crash Site:*** If an aircraft was unable to dump its bomb load before impacting the ground, due to mechanical fault, any externally fitted bombs could have become buried on impact.

German 1kg / 2kg incendiaries were cylindrical and approximately 50mm in diameter. They had tailfins, which meant they landed nose first, which in soft ground could result in full penetration of the bomb below the surface. Therefore, such items are usually found close to the surface.

8.4.3 British / Allied UXO

The nature of British / Allied military activity involving LSA / SAA and the smaller size of these

munitions (in relation to German HE bombs) indicates that any resulting UXO contamination on a site will be limited to shallow depths, usually within 1.5m of the surface, unless any post contamination fill material has raised the ground level, effectively burying the UXO even deeper.

Domestic military LSA and SAA contamination will either be the result of expending dud ammunition (shells) which bury into the ground on impact or munitions purposefully buried, for a number of reasons. Either way, these types of UXO are all found at shallow depth.

8.4.4 Deductions

At the time of writing the extent and depth of the future construction works were not known. Consequently, no specific comment can be made regarding the likelihood of a UXO encounter during the development works.

It can be said however that a large German UXB buried under the former clay pits would reside beyond the reach of shallow traditional foundations for any low-rise housing. However, as the proposed deep boreholes would reach and penetrate the WWII-era quarry floor, these works would be at risk of a UXO encounter. Similarly, if piled foundations extending below WWII-era ground level are required, the likelihood of a UXO encounter will increase.

Furthermore, a UXB buried under the peripheral parts of *The Site* could be encountered during more shallow excavations, as WWII-era ground level will exist at a shallow depth here.

It is possible that the post-war fill material occupying the majority of *The Site* is UXO contaminated and therefore a UXO encounter during shallow intrusions within this made ground cannot be discounted also.

8.5 OVERALL RISK RATING

Ratings for the likelihood of UXO contaminating *The Site*, remaining on *Site* up to the present day and being encountered during the proposed works, inform the overall risk rating. The UXO risk to the proposed works on *Site* has been assessed as **Moderate** and **High**. A Risk Map (likelihood of UXO remaining on *Site*) is displayed at ***FIGURE 6***.

RISK TABLE: MODERATE RISK				
UXO TYPE (ASSOCIATED HAZARD)	LIKELIHOOD OF UXO CONTAMINATION	LIKELIHOOD OF UXO REMAINING	LIKELIHOOD OF ENCOUNTER	OVERALL RISK RATING
WWII German General Purpose HE Bombs	MODERATE	HIGH	MODERATE	MODERATE RISK
WWII British Heavy Anti-Aircraft Shells	MODERATE	HIGH	MODERATE-HIGH	
WWII British Land Service Ammunition	LOW	HIGH	MODERATE-HIGH	LOW RISK
WWII German 2kg Incendiary / HE Bombs	MODERATE	MODERATE-HIGH	MODERATE-HIGH	MODERATE RISK
WWII German 1kg Incendiary Bombs	MODERATE	MODERATE-HIGH	MODERATE-HIGH	LOW-MODERATE RISK
WWII British Light Anti-Aircraft Shells	LOW-MODERATE	MODERATE	MODERATE-HIGH	
Various Dumped / Discarded UXO	MODERATE	MODERATE-HIGH	MODERATE-HIGH	MODERATE RISK

RISK TABLE: MODERATE-HIGH RISK				
UXO TYPE (ASSOCIATED HAZARD)	LIKELIHOOD OF UXO CONTAMINATION	LIKELIHOOD OF UXO REMAINING	LIKELIHOOD OF ENCOUNTER	OVERALL RISK RATING
WWII German General Purpose HE Bombs	MODERATE-HIGH	HIGH	LOW-MODERATE	MODERATE-HIGH RISK
WWII British Heavy Anti-Aircraft Shells	MODERATE-HIGH	HIGH	MODERATE	MODERATE RISK
WWII British Land Service Ammunition	LOW	HIGH	MODERATE	LOW RISK
WWII German 2kg Incendiary / HE Bombs	MODERATE-HIGH	HIGH	MODERATE	LOW-MODERATE RISK
WWII German 1kg Incendiary Bombs	MODERATE-HIGH	HIGH	MODERATE	
WWII British Light Anti-Aircraft Shells	MODERATE	HIGH	MODERATE	LOW RISK
Dumped / Discarded UXO - Various	MODERATE-HIGH	HIGH	MODERATE	MODERATE-HIGH RISK

9 RISK MITIGATION RECOMMENDATIONS

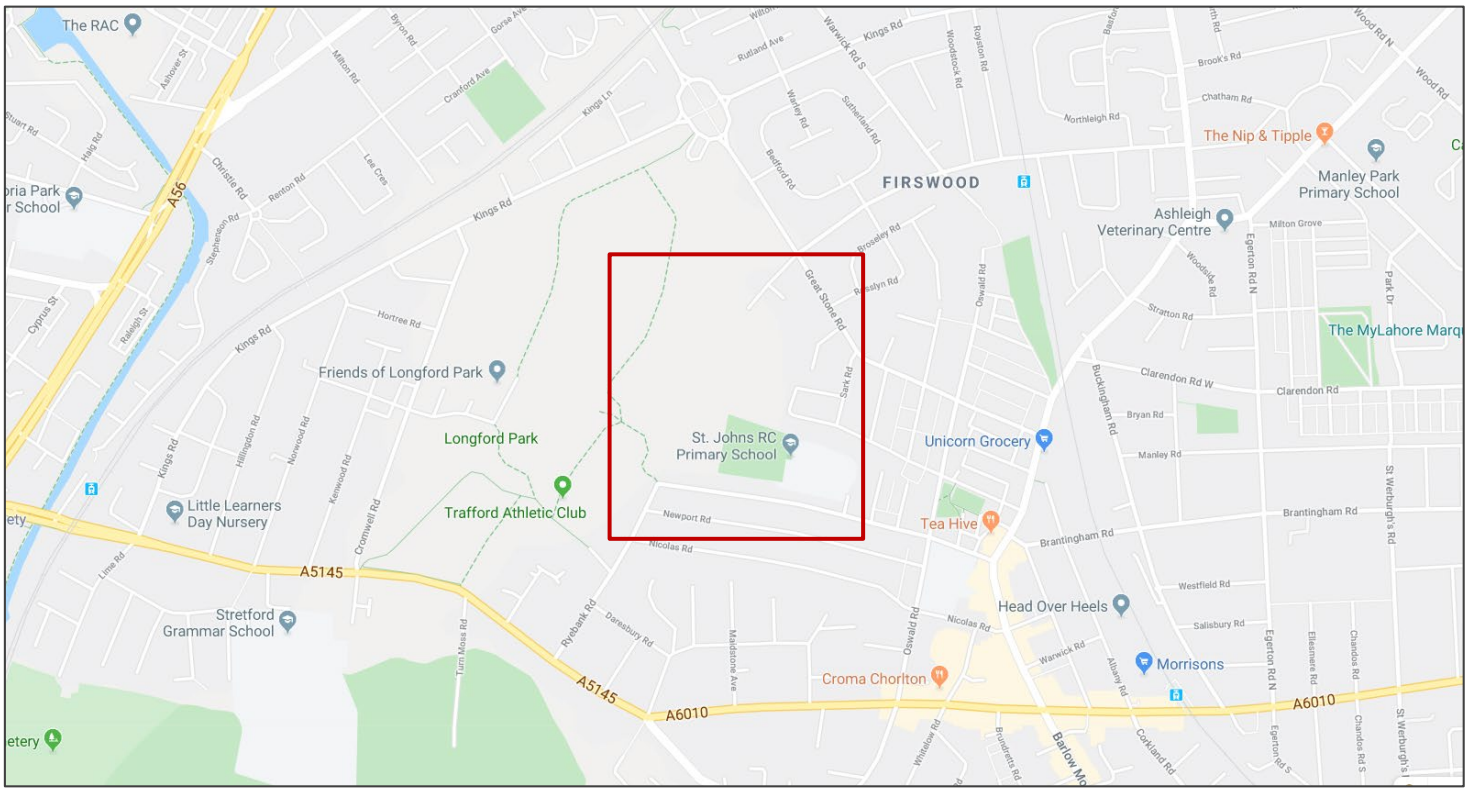
BSI has identified an elevated UXO risk on *Site.* The measures detailed below are recommended to mitigate the UXO risk to ALARP level.

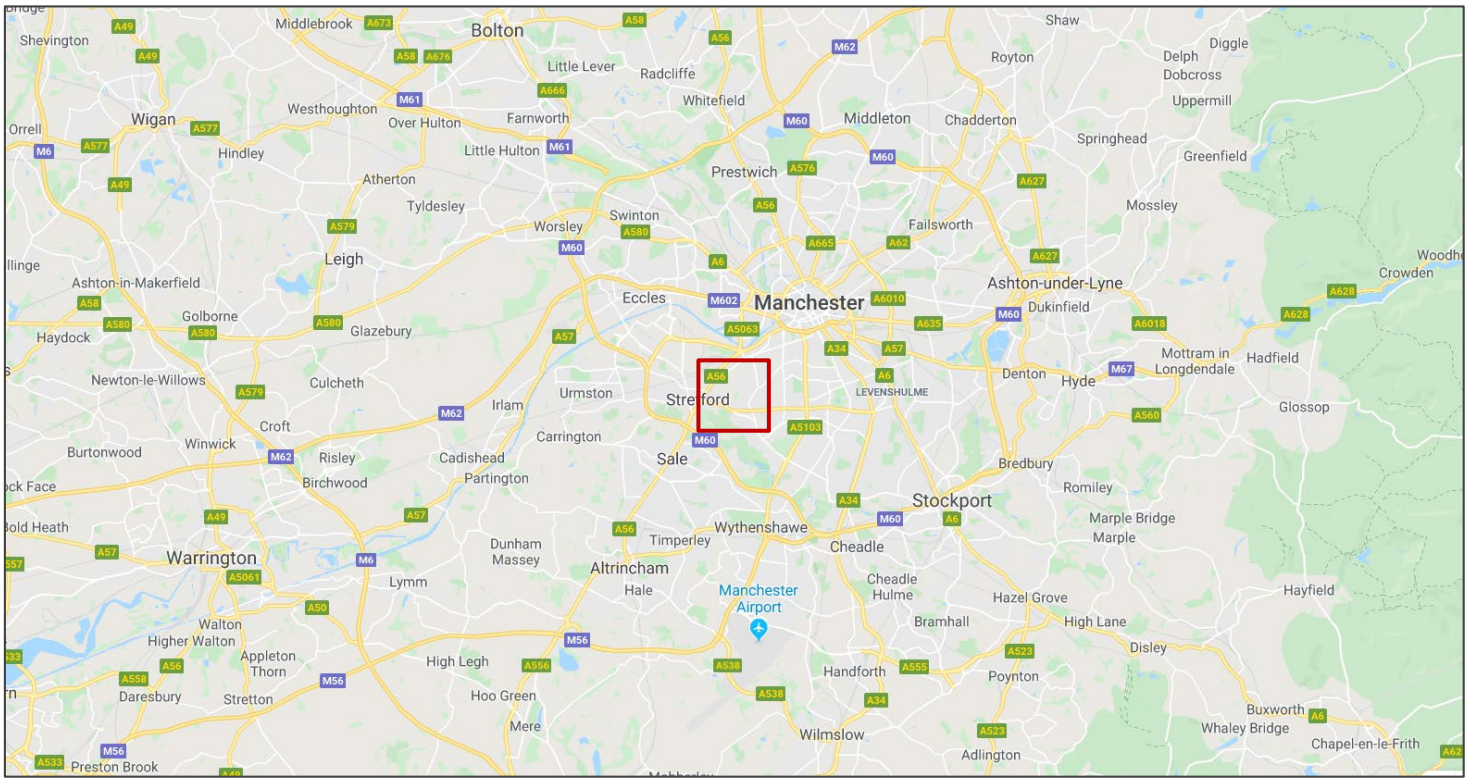
Risk Mitigation Measure	Recommended For?
UXO Safety Awareness Briefings: To all personnel conducting intrusive works on site. An essential part of the Health & Safety Plan for a site. Conforms to the requirements of CDM2015.	Ahead of all intrusive works.
EOD Engineer - On Site Supervision: Watching brief for open excavations within Made Ground. Portable magnetometer instruments for clearing ground ahead of shallow excavations and SI boreholes (where / when appropriate). Positive identification of suspicious (non UXO) objects. Liaison during confirmed UXO incidents. Provision of additional UXO Safety Awareness Briefings.	SI works Open excavations (construction phase)
OPTIONAL: Intrusive Magnetometer Probe Survey: A range of intrusive magnetometer methodologies can be deployed to survey the ground (down to the maximum bomb penetration depth) prior to deep intrusive works; pile foundations. The appropriate technique is governed by a number of factors, the most important being the site-specific ground conditions.	Any pile positions

FIGURES: 1 - 6

BRIMSTONE
SITE INVESTIGATION
1-3 Manor Road, Chatham,
Kent, ME4 6AE
+44 (0) 207 117 2492
www.brimstoneuxo.com
enquire@brimstoneuxo.com

Title:	SITE LOCATION MAPS	FIGURE: 1





N	Project	Ryebank Road, Manchester	BRIMSTONE SITE INVESTIGATION
	Client:	E3P	1-3 Manor Road, Chatham, Kent, ME4 6AE
	Report Ref:	DRA-19-1148	+44 (0) 207 117 2492
	General Site Location	Info Source: Google (open-source)	www.brimstoneuxo.com
			enquire@brimstoneuxo.com

Title:	RECENT AERIAL PHOTOGRAPH	FIGURE: 2

N

Project	Ryebank Road, Manchester
Client:	E3P
Report Ref:	DRA-19-1148
Approx. Site Boundary	Info Source: Google (open-source)

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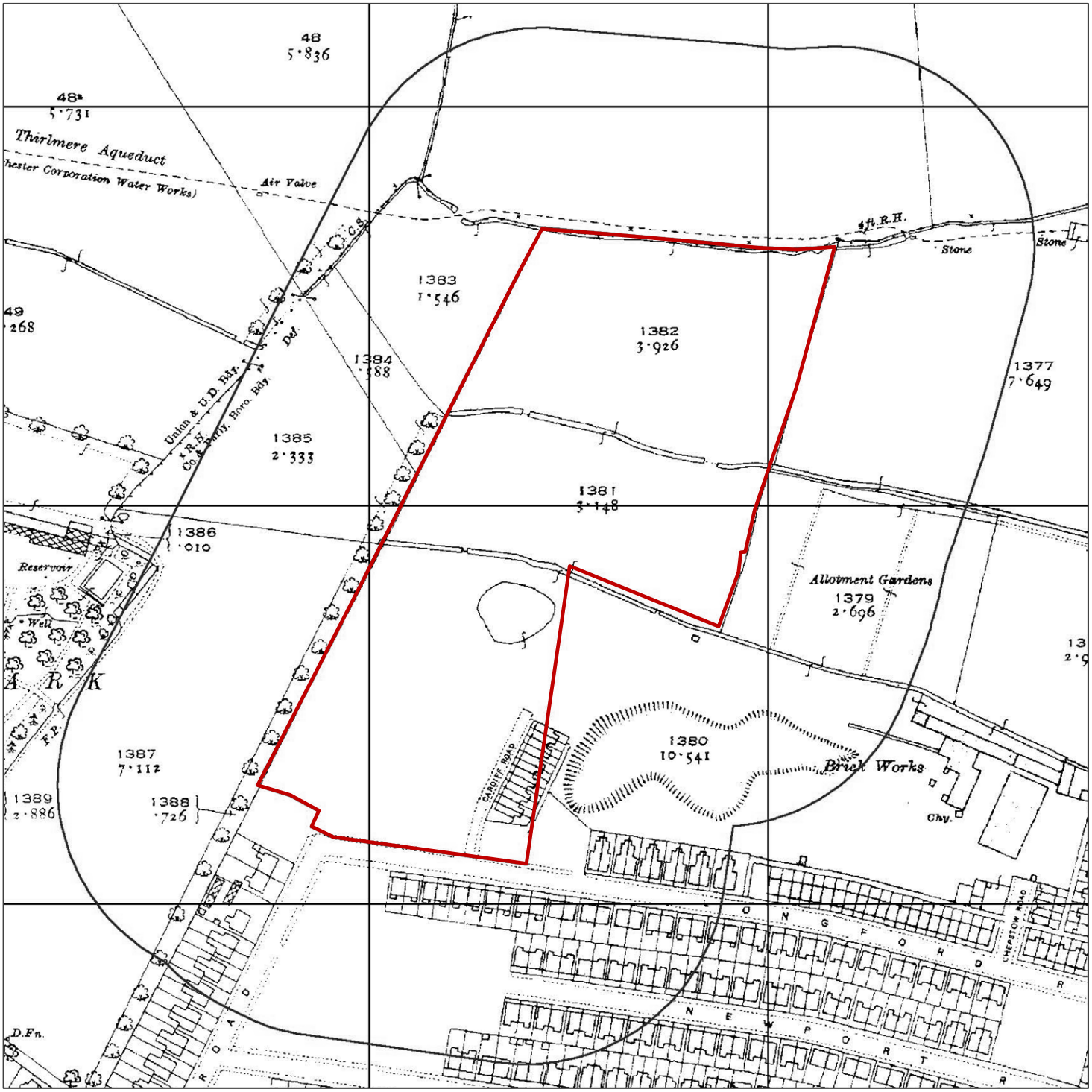
enquire@brimstoneuxo.com

Title:	HISTORICAL OS MAPPING - 1922	FIGURE: 3.1



N	Project	Ryebank Road, Manchester
	Client:	E3P
	Report Ref:	DRA-19-1148
	Approx. Site Boundary	Info Source: Landmark

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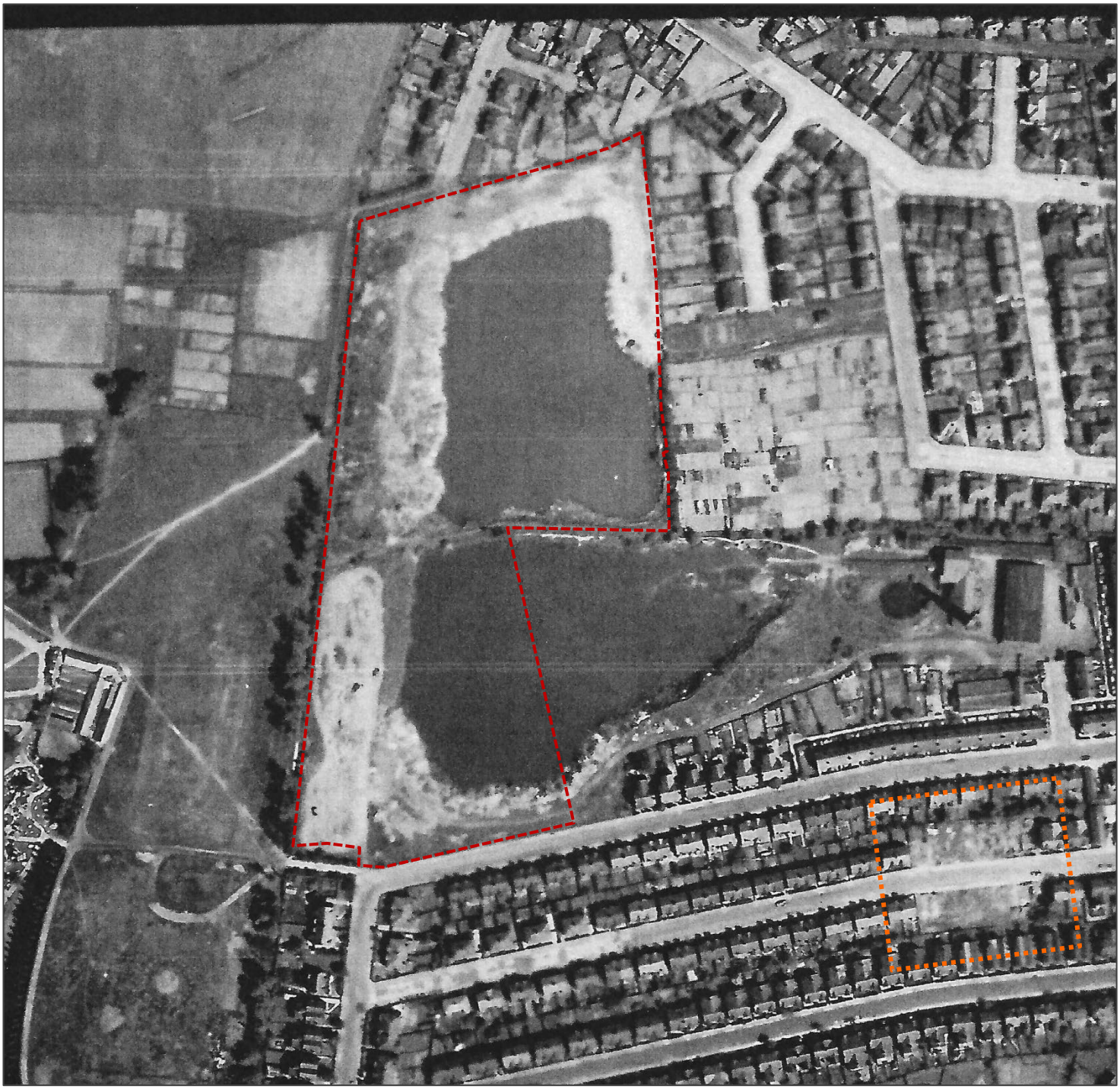
Title:	HISTORICAL OS MAPPING - 1952-55	FIGURE: 3.2

N	Project	Ryebank Road, Manchester	BRIMSTONE SITE INVESTIGATION
	Client:	E3P	1-3 Manor Road, Chatham, Kent, ME4 6AE
	Report Ref:	DRA-19-1148	+44 (0) 207 117 2492
	Approx. Site Boundary	Info Source: Landmark	www.brimstoneuxo.com
			enquire@brimstoneuxo.com

Title:	HISTORICAL AERIAL PHOTOGRAPHY - JUNE 1932	FIGURE: 4.1

Project	Ryebank Road, Manchester	BRIMSTONE SITE INVESTIGATION
Client:	E3P	1-3 Manor Road, Chatham, Kent, ME4 6AE
Report Ref:	DRA-19-1148	+44 (0) 207 117 2492
Simplified Site Boundary	Info Source: Historic England	www.brimstoneuxo.com
		enquire@brimstoneuxo.com

Title:	HISTORICAL AERIAL PHOTOGRAPHY - MAY 1946	FIGURE: 4.2



Bomb damage

Project	Ryebank Road, Manchester	
Client:	E3P	
Report Ref:	DRA-19-1148	
Approx. Site Boundary	Info Source:	Historic England

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Title:	HISTORICAL AERIAL PHOTOGRAPHY - APRIL 1949	FIGURE: 4.3

Project	Ryebank Road, Manchester	
Client:	E3P	
Report Ref:	DRA-19-1148	
Approx. Site Boundary	Info Source:	Historic England

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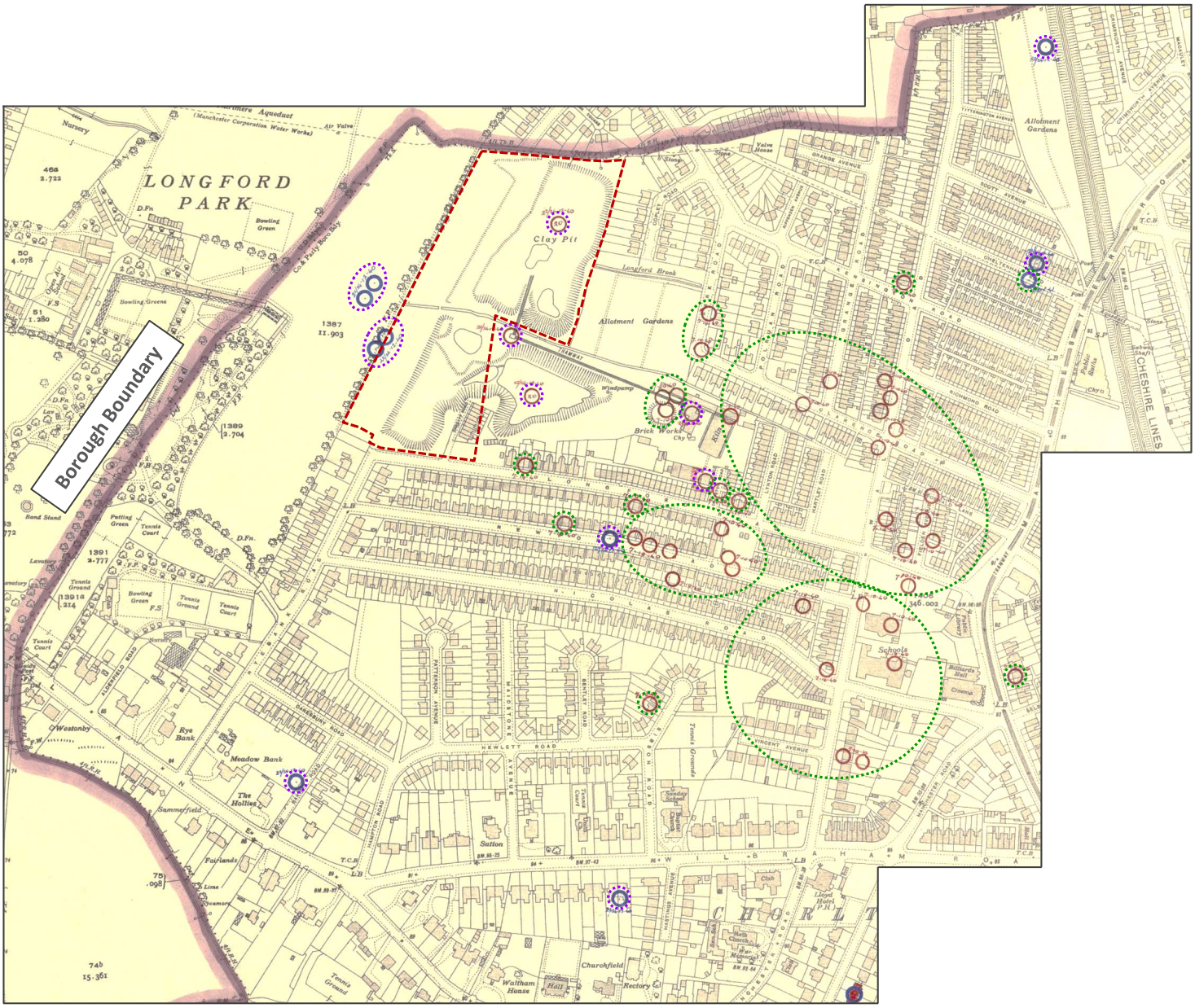
Title:	MANCHESTER CONSOLIDATED BOMB PLOT MAP	FIGURE: 5



Note: each bomb strike's date of fall has been identified by coloured circles;
07/10/40 ·····
22/12/40 ·····

HE bomb
HE parachute mine
Incendiary bomb

N

Project	Ryebank Road, Manchester
Client:	E3P
Report Ref:	DRA-19-1148
----- Approx. Site Boundary	Info Source: Manchester Archives & Local Studies

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Title:	RISK MAP: LIKELIHOOD OF UXO REMAINING	FIGURE: 6

MODERATE RISK ZONE

Elevated likelihood of German and British UXO remaining here.

MODERATE-HIGH RISK ZONE

Elevated likelihood of German and British UXO remaining here.

N

Project	Ryebank Road, Manchester
Client:	E3P
Report Ref:	DRA-19-1148
Approx. Site Boundary	Info Source: N/A

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APPENDICES: 1 - 7

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Recent German UXB Finds in the UK + Historical Analysis

- ***23rd May 2019*** - An SC250 (standard 250kg HE bomb) was found during shallow excavations at a building site in Kingston upon Thames, London. *Historical Analysis: The UXB landed in a small residential back garden belonging to an undamaged terraced house. It came to rest approximately 3 to 4m bgl.*
- ***15th May 2017*** - An SC250 (standard 250kg HE bomb) was found during shallow excavations at a building site in Aston, Birmingham. *Historical Analysis: The UXB landed in a small back garden belonging to a terraced house, part of a row. It J-Curved under a neighbouring garden and came to rest at just 1.4m bgl. NB: These houses had not sustained bomb damage.*
- ***2nd March 2017*** - A 250kg HE bomb was found during deep excavations at a building site in Brondesbury Park, London. *Historical Analysis: UXB landed in a large residential back garden. A single storey building was built on top of the UXB post-WWII.*
- ***19th January 2017*** - An SD50 (semi-armour piercing 50kg HE bomb) was dredged from the Thames during barge dredging works near Westminster Bridge, London.
- ***12th May 2016*** - A 500kg HE bomb was found buried just 1m below the playground of the former Royal High Junior School in Bath. *Historical Analysis: The UXB landed in a plot of neglected, unmaintained vegetation in between the school gym and main school building.*
- ***23rd September 2015*** - A 1,000kg HE bomb was encountered by a mechanical excavator on a building site in Paradise Street, Coventry. *Historical Analysis: the UXB landed in a large residential back garden occupied by dense vegetation. A two storey building was built on top of the UXB post-WWII.*
- ***10th August 2015*** - A 250kg HE bomb was found immediately beneath a basement floor during refurbishment works in Temple Street, Bethnal Green (London). *Historical Analysis: The UXB struck a house that had been damaged beyond repair during a previous air raid. The existing house was then built on top of UXB post-WWII.*
- ***21st May 2015*** - An SC50 (general purpose 50kg HE bomb) was found during deep excavations at a construction site in Wembley, London. *Historical Analysis: UXB landed in a large residential back garden.*
- ***23rd March 2015*** - A 250kg HE bomb was found during deep excavations at a building site in Grange Walk, Bermondsey (London). *Historical Analysis: inconclusive - reported UXB position is likely inaccurate.*

NB: Domestic UXO finds in the UK are too numerous to list. Between 2006 and 2009, over 15,000 items of British / Allied UXO (excluding small arms ammunition) were found on UK construction sites (CIRIA).

Initiation of WWII Allied Bombs

- ***6th January 2014*** - Mechanical excavator stuck a WWII bomb in Euskirchen (Germany) causing it to explode, killing the operator and injuring 13 more, two critically. The explosion was so large it damaged buildings 400m away.
- ***1st March 2013*** - During piling at a construction site in Ludwigshafen (Germany) a small buried WWII bomb exploded, injuring one worker.
- ***2nd June 2010*** - A British 500kg bomb detonated whilst being defused, killing three EOD engineers in Goettingen, Germany. The bomb was found as builders dug the foundations for a new sports hall. Several houses had their fronts blown off by the blast.
- ***19th September 2008*** - Seventeen people were injured and buildings were damaged when an excavator apparently drove over and set off a 250kg American bomb at a construction site in Hattingen, Germany.
- ***23rd October 2006*** - A construction worker breaking up tarmac at the side of a highway near the south-western German town of Aschaffenburg was killed when his machine struck and detonated a WWII bomb. In addition, the blast injured several motorists who were driving past.
- ***2006*** - A piling rig and dump truck were destroyed when a piling rig struck an Allied bomb on a construction site in Austria.
- ***2003*** - In the Austrian city of Salzburg, two people were killed while attempting to defuse a 250kg Allied bomb.
- ***1994*** - At a central Berlin construction site a piling rig struck a large WWII Allied bomb. 3 were killed and 14 more were injured. Dozens of cars in a 250m radius were wrecked, the top 10 floors of neighbouring office building collapsed and human remains were found 100m away.
- ***1990*** - In Wetzlar (Germany) two EOD engineers were blown up as they removed the detonator of an allied WWII UXB.

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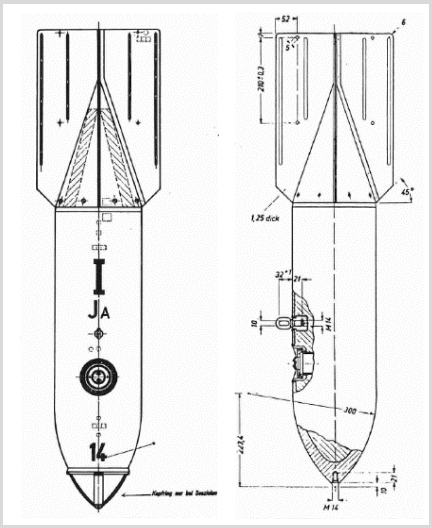
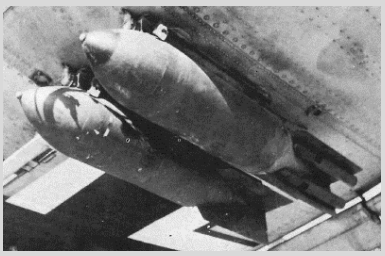
SC 50

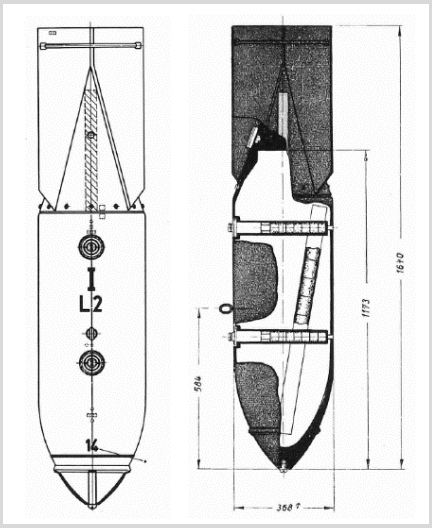
Bomb Weight:	40-54kg (110-119lb)
Explosive Weight:	25kg (55lb)
Filling:	TNT, Amatol or Trialen
Charge/Weight Ratio:	46%
Fuse Type:	Electrical impact fuse or mechanical delayed action fuse
Body Dimensions:	1,100mm length x 200mm diameter
Appearance:	Bomb body and tail painted grey/green with a yellow stripe on the tail unit. Steel construction.
Variants:	8 x variants. Additional fittings: Kopfring nose for limited penetration and Stabbo nose for dive-bombing.





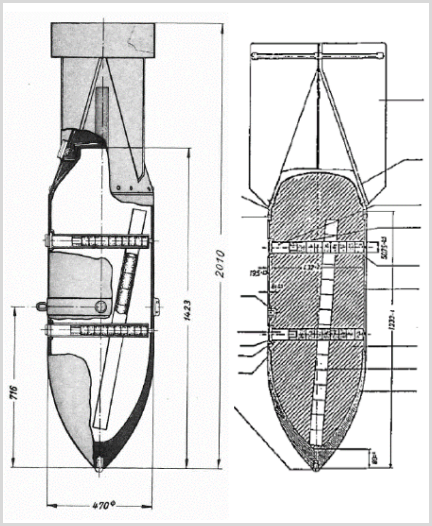
SC 250

Bomb Weight:	245-256kg (540-564lb)
Explosive Weight:	125-130kg (276-287lb)
Filling:	TNT, Amatol and Trialen mix
Charge/Weight Ratio:	44%
Fuse Type:	1 or 2 electrical impact fuse(s) or mechanical delayed action fuse(s)
Body Dimensions:	1,173mm length x 368mm diameter
Appearance:	Bomb body and tail painted grey/green with a yellow stripe on the tail unit. Steel construction.
Variants:	8 x variants. Kopfring nose for limited penetration. Stabbo nose for dive-bombing.



SC 500

Bomb Weight:	480-520kg (1,058-1,146lb)
Explosive Weight:	220kg (485lb)
Filling:	TNT, Amatol and Trialen mix
Charge/Weight Ratio:	44%
Fuse Type:	2 electrical impact fuses or mechanical delayed action fuses
Body Dimensions:	1,423mm length x 470mm diameter
Appearance:	Bomb body and tail painted grey/green or buff with a yellow stripe on the tail unit. Steel construction.
Variants:	3 x variants. Kopfring nose for limited penetration.



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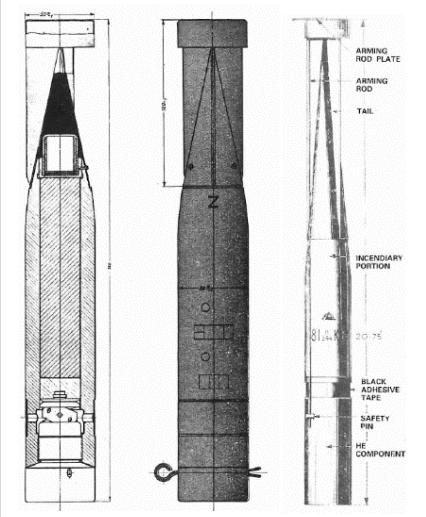
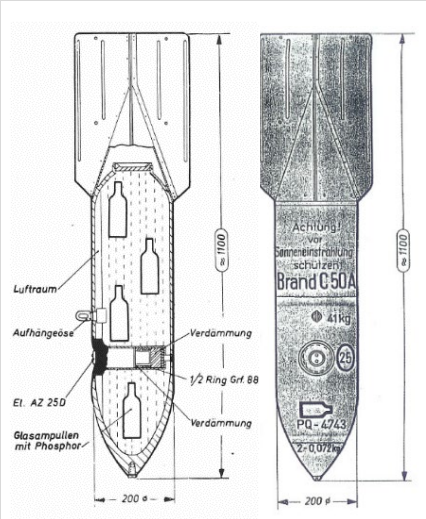
B-1E Sub-Munition

Bomb Weight:	1-1.3kg (2.2-2.87lb)
Incendiary Weight:	680g (1.4lb)
Filling:	Thermite
Fuse Type:	Simple impact fuse
Body Dimensions:	247mm length x 50mm diameter
Appearance:	Grey body and dark green painted tail unit. Magnesium alloy case.
Operation:	Small percussion charge ignites Thermite (>1,000°C burn).
Variants:	Most common variant: B 2EZ (2kg) included a small HE charge
Remarks:	Drop containers varied in size. The smallest cluster bomb held 36 x B-1Es and the largest 620 x B-1Es.



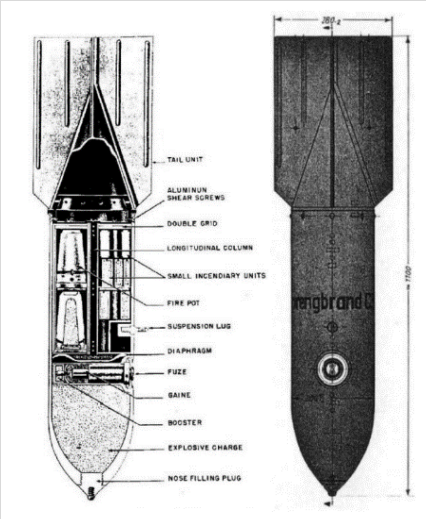
Brand C50

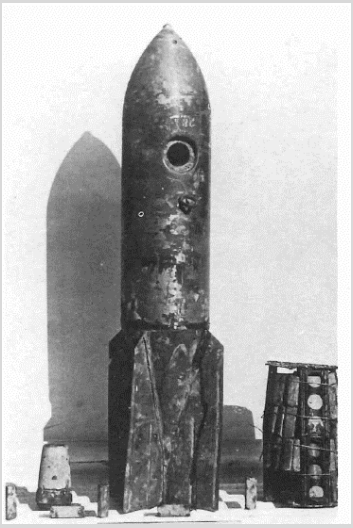
Bomb Weight:	41kg (90.4lb)
Incendiary Weight:	13kg (30lb)
Filling:	Main fill (86% Benzine, 10% Rubber) plus 4% Phosphorus in glass bottles
Fuse Type:	1 x electrical impact fuse
Bomb Dimensions:	762mm length x 203mm diameter
Appearance:	bomb body and tail painted grey or green with the rear of the bomb painted red and a red band around the centre of the body.
Variants:	C 50 B: 77% White Phos fill C 250 A: 87.7% Petroleum, 11.7% Polystyrene, 0.5% White Phos (185kg version)



Spreng-Brand C50 - *Fire Pot*

Bomb Weight:	34kg (75lb)
Explosive Weight:	9kg (20lb)
Filling:	TNT burster charge, 6 x Thermite containers (fire pots) and 67 x small triangular incendiary elements.
Fuse Type:	1 x electrical impact fuses or aerial burst fuse
Bomb Dimensions:	711mm length x 203mm diameter
Appearance:	Bomb body and tail painted grey/green or pale blue with red base plug and red or green incendiary markings. Steel construction.
Operation:	A charge blows off the base plate, firing a plume of incendiary mixture 100 yds. Approx 1 second later the HE charge detonates.





Project	Ryebank Road, Manchester	
Client:	E3P	
Report Ref:	DRA-19-1148	
	Info Source:	*W, Ramsey.1988 / various news sources*

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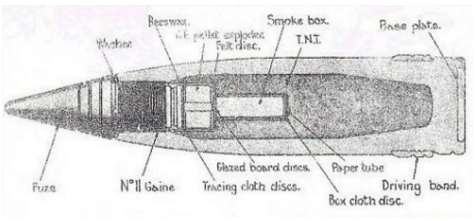
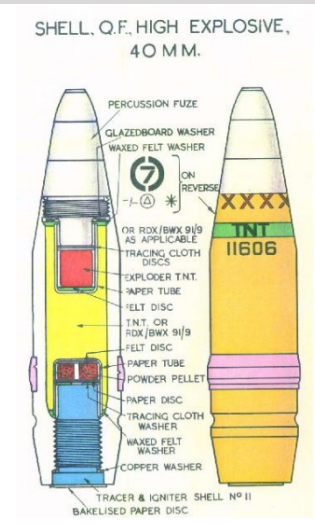
HAA Battery - 3.7" QF Shell

Shell Weight:	12.7kg
Shell Dimensions:	94mm x 438mm
Fill Weight:	1.1kg
Fill Type:	TNT
Fuse Type:	Mechanical Time Delay fuse
Appearance:	Grey body, copper driving bands, brass neck
Rate of Fire:	10 - 20 rpm
Ceiling:	9,000 - 18,000m
Variants:	HE or shrapnel shells. Note, the 4.5" gun was also used in an HAA role throughout the UK.



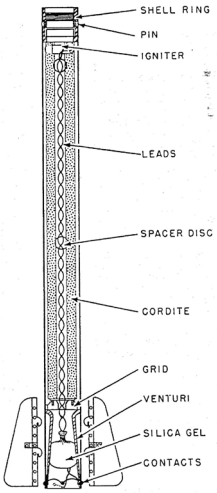
LAA Battery - 40mm Bofors Shell

Shell Weight:	0.84kg
Shell Dimensions:	40mm x 180mm
Fill Weight:	70g
Fill Type:	TNT
Fuse Type:	Impact fuse
Appearance:	Grey body, copper driving bands, brass neck
Rate of Fire:	120 rpm
Ceiling:	7,000m
Variants:	HE or AP shells. Both with rear tracer compartment



Z Battery - 3" U.P Rocket

Rocket Weight:	24.5kg
Warhead Weight:	1.94kg
Filling:	TNT warhead. Black Powder solid fuel rocket motor.
Fuse Type:	Mechanical Time Delay fuse
Rocket Dimensions:	1,930mm x 76mm
Ceiling:	6,770m
Operation:	Fired from single, tandem and (later) 36 x rail launchers (Z Batteries). Limited use throughout the UK.



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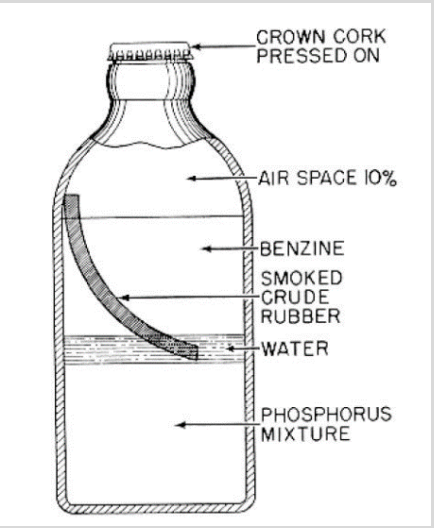
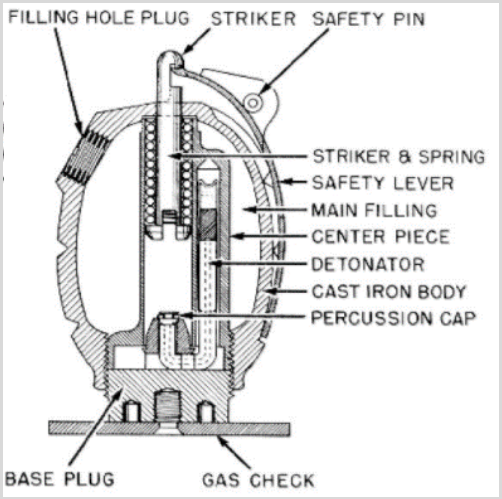
No. 76 Self Igniting Grenade (SIP)

Construction:	Glass bottle and metal stopper
Weight:	0.59kg
Dimensions:	152mm x 63mm
Hazardous Fill:	White Phosphorus and Benzene
Fuse:	n/a
Appearance:	White / off yellow milk bottle
Hazards:	Choking fumes of Phosphorus Pentoxide and Sulphur Dioxide, as well as heat. Severe burns if comes into contact with skin.
Remarks:	By August 1941 well over 6,000,000 of these grenades were available and mainly issued to the Home Guard.



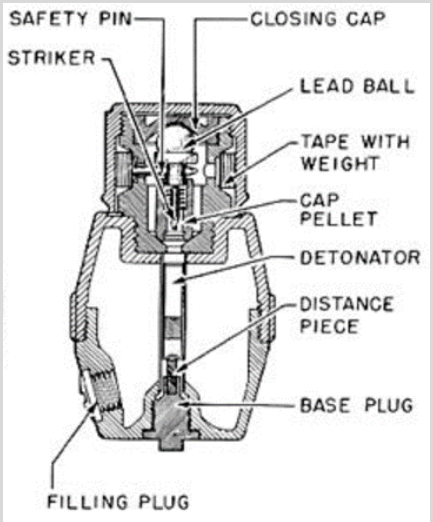
No. 36 Hand Grenade (Mills Bomb)

Construction:	Metal
Dimensions:	95mm x 61mm
Weight:	760g
Fill weight:	71g
Hazardous Fill:	Baratol
Fuse:	Percussion cap and 4 second time delay fuse
Hazards:	Blast, fragmentation. ~30m effective range.
Remarks:	>70 million were produced between 1915 and the 1980s



No. 69 (Blast) Hand Grenade

Construction:	Bakelite (plastic)
Dimensions:	114mm x 60mm
Weight:	383g
Fill weight:	92g
Hazardous Fill:	Baratol, Amatol or Lyddite
Fuse:	'All-Ways' Impact fuse
Hazards:	Blast effect. <20m effective range.
Remarks:	Green bands around the grenade signified a HE fill.



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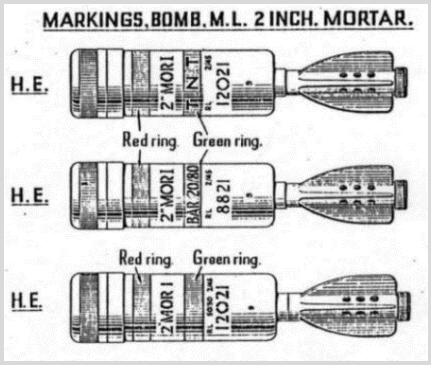
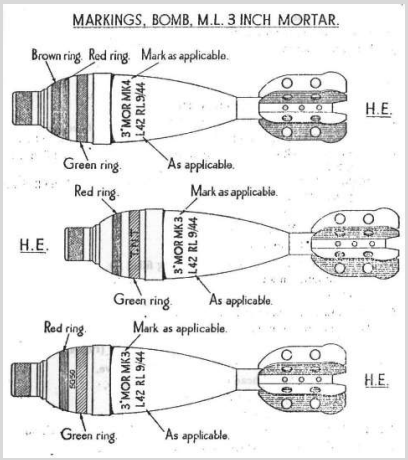
2” ML Mortar - High Explosive

Weight:	1.02kg
Dimensions:	51mm x 290mm
Hazardous Fill:	200g of RDX/TNT
Fuse:	Impact fuse
Appearance:	Cylindrical shape. Brown body, green and red bands, five finned tail
Variants:	Several smoke, inert practice and parachute illumination versions were manufactured
Remarks:	Common anti-personnel weapon in use with British Army throughout WWII. >12.5 million HE rounds were produced in 1942 alone



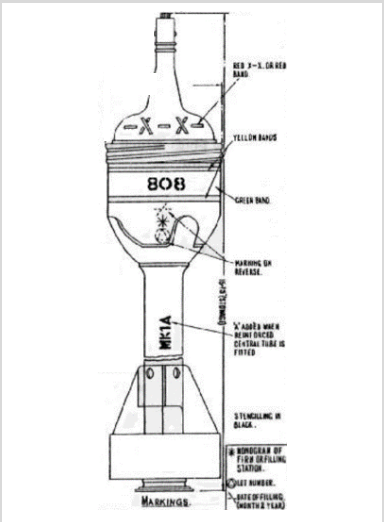
3” ML Mortar - High Explosive

Weight:	4.5kg
Dimensions:	81mm x 490mm
Hazardous Fill:	882g of RDX/TNT
Fuse:	Impact fuse
Appearance:	Pear-drop shape. Brown body, green and red bands, five finned tail
Variants:	Several smoke, white Phosphorus, inert practice and parachute illumination versions were manufactured
Remarks:	Common anti-personnel weapon in use with British Army throughout WWII. >6.5 million HE rounds were produced in 1942 alone



PIAT Anti-Tank Weapon

Projectile Type:	HEAT - shaped charge
Projectile Dimensions:	400mm x 90mm
Hazardous Fill:	Hollow HE charge and small solid propellant charge
Fill Weight:	1.13kg (charge)
Fuse:	Impact fuse
Remarks:	115,000 launchers were produced in Britain during WWII and the PIAT was used by most Allied armies during this conflict



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20mm Cannon Ammunition (various)

Cartridge Weight: 256g (approx.)

Total Cartridge length: 182mm (approx.)

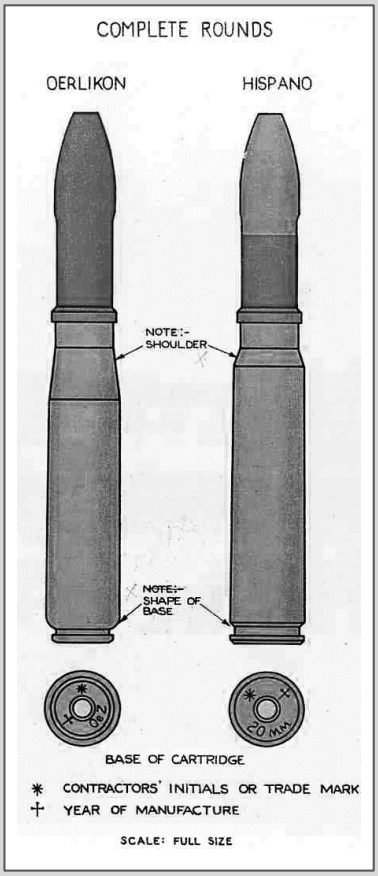
Hazardous Fill: Various HE, incendiary and tracer compositions. Typically TNT, Tetryl and Pentolite.

Fuse: Impact fuse

Appearance: Cylindrical shape. Brown body, green and red bands, five finned tail

Variants: Oerlikon and Hispano 20mm ammunition was deployed in the UK during WWII. These varied slightly in shape and also in the colours used to identify different projectile types.

Remarks: Today, 20mm rounds of WWII vintage may be found unexpended as full single cartridges or in belts of multiple cartridges. Or expended, i.e just the fused projectile without the brass base.

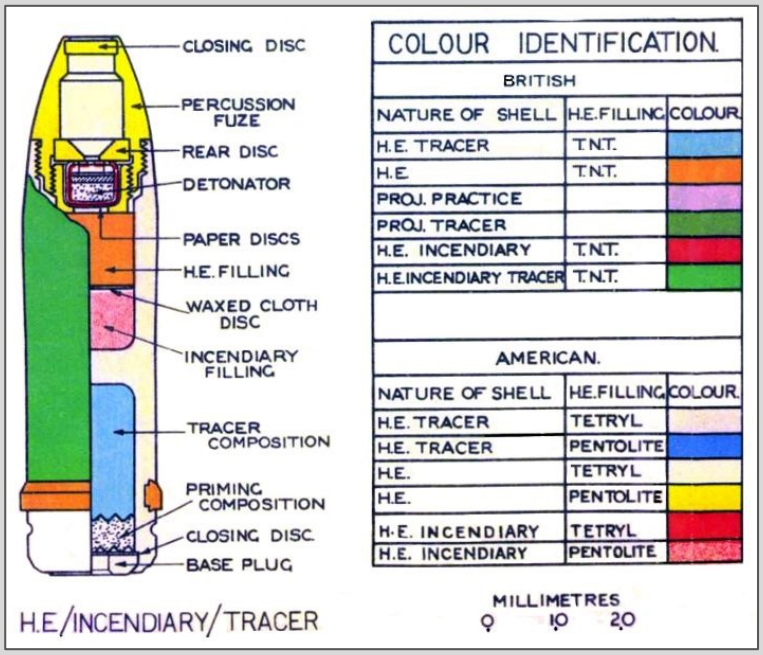



WWII belted 20mm rounds

Recent WWII 20mm rounds find

Bottom Right: Colour identification of Hispano rounds

Bottom Left: Colour identification of Oerlikon rounds



COLOUR IDENTIFICATION

BRITISH

NATURE OF SHELL	H.E. FILLING	COLOUR
H.E. TRACER	T.N.T.	
H.E.	T.N.T.	
PROJ. PRACTICE		
PROJ. TRACER		
H.E. INCENDIARY	T.N.T.	
H.E. INCENDIARY TRACER	T.N.T.	

AMERICAN.

NATURE OF SHELL	H.E. FILLING	COLOUR
H.E. TRACER	TETRYL	
H.E. TRACER	PENTOLITE	
H.E.	TETRYL	
H.E.	PENTOLITE	
H.E. INCENDIARY	TETRYL	
H.E. INCENDIARY	PENTOLITE	


20mm x 110mm Hispano Armour Piercing - 1935 > Present


20mm x 110mm Hispano High Explosive - 1935 > Present


20mm x 110mm Hispano High Explosive Incendiary - 1935 > Present


20mm x 110mm Hispano High Explosive Incendiary Tracer - 1935 > Present


20mm x 110mm Hispano High Explosive Tracer - 1935 > Present

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AA	*Anti-Aircraft (defences)*
AFS	*Auxiliary Fire Service*
AP	*Anti-Personnel*
ARP	*Air Raid Precautions*
ASW	*Anti-Submarine Warfare*
BDU	*Bomb Disposal Unit (historic term for EOD)*
Bgl	*Below Ground Level*
EOC	*Explosive Ordnance Clearance*
EOD	*Explosive Ordnance Disposal*
FP	*Fire Pot (German bomb)*
GI	*Ground Investigation*
HAA	*Heavy Anti-Air (gun battery)*
Ha	*Hectare (10,000m2)*
HE	*High Explosive*
IB	*Incendiary Bomb*
Kg	*Kilogram*
LAA	*Light Anti Air (gun battery)*
LCC	*London County Council*
LRRB	*Long Range Rocket Bomb (V2)*
LSA	*Land Service Ammunition*
Luftwaffe	*German Air Force*
OB	*Oil Bomb (German bomb)*
PM	*Parachute Mine (German bomb)*
RAF	*Royal Air Force*
RFC	*Royal Flying Corps*
RN	*Royal Navy (British)*
RNAS	*Royal Naval Air Service*
ROF	*Royal Ordnance Factory*
SAA	*Small Arms Ammunition*
SD2	*2kg AP bomb (German bomb)*
SI	*Site Investigation*
U/C	*Unclassified (German) bomb*
UP	*Unrotating Projectile (British 3" AA rocket)*
USAAF	*United States Army Air Force*
UX	*Unexploded*
UXB	*Unexploded Bomb*
UXO	*Unexploded Ordnance*
V1	*German Flying (pilotless) bomb - "Doodlebug"*
V2	*German LRRB - "Big Ben"*
WAAF	*Women's Auxiliary Air Force*
WWI	*World War One*
WWII	*World War Two*

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