

Pyramid Park, Bury
Land Quality Statement

For
Bury Council

Project No.
14111

Date
April 2024

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DOCUMENT HISTORY AND STATUS

Revision	Date	Purpose/ Status	File Ref	Author	Check	Review
P01	19/04/2024	Preliminary	14111-CRH-XX-XX-RP-LQ-0001	SM/ RA	TS	PK

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Document Details

Last Saved	22/04/2024 13:07
Author	Shauna McLoughlin and Rose Ashmore
Project Partner	Simon Boots
Project Number	14111
Project Name	Pyramid Park, Bury
Revision	P01
File Ref	14111-CRH-XX-XX-RP-LQ-0001.docx

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EXECUTIVE SUMMARY

SITE OUTLINE	The site is located off Market Street in Bury, Greater Manchester. It is approximately 300m to the south of Bury town centre and the approximate National Grid Reference at the centre of the site is 380500, 410315, postcode BL9 0EQ. Redevelopment proposals are currently at Masterplan stage and have not yet been finalised. It is anticipated that the final development will be predominantly residential with associated infrastructure, hardstanding and landscaped areas. A new access ramp off the existing access road from Market Street is proposed as part of the enabling works. The site is currently disused having more recently been used as a park with large pond. Historical maps indicate that the site was largely occupied by railway sidings, platforms, goods sheds and cattle pens in the west of the site, likely associated with the former abattoirs to the northwest. Extensive ground workings to reduce site levels around 1890's appear to have taken place to facilitate the expansion of the railway sidings. Later, the site was used as public open space and a pond was present in the central and eastern section of the site along with three large pyramid features, still present today. The ground conditions generally consist of varying thicknesses of Made Ground over Glacial Deposits comprising a mix of clays and sands. The underlying mudstone bedrock of the Pennine Lower Coal Measures was encountered at several locations typically between 3m and 7m below ground level.
ENVIRONMENTAL SETTING	The site is considered to have a Moderate hydrogeological Sensitivity associated with the presence of superficial and bedrock Secondary A Aquifers, and a Low / Moderate hydrological Sensitivity due to presence of the River Irwell and River Roch over 700m from the site
GEOTECHNICAL HAZARDS	The ground investigation identified a number of geotechnical risks at the site: ▪ Significant thicknesses of Made Ground ▪ Shallow groundwater ▪ Soft waterlogged soils in and around the historical pond area ▪ Possible presence of boulders in the Made Ground and Glacial Deposits ▪ Hard obstructions i.e. concrete in the Made Ground ▪ Low to medium volume change potential soils. ▪ Ground conditions aggressive to buried concrete. ▪ Large variations in site level and consequent need for earthworks
CONTAMINATION ISSUES	Risk Summary: ▪ End Users. A LOW – MODERATE RISK has been identified for site end users associated with the presence of asbestos in soils. Statistical assessment indicates no significant risk from other soil contaminants which exceed the residential with plant uptake end use criteria. ▪ Groundwater. A LOW RISK has been identified from the potential migration of dissolved phase and mobile contaminants to the underlying Secondary A Aquifer. A benzo(a)pyrene DWS exceedance was encountered at one location, but the low permeability Glacial Till will limit migration. ▪ Surface Water. A LOW RISK has been identified from migration of potential contaminants given the nearest surface watercourse is >700m from the site. ▪ Ground Gas Characteristic Situation. The site has been classified as Characteristic Situation 2 (low risk), and gas protection measures are required. However, flow rates were sporadic between visits and therefore further monitoring is advised. No vapour risk has been identified.

	▪ Groundworks. A LOW – MODERATE RISK has been identified based on the assumption that basic health and safety provisions are in place. The type of RPE required for asbestos will be defined by the JIWG decision support tool. ▪ Waste Soils. A total of 5 no. samples were classified as Hazardous in accordance with WM3 due to elevated TPH concentrations. The remaining 47 no. were Non-Hazardous. ▪ Services. The presence of TPH and PAH concentrations in soils indicates a possible need for protection of public water supply pipework, such as the use of organic resistant pipework. ▪ Japanese Knotweed was identified in the marshy grassland adjacent the road overpass during a Phase 1 habitat survey by TEP.
GEOTECHNICAL RECOMMENDATIONS	Traditional shallow strip foundations are anticipated to be viable where the Glacial Deposits are present within the top 2m of site and the proposed loading is modest (i.e. low-rise structures). In areas underlain by considerable thicknesses of Made Ground and/ or high loading (i.e. high-rise structures) are proposed, ground improvement methods (i.e. vibro stone columns) or a piled foundation solution may be required. Foundations placed within the Glacial Clays will need to be deepened to account for the volume change potential of the cohesive soils. Suspended floor slabs will also be required across this area of site due to the soil volume change potential. Chemical laboratory test results suggest a concrete class of DS-3 is required. Additional testing is recommended in the mudstone bedrock if deeper foundations (i.e. piles) are considered. A preliminary CBR of 1% is considered suitable for road and pavement design however, testing of the pavement formation will be required to verify this. It is recommended that additional in situ CBR test are undertaken. Near surface soils are frost susceptible. The soakaway tests could not be undertaken due to water ingress near to existing ground surface; a soakaway drainage strategy is therefore not likely to be viable. Provisions for pumping may be required where excavations are excavated below the groundwater table and/or left open for significant periods of time. It is recommended that further investigation is undertaken to determine the depth and nature of the soils within the historical pond.
RECOMMENDATIONS	▪ Soils. A capping layer is required for any soft landscaped areas due to the presence of asbestos. ▪ Groundwater. No remediation of the groundwater is required. ▪ Ground Gas. Currently assessed as CS which indicates the need for gas protection measures. However, additional monitoring visits are recommended following completion of enabling works and confirmation of final site development proposals. ▪ Services. The infrastructure designer should assess requirements for pipework with respect to hydrocarbon contamination and consult statutory utility companies. ▪ Waste Soils. A preliminary waste classification exercise has been carried out. Additional assessment may be required to enable more accurate budget costs to be developed regarding soil disposal. ▪ Site Work Controls. A watching brief should be maintained throughout the earthworks to identify any as yet unidentified contaminations that may be present, particularly at excavation formation level. ▪ It is recommended that any hydrocarbon odorous soils are excavated and removed off site as a precautionary measure. ▪ As asbestos has been detected, groundworks should be undertaken by a suitably qualified Contractor in accordance with the Control of Asbestos Regulations 2012,

	associated Approved Code of Practice (ACoP) and guidance prepared by CL:AIRE and the Joint Industry Working Group (JIWG), and CIRIA. ▪ There is the potential for impacted Made Ground to be present beneath the existing pyramid structures. Therefore, the nature and composition of the soils beneath the pyramid structures will need to be assessed appropriately. ▪ An invasive species specialist should be consulted to confirm the best approach to remediate the area of the current Japanese Knotweed stand in the east of the site.
DOCUMENTATION	This report should be submitted as part of the planning process. It is likely that further documentation, such as a Remediation Specification and Verification Report, will be required to discharge contamination related planning conditions. An Earthworks Specification has been issued under a separate cover.

1.0 INTRODUCTION

1.1 Appointment

1.1.1 This geo-environmental and geotechnical report has been produced by Campbell Reith Hill LLP (CampbellReith) on behalf of Bury Council (the Client) relating to Pyramid Park, Bury (hereafter referred to as the site). The limitations associated with this report follow the main text.

1.1.2 Figures showing the site location, layout and intended development are presented in Appendix 1.

1.2 Objectives

1.2.1 The objective of the report is to provide:

- a description of the site;
- a summary of the site's geo-environmental setting and history;
- a conceptual site model and a generic quantitative risk assessment for contamination;
- outline remedial recommendations;
- a preliminary geotechnical evaluation;
- a geotechnical risk assessment; and,
- a Hazardous Properties Assessment and waste soil classification.

1.3 Basis of Assessment

1.3.1 The standards upon which this report is based are summarised in the Environmental Risk Assessment Standards and Supporting Information section, which follows the main text.

1.3.2 The report is based upon a site reconnaissance visit, regulatory consultations and desk study /ground investigation information. Readily available site-specific reports/ information as detailed in Table 1.1. Technical references are included as footnotes throughout the report.

Table 1.1 Information Reviewed

Reference Details		Author	Reference
Phase 1 Habitat Survey	Drawing Number G9302.007A, dated October 2023	The Environment Partnership (TEP)	[1]
Preliminary Ecological Assessment	Ref: 9302.02.001, dated October 2023	The Environment Partnership (TEP)	[2]
Geotechnical and Geo-Environmental Desk Study Report (including Groundsure report Ref. CAR1-8402039)	Ref: 13819-CRH-XX-XX-RP-LQ-0001, dated March 2022	CampbellReith	[3]
Phase 2 Interpretative Report (Contamination)	Ref: 13819-CRH-XX-XX-RP-LQ-0002, dated July 2022	CampbellReith	[4]
Factual Report on Site Investigation for Land at Townside Fields, Bury	Ref: M1062/01, dated April 2022	Dunelm Geotechnical and Environmental	[5]

Reference Details			Author	Reference
Factual Report Pyramid Park, Bury	Ref: PN234595, dated February 2024		Geotechnics	[6]

1.4 Technical Competence

- 1.4.1 This report has been authored by Shauna McLoughlin BSc Ph.D MEnvSc (Senior Environmental Scientist) and Rose Ashmore MSci MSc FGS (Senior Geotechnical Engineer), checked by Tom Samson MEng CEng MICE (Associate) and reviewed by Peter Kenny BSc CSci FGS, MEnvSc (Associate).

2.0 SITE DESCRIPTION AND ENVIRONMENT SETTING

2.1 Site Location

2.1.1 The site location is presented in Figure 1, Appendix 1. The site is located off Market Street in Bury, Greater Manchester. It is approximately 300m to the south of Bury town centre and the approximate National Grid Reference at the centre of the site is 380500, 410315, postcode BL9 0EQ.

2.2 Site Layout

2.2.1 An annotated site layout plan is presented in Figure 2, Appendix 1. The site forms a roughly rectangular shaped parcel of land covering an approximate area of 3.0 hectares.

2.2.2 The site comprises a low-lying central area of relatively flat land with slopes leading up to surrounding higher ground present along the northern and southern areas of the site. A masonry arch bridge (Market Street) spans the eastern section of the site. The bridge abutments are formed into the slopes in the north and south of the site. An access track slopes down along the southern boundary from vehicle access gates off Market Street. Pedestrian access can also be gained from the east via Town Fields Close.

2.2.3 Three large pyramid features, predominantly grass covered, are present in the western area of the site. A former pond is present in the central and eastern areas of the site. The ground in this area remained boggy / saturated (noting that the site visit was undertaken following a prolonged period of heavy rainfall), and small areas of standing water were noted.

2.2.4 The majority of the site comprises marsh/marshy grassland, semi-improved neutral grassland, continuous bramble scrub with small areas of broadleaved woodland as detailed in the TEP Habitat Survey [1]. Footpaths are also present in the west of the site, leading around the pyramid features.

2.3 Surrounding Land-Use

2.3.1 Land to the north of the site is occupied Bury College buildings (Woodbury Centre and Business Solutions) and areas of car parking. To the east, residential properties around Town Fields Close are present. A railway line is present to the south, beyond which is Bury College and residential properties on Westminster Street. Tramlines form the western site boundary with a multi-storey car park and hotel located beyond.

2.4 Invasive Plant Species

2.4.1 The invasive plant species Japanese Knotweed has been historically recorded within the site boundary by Greater Manchester Ecology Unit. TEP produced a Preliminary Ecological Assessment Report [2] after an updated Phase 1 Habitat Survey [1] was carried out in October 2023.

2.4.2 The TEP Preliminary Ecological Assessment details that a stand of Japanese Knotweed is present within the marshy grassland habitat which was once occupied by a lake. The Japanese knotweed is located adjacent to the road overpass on the eastern section of the site.

2.4.3 The TEP report recommended that prior to development, the Japanese Knotweed should be controlled and treated in line with an invasive species management plan.

2.5 Redevelopment Proposal

2.5.1 The proposed site redevelopment is shown in Figure 3, Appendix 1.

2.5.2 At this stage, redevelopment proposals are at Masterplan stage and have not yet been finalised. Masterplan options currently include a variety of mixed-use residential and commercial schemes, with associated access, infrastructure, hardstanding and landscaped areas. Additionally, limited residential development, most likely in the eastern area of the site, is anticipated to include private garden areas.

2.5.3 Current proposals are to prepare the site for future development with the construction of a new access road off Market Street and the creation of development platforms.

2.5.4 Based on the anticipated development to include both managed and private residential properties, the end user sensitivity following redevelopment of the site is considered as Moderate – High.

2.6 Geology

2.6.1 The site geology as recorded by the BGS is presented as Figure 4a and 4b, Appendix 1.

2.6.2 The site geology is summarised in Table 2.1 and is based on the existing site-specific information included in the desk study research [3].

2.6.3 The BGS GeoIndex¹ shows two historical boreholes are present to the south of the site. The boreholes record cohesive Made Ground overlying cohesive and granular Glacial Deposits which in turn overlies mudstone and sandstone of the Pennine Lower Coal Measures with a weathered upper profile.

Table 2.1 Summary of Anticipated Geology

Strata	Typical Description
Made Ground	Firm to stiff sandy clay with gravel of brick / possible rail ballast / mining waste and colliery spoil.
<i>Superficial Deposits</i>	
Glacial Deposits	Firm to stiff sandy clay and medium dense sandy gravel and sand with occasional cobbles and boulders.
Glaciofluvial Deposits	Sand and gravel with cobbles and boulders.
<i>Bedrock</i>	
Pennine Lower Coal Measures (PLCM)	Mudstone and siltstone interbedded with subordinate medium-grained sandstones, seatearths and coal seams (upper weathered profile reduced to clay / sand / gravel).

¹ British Geological Survey (BGS) GeoIndex (<https://mapapps2.bgs.ac.uk/geoindex/home.html>)

Structural Geology

- 2.6.4 The published BGS map² indicates the bedrock dips towards the west-southwest by 5° to 15° although the inherently complex faulting of the coal seams results in a variable dip across the area. Several northwest to southeast trending faults with downthrows to the southwest and northeast are present in the surrounding area. One such fault with a southwest downthrow is located 15m beyond the south-western corner of the site. Smaller unrecorded and complex faulting is likely to be present within the underlying coal measures.

Coal Seams

The Cannel Coal Seam outcrops approximately 225m southwest of the site and the Arley Coal Seam 148m northeast. The downthrow of the fault to the southwest has juxtaposed the older Arley Coal to a similar level of the Cannel Seam. Owing to the southerly dip of the strata it is anticipated that the Arley seam is located at some depth beneath the site.

The Arley seam is recorded to have a thickness of 0.9m to 2.0m. The seam is anticipated to terminate at the location of the fault at the south-western corner of the site. The published BGS information³ indicates that this seam was exploited via deep mining, crop working and opencast excavation.

2.7 Natural Ground Hazards

- 2.7.1 A summary of the Hazard Ratings for natural ground subsidence hazards from the Groundsure Report [3] are presented in Table 2.2 and assessed against available information on ground conditions to provide updated hazards ratings.

Table 2.2 Summary of Natural Ground Subsidence Hazards

Hazard	Groundsure Hazard Rating	Comment
Shrink swell clays	Very Low	Ground conditions predominantly low to intermediate plasticity.
Running sands	Very Low	Running sand conditions are unlikely. May occur if water table rises.
Compressible deposits	Very Low - Negligible	Soft clays were encountered during the ground investigation as discussed in Section 6.0.
Collapseable deposits	Very Low - Negligible	Collapseable deposits are unlikely to be present.
Landslides	Very Low	Slope stability problems are not likely to occur within the site area.
Ground dissolution	Negligible	Soluble rocks are either not thought to be present within the ground, or not prone to dissolution.

² British Geological Survey (BGS) Drift and solid Sheet 85, 1:50,000 scale map.

³ British Geological Survey (BGS) Geology of the Manchester district: a brief explanation of the geological map Sheet 85 Manchester, 2012

2.8 Coal Mining

2.8.1 A review of the Coal Authority's Interactive Map⁴ has been undertaken indicating the following:

- Two mine entries are located approximately 50m to the south of the site;
- The site is not with a development high risk area;
- Probable shallow workings are located adjacent to the eastern boundary of the site;
- A worked coal outcrop is indicated approximately 70m to the east of the site; and,
- The site is within a surface coal resource area.

2.9 Seismicity

2.9.1 The national forward to BS EN 1998-1:2004+A1:2013 'Eurocode 8: Design of Structures for Earthquake Resistance – Part 1' states there are no requirements in the UK to consider seismic loading, and the whole of the UK may be considered an area of very low seismicity in which the provisions of EN 1998 need not apply.

2.10 Hydrogeology

2.10.1 The site hydrogeology has been assessed using desk study information provided by Groundsure [3] and the MAGIC website⁵ and is summarised in Table 2.3.

Table 2.3 Summary of Hydrogeology

Type	Description
Superficial Deposits: [Glacial Till] [Glaciofluvial Deposits]	Secondary A Aquifer. Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
Bedrock Geology: [Pennine Lower Coal Measures Formation]	Secondary A Aquifer. Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
Groundwater Vulnerability	Noted as moderate based on a combined classification for both superficial and bedrock aquifers.
Source Protection Zone (SPZ)	None located within 1km of the site.
Groundwater Bodies	Northern Manchester Carboniferous Aquifers. Overall water quality rating noted as poor (2019).

2.10.2 The site is considered to have a Moderate Sensitivity with respect to hydrogeology. The sensitivity is based upon the definitions provided in NHBC R&D66⁶, as amended to include the requirements of the Water Framework Directive and the EA's River Basin Catchment Plans.

⁴ BGS Coal Authority Interactive viewer (<http://mapapps.bgs.ac.uk/coalauthority/home.html>)

⁵ Multi Agency Geographic Information for the Countryside (MAGIC Map). Department for Environment, Food & Rural Affairs. <https://magic.defra.gov.uk/magicmap.aspx>

⁶ Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66: 2008 Volume 1 (Environment Agency, NHBC and CIEH)

2.11 Hydrology

2.11.1 The site hydrology has been assessed using desk study information provided by Groundsure [3] and the MAGIC website⁵ and is summarised in Table 2.4.

Table 2.4 Summary of Hydrology

Type	Distance	Description
Surface Waters	On site	Former Pond in central and eastern section of site.
	700m W	River Irwell, overall water quality rating Moderate, 2019.
	780m E	River Roch, overall water quality rating Moderate, 2019.
Surface Water Catchment	On site (east)	River Roch (Spodden to Irwell).
	On site (west)	River Irwell (Rossendale STW to Roch).
Surface Water Abstractions	745m NW	For general use, operated by Cemex UK Materials Limited.
Surface Water Flooding	On site	Flood Zone 1 [3].

2.11.2 The site is considered to have a Low/Moderate sensitivity with respect to hydrology. The sensitivity is based upon the guidance detailed for the hydrogeological assessment above.

2.12 Radon

2.12.1 With reference to the Groundsure Report [3] and the Radon Atlas of England and Wales⁷, the site is located in an area where <1% of homes are above the action level for radon.

2.12.2 As such the associated risk to any structures and buildings proposed in the area is considered to be LOW, where radon protection measures are not required for new buildings.

2.12.3 If basements are proposed as part of the site redevelopment, radon risk should be reconsidered.

2.12.4 BRE Report BR 211⁸: notes that all basements are at increased risk of elevated levels of radon regardless of geographic location, because more walls are in contact with the ground as well as the floor, and reduced natural ventilation below ground level increases the risk of elevated radon levels. In addition, the Management of Health and Safety at Work Regulations (1999)⁹ require the assessment of health and safety risks and both the Health and Safety Executive (HSE) and Public Health England (PHE) state that this should include the measurement of radon for occupied below ground workplaces (occupied for more than 1 hour per week/52 hours of the year), irrespective of whether a site is situated in a radon affected area. This is the responsibility of the Employer. For residential developments, Public Health England advise that consideration should be given to testing for radon if the basement includes a room that is used regularly.

⁷ Radon Atlas for England and Wales (<https://www.ukradon.org/information/ukmaps>)

⁸ BRE Report BR 211 Radon: Guidance on Protective Measures for New Buildings. 2023

⁹ The Management of Health & Safety at Work Regulations 1999, Legislation.gov.uk

2.13 Sensitive Land Uses

2.13.1 A review has been made of Designated Ecological and Heritage sites using desk study information provided by Groundsure [3] and the MAGIC website⁵ and is summarised in Table 2.6. The main purpose of this is to identify receptors that may be at risk due to potential contamination at the site.

Table 2.5 Summary of Designated Sites

Type	Description
Ecological	No records within 1km
Heritage	Several Grade II Listed buildings located between 163m and 249m
	Conservation area (Bury Town Centre) located 105m to the northwest

3.0 SITE HISTORY AND INDUSTRIAL SETTING

3.1 Site History

3.1.1 Information relating to the site history has been obtained by reference to historical plans provided in the Groundsure report [3]. This is summarised for the site and its surroundings in Tables 3.1 and 3.2.

Table 3.1 Site History

Date	Development
1849 – 1851	An area of land in the northwest of the site appears to be part of a network of ornamental gardens, which extend off site to the north. The extreme eastern area of the site is occupied by a small building and grounds. Railway lines/sidings are present along the southern area of the site, generally running east to west. A bridge is present in the southeast area of the site, spanning the railway lines in the south. Three rectangular structures are present in the western area of the site, associated with the railway lines.
1890 - 1891	The majority of the site is shown to be occupied by railway lines/sidings and is labelled as a “goods station”. The site now appears to be within a cutting, with slopes shown along the northern and southern areas of the site. The bridge in the southeast has now been extended to span across the full eastern area of the site and is noted as Market Street. The rectangular buildings in the west of the site are noted as “goods sheds” and further small buildings are now shown in the east, one of which is noted as a “signal box”. Two irregular shaped structures are located adjacent to the goods shed in the west, possibly part of a platform for the railway lines.
1908 – 1910	Cattle pens are shown in the northwest of the site and a crane is present adjacent to the goods sheds. A signal bridge is located in the south.
1928 – 1938	No significant changes noted.
1955 – 1959	A tank is shown adjacent to the southern site boundary.
1976 – 1984	Railway infrastructure and associated buildings including the goods sheds have been cleared from site. A pond is located in the central and eastern area of the site. In the west, three large pyramid shaped features are present and a further pyramid is present straddling the eastern boundary. Site is noted as “Townside Field”. A small triangular shaped feature is also present in the central area of the site within the pond. A subway is shown on the western site boundary linking the site to the west beneath the adjacent railway lines.
1992	No significant changes noted.
2001 – Present	No significant changes noted.

Table 3.2 Adjacent Land History

Date	Development
1849 -1851	Majority of land immediately to the north remains free from significant development. An area of ornamental gardens extends off site to the north. Railway lines extend off site to the east and west. A rope walk is located to the east of the site and land immediately to the south remains undeveloped with the exception of railway lines to southwest, beyond which, sloping ground is detailed. A woollen mill, station and goods sheds are present to the west.
1890 – 1891	An abattoir is present approximately 30m to the northwest of the site. Extensive residential development is now shown on the land adjacent to the northeast of the site and extensive railway sidings lead off site to the east. A small reservoir is located beyond the railway lines to the southwest of the site. The mill to the west is now noted as “cotton waste”.
1908 – 1910	The abattoir to the northwest has been extended and the layout of the good shed to the west has been altered with the addition of some smaller buildings. A further railway line leading from the southwest is shown to the south of the site, within a cutting. An area of ground workings is present approximately 180m to the southeast.
1928 – 1938	A school and bakery are now shown to the north of the site. A school is also present to the south beyond the railway lines along with associated playing fields.
1955 – 1959	Bury Technical College is located immediately to the north of the site.
1976 – 1984	A garage and a works are now located to the northeast of the site, where the bakery was formerly located. A college is now located to the south. The Town Hall is located approximately 120m to the west of the site, beyond a subway and carpark area.
2010	The college to the south has been extended.

3.1.2 In summary, the site was largely occupied by railway sidings with goods sheds and cattle pens in the west of the site, likely associated with the former abattoirs to the northwest. Extensive ground workings to reduce site levels around 1890's appear to have taken place to facilitate the expansion of the railway sidings. Later, the site was used as public open space and a pond was present in the central and eastern section of the site along with three large pyramid features, still present today.

3.2 Regulatory Consultation

3.2.1 Environmental Health team at Bury Council have been contacted with regards to the current status and proposed redevelopment of the site.

3.2.2 The Council has confirmed that they do not currently hold any information relating to ground conditions at the site. The Council notes that the site was historically used as railway land with lines, sidings and a goods station and was later developed as a lake and area of public open

space. The Council states that if the site is to be redeveloped, characterisation of the ground conditions including sampling of soils will be required.

- 3.2.3 The council has identified several landfill sites located within 250m of the site. This includes a landfill named as Peel College, Bury (Ref: C087) located adjacent to the south of the site and was noted to have been backfilled with unknown materials pre-licensing act (1974).
- 3.2.4 Land to the west of the site is also noted to be a landfill (not identified as such within the Groundsure Report) (Ref: C078). The Council states that the land was filled with inert waste as part of a reclamation scheme in 1973. Ground investigations from 2005/06 are stated to have encountered reworked natural clays over shallow demolition wastes. This site was redeveloped in 2000s for use as a hotel, offices and car park and remedial measures including earthworks and gas protection measures are stated to have been completed.
- 3.2.5 It is noted that no areas of land at or near to the site have been determined as Contaminated Land under Part 2A of the Environmental Act (EPA) 1990. As the site has previous potentially contaminating land use, the site is considered to be a potential site of concern by the council, however, the site is not high priority for investigation under Part 2A of the EPA. The Council further states that it would be prudent to conduct assessments and sampling to indicate potential problems which may require further investigation and/or remedial action.
- 3.2.6 It is confirmed that the site is not located in an area affected by radon. There are no records associated with nuisance incidents or pollution incidents within the last 12 months.
- 3.2.7 The eastern area of the site, in the area of the former lake, is designated as a Site of Biological Importance (SBI).
- 3.2.8 The Environmental Report from Bury Council is included in Appendix 2.

3.3 Unexploded Ordnance (UXO)

- 3.3.1 A preliminary review has been made of the UXO risk presented by the site based upon CIRIA C681¹⁰ ('Unexploded Ordnance (UXO) – A guide for the construction industry') and the assessment matrices presented in Tables 5.1-5.3 therein.
- 3.3.2 Reference to the Zetica unexploded bomb risk maps [9] indicates that the site is located within a "low" risk area in relation to the potential presence of unexploded ordnance being present on site.
- 3.3.3 Notwithstanding this, any works that disturb the ground such as demolition and groundworks should include UXO tool-box talks and further advice sought from a specialist if suspicious articles are encountered.

3.4 Tunnels and Infrastructure

- 3.4.1 Historical plans indicate that a subway was previously present on the western site boundary. A masonry arched bridge (Market Street) also spans the east of the site in a roughly north-north-west to south-south-east orientation.

¹⁰ CIRIA C681 'Unexploded Ordnance (UXO) – A guide for the construction industry' 2009.

3.4.2 Given the extensive nature of previous development across the site service ducts, basements and substructures should be anticipated to be present. Utility plans indicate the presence of a masonry arch culvert that enters the site on the north eastern boundary and follows the northern edge of the former pond.

3.4.3 It should be noted that the above review does not constitute a formal review of all buried structures and utilities that may be present at the site.

3.5 Previous Ground Investigation Report

3.5.1 The site has been subject to a previous preliminary ground investigation by CampbellReith with the findings presented in a Land Quality Statement [4]. The LQS report included a conceptual model for the site ground conditions (soil, water and gas), a generic quantitative risk assessment for human health and gas, and outline recommendations for land contamination issues. A summary of the report is presented below.

3.5.2 The intrusive works were carried out by Dunelm Geotechnical and Environmental between 31st January and 3rd February 2022 with details included in the factual report [5]. The investigation comprised the following:

- 6 no. Windowless Sample Boreholes (WS01-WS06) to a maximum depth of 4.45m below ground level.
- 10 no. Trial Pits (TP01-TP04, TP04A, TP05-TP09) to a maximum depth of 4.00m below ground level.

3.5.3 The report details the presence of Made Ground comprising sandy gravelly clay and gravelly clayey sand with ash, varying in thickness from 0.20m and 4.45m bgl. A total of 6 no. trial pits and 2 no. window sample boreholes were terminated within the Made Ground, therefore the full thickness was not proven.

3.5.4 Glacial Deposits, generally described as light grey and brown slightly gravelly silt, with gravel comprising siltstone and mudstone, were encountered in TP05, TP06, TP08, TP09 and WS01 to WS04.

3.5.5 No groundwater strikes were observed during the ground investigation. Monitoring wells installed in boreholes WS01 to WS06 encountered standing water at depths between 0.56m and 1.83m bgl. However, WS01 was recorded as dry on 1 no. visit.

3.5.6 A strong hydrocarbon odour was noted in the Made Ground at 2.20m bgl in TP03 and at 0.50 – 2.60m bgl in TP09. No visual evidence of potential contamination was observed.

3.5.7 A human health risk assessment was carried out by CampbellReith based on the assessment of thirteen samples collected from the site. Contaminant concentrations were not considered elevated when compared to the screening levels used for a residential with plant uptake end-use. In addition, asbestos was not detected in any of the eight samples analysed.

3.5.8 CampbellReith assessed the risk to end users to be LOW-MODERATE mainly due to the presence of suspected hydrocarbon impacted soils. Given the limited coverage of the preliminary investigation, further assessment was required to refine the contamination risk.

3.5.9 Gas and groundwater monitoring was carried out on three occasions between 3rd and 31st March 2022. During the monitoring, methane concentrations were not detected, and carbon dioxide concentrations were generally detected between 1.6% to 6.4%. However, an absence of flow rates was recorded across the rounds of gas monitoring, with the exception of WS05 which recorded 0.1 l/hr on 1 no. visit. As such, the ground gas risk was initially classified as a Characteristic Situation 1 'Very Low Gas Risk'. However, due to the concentration of carbon dioxide exceeding 5%, further gas monitoring is required to confirm the gas regime on site and whether an increase to CS2 should be considered.

3.6 Current Industrial Setting

3.6.1 Table 3.3 summarises identified industrial features, which may present a potential source of contamination to the site based upon the Groundsure report [3] which should be consulted for further details. Unless otherwise stated, only those features that are within the stated review distances have been included.

Table 3.3 Industrial Setting

Type	Distance Reviewed	Distance from Site	Description
Contaminated land register entries and notices	<500m	-	None identified.
Landfills	<250m	On site	Historical Landfill Historical Mapping. Railway Cuttings, no further details supplied (*)
		8m S	EA historical landfill site. Site address given as Peel College, Greater Manchester (Ref: C087). No further details provided.
		129m NW & 198m W	EA historical landfill site. Railway cutting east and west of Manchester Road, Bury (Ref: RD/LIC/503/88, C077). Licence holder Bury MBC, June 1988. Waste type noted as inert.
		226m S	EA historical landfill site. Wellington Road, Bury, Greater Manchester (Ref: C085). Operator: County Borough of Bury, October 1971. Waste type noted as industrial, commercial household, liquid, sludge.
Waste Transfer/Treatment Stations	<100m	-	None identified.
Potentially Infilled Land	<250m	On site	Infilled ground – artificial deposit.
			Made ground – artificial deposit.
			Worked ground – void.
		15m NW	Infilled ground – artificial deposit.
		236m S	Worked ground – void.

Type	Distance Reviewed	Distance from Site	Description
		240m S	Made ground – artificial deposit.
		249m S	Worked ground – void.
		249m S	Worked ground – void.
Pollution Incidents	<50m	On site	None identified.
Environmental Permits	<150m	-	None noted, other than those covered under waste.
Discharge Consents	<100m	-	None identified.
Abstractions	<250m	-	None identified.
Fuel Stations	<200m	141m NE	Angouleme Way, Bury (noted as obsolete).
Contemporary trade directory entries – active	<100m	0 – 100m	Includes: business park, industrial estate, substation, tram and railway lines and infrastructure.
Contemporary trade directory entries – non active	<100m	0 – 100m	Includes: tanks, railways, railway buildings, railway station, goods station, abattoirs and cattle pens, substations, rope walk, garages, reservoir, cuttings and unspecified pits.
Control of Major Accident Hazards (COMAH) Sites	<500m	-	None identified.

(* note, corresponded from Groundsure indicates “these are referring to old railway sidings/cuttings, goods stores etc. which have been identified in the past land use section”)

3.6.2 The features that are highlighted (in bold) are those that are considered to require further consideration from a risk perspective.

4.0 PRELIMINARY CONCEPTUAL SITE MODEL

4.1 Introduction

4.1.1 Current practice for land contamination evaluation comprises the identification of contaminant source-pathway-receptor pollutant linkages. The sources have been identified in Table 4.1 and Table 4.2 provides a list of the potential contaminant linkages together with the rationale for the site investigation that was carried out.

4.2 Potential Sources of Contamination

4.2.1 Table 4.1 summarises the potential contamination sources that have been identified on or near the site. The potential contaminant types associated with these is then given based upon a review of industry profiles and anecdotal information:

Table 4.1 Potential Sources of Contamination

Feature on or near site	Potential Contaminant
Presence of Made Ground indicated in the south east of the site (BGS plans) and infilled ground in the west and to the west of the site. Made Ground is also anticipated to be present associated with previous development, including ash and railway ballast. Additionally, the nature and composition of the material within the pyramids is unknown. Made Ground may also include coal mining derived waste/spoil.	M, IC, OC (TPH, PAH, VOC, SVOC), ACM, GG, CF.
Potential presence of impacted Made Ground and natural soils associated with former land use including railway land, substation, abattoirs, garages and works.	M, IC, OC (TPH, PAH, VOC, SVOC, PCB), ACM, GG. Abattoirs have a notional potential for pathogens; however, this will diminish over time.
Notes: M – Metals and metal compounds. IC – Inorganic Compounds (including acids and alkalis, sulphates, sulphides, ammonia and others), OC – Organic Compounds (including TPH – Total Petroleum Hydrocarbons, PAH – Polycyclic Aromatic Hydrocarbons, VOC – Volatile Organic Compounds, SVOC - Semi Organic Compounds, phenols). ACM – Asbestos Containing Materials / Asbestos in Soil. R - Radioactivity. PCB – Poly chlorinated biphenyls. GG – Ground Gases (including both 'bulk gasses' and volatile compounds). CF – Elevated Calorific Values.	

4.2.2 Given the previous land use and extensive development across the site, there is the potential for a wide range of below ground infrastructure including tanks, pipelines, drains and adits that may locally contain contamination.

4.2.3 Made Ground associated with the use of the site as railway land is anticipated to be present. This is likely to contain ballast type materials, which can include steam locomotive ash. Additionally, materials used as infill may have been sourced from the general area and therefore has the potential to contain a wide array of contamination, including asbestos.

- 4.2.4 The Made Ground indicated to be present in the south east of the site (and leading off to the south) on geological plans may potentially contain coal mining waste arisings, some of which may have a high calorific value. Such materials have a notational potential to combust under the right conditions and may be present locally across the site.

4.3 Targeted Potential Contaminant Linkages

- 4.3.1 Table 4.2 provides a list of the potential contaminant linkages together with the rationale for the site investigation design.

Table 4.2 Targeted Potential Contaminant Linkages

Issue	Exploration
End user exposure to Made Ground soils.	General investigation coverage across the site with sampling from soils within the top 1m of the site.
Tanks	Trial pits and boreholes with installations provided for ground gas, vapour and groundwater monitoring and sampling.
Potential vertical migration of contamination to underlying groundwater	Targeted and general site coverage. Boreholes with targeted groundwater specific installations provided.
Ground gas and vapour generation from the Made Ground infilling and boiler rooms	Targeted ground gas monitoring installations within the proposed building footprints.

- 4.3.2 Considering the past and current uses of the site, a contamination analysis suite should be applied that considered metals, semi-metals, inorganic chemicals and speciated hydrocarbon contaminants in order to provide data for human health risk assessment. In addition, the presence of asbestos in soils should be appraised by testing. Such testing should be completed in accordance with UKAS and MCERTS standards. Subject to the determination of the final objectives of the ground investigation, the test suite may also be modified to facilitate the classification of waste soil arisings.
- 4.3.3 The findings of the intrusive investigation of the potential contaminant sources and pathways are reported in Section 5.0. This has informed the Generic Quantitative Risk Assessment presented in Section 7.0, Waste Soils in Section 8.0, Revised Conceptual Site Model in Section 9.0, and the subsequent conclusions and recommendations regarding risk in Section 11.0.

5.0 SITE INVESTIGATION

5.1 Scope of Works

5.1.1 The second phase of intrusive works were carried out by Geotechnics between 15th and 30th November 2023. The factual report [6] is provided in Appendix 3.

5.1.2 The exploratory locations are shown on Figure 5, Appendix 1. A summary of the exploratory holes is given below:

- 19 no. machine dug trial pits (SA101, SA102, TP101 to TP104, TP106 to TP110, TP112, TP116A and TP118 to TP123) were excavated to a maximum depth of 4.00m bgl;
- 6 no. hand-dug pits (HP111, HP113 to HP115, HP117E and HP117W) were excavated to a maximum depth 1.10m bgl.
- 8 no. 150mm diameter cable percussive boreholes (BH101 to BH108) were sunk to a maximum depth of 11.77m bgl.

5.1.3 TP105 was not carried out due to access problems encountered from the existing trees.

5.1.4 TP112 was terminated at shallow depth due to substantial inflow of standing water. As a result, scheduled machine dug trial pits TP111, and TP113 to TP115 which were located in close proximity to TP112 were subsequently replaced by hand-dug trial pits. Machine dug trial pit TP117 was also replaced by HP117W and HP117E given the proximity to the Market Street bridge abutments.

5.1.5 HP111 and HP113 to HP115 were terminated at shallow depth due to substantial inflow of standing water, noting that these exploratory holes are located within the former pond area. HP117W and HP117E were terminated at 0.9m due to rapid inflow of groundwater.

5.1.6 A concrete obstruction was encountered was encountered in TP104 at 2.40m. In addition, obstructions were noted in BH103 and BH105 log records within the Glacial Deposits. Chiselling during drilling of the cable percussive boreholes was recorded in the Made Ground at BH107 at 2.00m to 2.30m and 5.50m to 5.60m bgl.

5.1.7 Chiselling was also so undertaken at BH103 from 1.50m to 1.60m, BH104 from 6.80 to 7.00m, BH105 from 1.20m to 1.40m, BH106 from 5.50m to 5.70m and, BH107 from 11.30m to 11.40m.

5.1.8 The ground conditions encountered with respect to the monitoring installations are summarised in Table 5.1. Visits have been made to site on 3 no. occasions between 10th and 31st January 2024 to monitor gas and water levels within the installations and to obtain samples.

Table 5.1 Standpipe Summary

Exploratory Hole	Response Zone (m bgl)	Response Zone (m OD)	Standpipe Diameter (mm)	Full Strata Depth (m bgl)	
BH101	2.00 - 6.00	84.35 – 80.35	50	2.00 – 6.00	Sandy gravelly clay (Glacial Clays)

Exploratory Hole	Response Zone (m bgl)	Response Zone (m OD)	Standpipe Diameter (mm)	Full Strata Depth (m bgl)	
BH102	0.50 – 1.50	86.24 – 85.24	50	0.50 – 1.50	Sandy gravelly clay (Glacial Clays)
	4.50 – 7.50	82.24 – 79.24	33	4.50 – 7.50	Mudstone
BH103	1.00 – 6.80	85.05 – 79.25	50	1.00 – 6.80	Sandy gravelly clay (Glacial Clays)
BH104	2.00 – 5.00	83.51 – 80.51	50	2.00 – 5.00	Sandy gravelly clay (Glacial Clays)
BH105	1.40 – 4.00	84.81 – 82.21	50	1.40 – 4.00	Sandy gravelly clay (Glacial Clays)
BH106	1.00 – 2.50	84.83 – 83.03	50	1.00 – 1.80	Clayey sand (Glacial Sands)
				1.80 – 2.50	Sandy gravelly clay (Glacial Clays)
	4.00 – 7.00	81.53 – 78.53	19	4.00 – 6.90	Sandy gravelly clay (Glacial Sands)
				6.90 – 7.00	Mudstone
BH107	1.00 – 4.00	89.59 – 86.59	50	1.00 – 4.00	Made Ground
	6.50 – 8.50	84.09 – 82.09	19	6.50 – 8.50	Gravelly sand (Glacial Sands)
BH108	1.00 – 3.00	84.57 – 82.57	50	1.00 – 3.00	Clayey gravel (Glacial Sands)

5.2 Groundwater Observations

5.2.1 Water strikes observed during the site works and the results of the monitoring visits are summarised in Table 5.2.

Table 5.2 Groundwater Observations

Exp Hole	Water Strikes				Standing Water Level During Monitoring			
	Struck		Rose to		Shallowest		Deepest	
	m bgl	m OD	m bgl	m OD	m bgl	m OD	m bgl	m OD
BH101	-	-	-	-	3.18	83.17	3.19	83.16
BH102 (33mm)	-	-	-	-	4.31	83.56	4.69	82.05
BH102 (50mm)					1.13	83.56	1.23	85.51
BH103	0.00	86.05	-	-	2.92	82.87	3.34	82.71
BH104	-	-	-	-	2.82	82.33	3.81	81.7
BH105	-	-	-	-	0.19	83.03	0.48	85.73

Exp Hole	Water Strikes				Standing Water Level During Monitoring			
	Struck		Rose to		Shallowest		Deepest	
	m bgl	m OD	m bgl	m OD	m bgl	m OD	m bgl	m OD
BH106 (19mm)	2.00	83.53	1.00	84.53	1.13	82.35	1.31	84.22
BH106 (50mm)					2.37	82.35	2.81	82.72
BH107 (19 mm)	7.00	83.59	6.00	84.59	5.97	87.41	6.05	84.54
BH107 (50mm)					Dry	Dry	Dry	Dry
BH108	0.20	85.37	0.00	85.57	0.13	82.39	0.37	85.20
HP111	0.00	85.64	-	-	-	-	-	-
HP113	0.00	85.58	-	-	-	-	-	-
HP114	0.00	85.56	-	-	-	-	-	-
HP115	0.00	85.56	-	-	-	-	-	-
HP117E	0.90	85.06	-	-	-	-	-	-
HP117W	0.90	85.04	-	-	-	-	-	-
SA101	0.40	85.71	-	-	-	-	-	-
SA102	0.15	85.94	-	-	-	-	-	-
TP103	1.70	85.07	-	-	-	-	-	-
TP106	1.20	86.36	-	-	-	-	-	-
TP112	0.00	85.52	-	-	-	-	-	-
TP116A	2.30	83.69	-	-	-	-	-	-

- 5.2.2 Groundwater monitoring was undertaken between the 10th and 31st January 2024. The cable percussive boreholes (BH101, BH102, BH104 to BH108) were monitored on three visits, and BH103 was monitored on two visits.
- 5.2.3 Groundwater was generally encountered in the shallow 50mm diameter standpipes at depths between 0.13m bgl (BH108) and 3.81m bgl (BH104). However, it should be noted that the monitoring standpipe installed in location BH107 was dry on all 3 no. visits. Due to the shallow groundwater levels encountered in BH105 and BH108, the response zones were completely submerged.
- 5.2.4 Groundwater was encountered in the deeper 19mm and 33mm diameter standpipes installed in BH102, BH106 and BH107 at depths between 2.37m and 6.05m bgl. As a result, the response zones were submerged.

5.3 Geotechnical Testing

- 5.3.1 In-situ testing was undertaken for geotechnical purposes and samples were obtained for appropriate laboratory analysis. Site based geotechnical testing is summarised in Table 5.3. Any limitations to the testing that require consideration during the evaluation of the data are described in the following paragraphs.

Table 5.3 In-situ Tests (Geotechnical)

Test Type and Reference	2022 Dunelm GI	2024 Geotechnics GI
Standard penetration test (BS EN ISO 22476-3:2005+A1:2011)	17	49

- 5.3.2 Although a standardised test, uncorrected Standard Penetration Test (SPT) 'N' values display a considerable amount of scatter. Calibrated SPT hammers were used by the ground investigation contractor and in our appraisal (given in Section 6.0) and the results have been normalised to 'N₆₀' in accordance with Eurocode 7¹¹. Correcting the tests with respect to energy ratio to determine 'N₆₀' reduces the scatter but does not eliminate it.
- 5.3.3 Some grossly elevated SPT N values, likely due to encountering boulders within the Glacial Deposits were recorded between 2m and 6m below ground level. These are not considered representative of the stratum as a whole and have therefore been discounted from subsequent analysis.
- 5.3.4 The SPT undertaken in BH107 at 6.00m straddles two strata and so is considered to be representative of neither and has been discounted from subsequent analysis.
- 5.3.5 Geotechnical laboratory testing is summarised in Table 5.4.

Table 5.4 Laboratory Tests (Geotechnical)

Test type and reference (BS 1377: 1990 unless stated*)	2022 Dunelm GI	2024 Geotechnics GI
Water (Moisture) Content (BS EN ISO 17892-1/ Part 2:3.2)	5	43
Liquid and plastic limits and plasticity index (BS EN ISO 17892-12:2018/ Part 2:4.3, 5.3 and 5.4)	5	28
Particle size distribution - wet sieving (BS EN ISO 17892-4/ Part 2:9.2)	3	14
Particle size distribution - sedimentation by pipette method (BS EN ISO 17892-5)		3
Dry Density/Moisture Content relationship determination - 2.5 kg Hammer (Part 4: 3.3)		22
California Bearing Ratio (CBR) Measurement – recompactd (Part 4: 7)		6
Moisture Condition Value Calibration Tests (Part 4: 5.5)		14

¹¹ EN 1997-2:2007 Eurocode 7 Geotechnical design – Part 2 Ground Investigation and Testing

Test type and reference (BS 1377: 1990 unless stated*)	2022 Dunelm GI	2024 Geotechnics GI
Shear Strength Estimation using Hand Vane (Manufacturer's Instructions)		56
Unconsolidated Undrained Triaxial Test (BS EN ISO 17892-8:2018)		1
Organic matter content (Part 3:3)		4
Water soluble sulphate content 2:1 aqueous extract (BRE SD1 2005)	4	20
Total sulphur content (BRE SD1 2005)	4	20
Acid soluble sulphate content (BRE SD1 2005)	4	20
Soil pH (BRE SD1 2005)	4	20
Sulphate content in groundwater (BRE SD1 2005)		7
Groundwater pH (BRE SD1 2005)		7

*Note, due to contamination being detected in the Made Ground some samples were tested in a sperate laboratory. These samples were all tested using the BS 1377:1990 test methodologies.

- 5.3.6 As with in-situ testing, it is necessary to consider the limitations associated with any laboratory testing and to review any potentially anomalous results. In all geotechnical tests, it should be noted the specimen is selected from a much larger volume of material, which may have an inherent degree of variability, particularly in Made Ground.
- 5.3.7 Water content determinations on disturbed samples may not be wholly representative due to disturbance arising from the sampling process. In addition, moisture content results can be influenced by climatic factors and it cannot be guaranteed that the values determined at the time of investigation will be the same as those that prevail at the time of construction.
- 5.3.8 Obtaining coarse-grained soils from cable tool boreholes can result in a loss of fine materials due to the nature of the sampling process. This can have an influence on the results of particle size distribution analyses.
- 5.3.9 Determinations of undrained shear strength can be affected by sample disturbance. Whilst this is reduced by the use of UT100 sampling equipment, it cannot be fully eliminated and requires due consideration in appraising the results, especially where an elevated number of blows were required to retrieve the sample. Determinations of undrained shear strength can also be affected by the presence of fissures. The application of a suitable confining pressure in the test can reduce this, but fissures can still affect the results when present.
- 5.3.10 Sampling and preparation of samples for California Bearing Ratio tests in laboratory may result in the material tested not being fully representative of the soils in their in-situ state. Of particular note is the need to compact the sample prior to testing. Even when done at natural moisture content this state of compaction is likely to differ from that of the soil in its situ state. However, this may inform an understanding of the effects of proof rolling.
- 5.3.11 The above factors have been considered in the appraisal of geotechnical results given in Section 6.0.

5.4 Contamination Observations and Testing

5.4.1 Olfactory and visual evidence of potential contamination is summarised in Table 5.5 and includes observations relating to organic materials that may indicate a ground gas risk potential.

Table 5.5 Summary of Evidence of Contamination

Exploratory Hole	Depth (m bgl)	Strata	Comment
SA101	0.10 – 0.70	Made Ground	Clinker
SA102	0.10 – 0.50	Made Ground	Clinker
TP101	0.30 – 0.80	Made Ground	Clinker
TP102	0.60 – 1.50	Made Ground	Clinker
	1.50 – 4.00	Made Ground	Hydrocarbon odour, clinker, coal, plant remains
TP103	0.20 – 1.70	Made Ground	Oily sheen on soil and perched groundwater, hydrocarbon odour, clinker, steel
TP104	0.10 – 2.20	Made Ground	Clinker, timber
TP106	0.00 – 0.20	Topsoil	Clinker
	0.20 – 1.30	Made Ground	Clinker, plastic
	1.30 – 3.40	Made Ground	Strong hydrocarbon odour, clinker
TP107	0.0 – 1.50	Made Ground	Clinker
	1.50 – 3.30	Made Ground	Slight hydrocarbon odour, clinker
	1.50 – 4.00	Made Ground	Strong hydrocarbon odour
TP108	0.10 – 2.00	Made Ground	Clinker
TP109	0.00 – 2.20	Made Ground	Clinker
	2.90 – 3.00	Made Ground	Asphalt
TP110	0.2 – 0.7	Made Ground	Ash
TP116A	0.40 – 0.80	Made Ground	Ash
TP119	0.00 – 0.20	Topsoil	Clinker
	0.20 – 3.00	Made Ground	Organic material, clinker
	3.00 – 3.70	Made Ground	Clinker
TP120	0.30 – 0.60	Made Ground	Clinker
	0.60 – 2.20	Made Ground	Coal
TP121	0.00 – 0.20	Topsoil	Clinker
	0.20 – 2.00	Made Ground	Clinker
	2.00 – 3.70	Made Ground	Clinker, coal, timber
	3.70 – 4.00	Made Ground	Clinker, decayed plant remains
TP122	0.00 – 0.40	Made Ground	Clinker

Exploratory Hole	Depth (m bgl)	Strata	Comment
	0.40 – 0.80	Made Ground	Clinker, asphalt
TP123	0.40 – 0.70	Made Ground	Ash, hydrocarbon odour
BH101	1.20 – 2.45	Sandy gravelly clay	Coal fragments
BH102	0.10 – 0.20	Made Ground	Ash
	0.20 – 0.50	Made Ground	Coal, ash, wood fragments
BH103	0.00 – 0.90	Made Ground	Ash
BH104	0.50 – 1.00	Made Ground	Ash
BH107	0.30 – 1.20	Made Ground	Clinker
	1.20 – 6.10	Made Ground	Slag

5.4.2 Table 5.6 summarises the chemical suites that were analysed based upon the preliminary conceptual model and observed site conditions.

Table 5.6 Laboratory Tests (Environmental)

Test type	2022 Dunelm GI	2024 Geotechnics GI
SOIL		
S1.6 General Suite: pH, moisture content, metals and inorganics, phenol, speciated polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH)	13	39
S1.4 Total organic carbon	7	11
S1.3 Asbestos screen	8	18
S1.7 Speciated petroleum hydrocarbons + BTEX	2	6
Volatile organic compounds (VOCs) & semi-volatile organic compounds (SVOCs)		2
WATER		
W1.1 General Suite: pH, metals and inorganics, phenol, total polycyclic aromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPH).		7
W1.4 Speciated polycyclic aromatic hydrocarbons (PAHs)		7
W1.5 Speciated petroleum hydrocarbons		4
W1.7 BTEX		1
Volatile organic compounds (VOCs) & semi-volatile organic compounds (SVOCs)		1
Speciated phenols		1

6.0 GEOTECHNICAL EVALUATION

6.1 Ground Conditions

6.1.1 The ground conditions encountered during the site investigation generally consisted of varying thicknesses of Made Ground over Glacial Deposits comprising a mix of clays and sands. The underlying mudstone bedrock of the Pennine Lower Coal Measures was encountered at several locations between 3m and 11m below ground level (bgl).

6.1.2 The general distribution of each stratum is shown in Table 6.1.

Table 6.1 Soil Profile

Stratum	From (m bgl)		To (m bgl)		Thickness (m)
	Range	Characteristic	Range	Characteristic	Range
Topsoil	0.00	0.00	0.01 to 0.50	<0.5	0.10 to 0.50
Made Ground	0.00 to 0.50	0.00	0.30 to 6.10	Variable across site	0.20 to 6.10
Glacial Deposits	0.01 to 6.10	<2	3.00 to 6.90	6 to 7	2.20 to 6.40
Mudstone (PLCM)	3.00 to 6.90	6 to 7	Not determined	-	-

PLCM = Pennine Lower Coal Measures

6.1.3 The ground model as outlined in Table 6.1 broadly agrees with the conditions anticipated however, isolated areas of deep Made Ground were found to be present across the site as discussed in the following sections.

6.1.4 The findings from BH107 have not been considered in Table 6.1 as this borehole was undertaken at a higher level at the top of the access road.

6.1.5 The following sections comprise discussion of each stratum and include the data provided from the 2022 ground investigation [5].

6.2 Topsoil

6.2.1 Topsoil was encountered at twenty-four of the thirty-three exploratory hole locations. Generally, it was recorded to depths of 0.20m however, locally was found to 0.50m bgl within BH104, BH106 and HP115. The full extent of the topsoil was not determined within some of the hand dug pits (HP111 and HP113 to HP115) due to ingress of water near the surface. The ingress of water is likely associated with the old pond that previously occupied this area of site.

6.2.2 The Topsoil typically comprises brown/ dark grey slightly sandy gravelly clay with some roots and rootlets.

6.2.3 It is noted that no topsoil was logged during the previous ground investigation carried out by Dunelm [5]. The log descriptions appear to have categorised the material as Made Ground and it is therefore considered in the following section.

6.2.4 No geotechnical testing was undertaken on samples from the Topsoil due to the minor thickness and inherent engineering variability.

6.3 Made Ground

6.3.1 Made Ground was encountered at twenty-five of the thirty-three exploratory hole locations. In addition, Made Ground was recorded at all sixteen exploratory holes carried out as part of the previous ground investigation [5]. The thickness of Made Ground is variable across the site ranging between <1m and 6m. In several locations the base of the Made Ground was not determined.

6.3.2 Areas of thicker Made Ground are situated within the pyramid features and embankment running along the southern boundary, as highlighted in Figure 6, Appendix 1. In these areas the thickness of Made Ground reaches in excess of 4m but reduces around the base of the pyramids to between 1m and 2m thick.

6.3.3 Beyond the pyramid structures and embankment, isolated spots of deep Made Ground were also recorded within TP01, TP04A, WS06 and TP110 as marked on Figure 6, Appendix 1.

6.3.4 The Made Ground has been broadly separated into two main units; "Fine Made Ground" dominated by clays and silts and "Granular Made Ground" comprising mainly sands and gravels.

6.3.5 The Fine Made Ground stratum generally comprises slightly sandy slightly gravelly clays with low to medium cobble content of sandstone and bricks. The gravel typically contains angular to sub rounded clasts of sandstone, siltstone, mudstone, clinker and brick fragments. Rootlets and organic material were noted at some locations with hydrocarbon odour described locally.

6.3.6 The Granular Made Ground soils typically include fine to coarse sands and gravels of siltstone, sandstones, mudstone, brick fragments, clinker and occasional concrete fragments. Medium cobble content was recorded at several locations with angular to sub angular limestone recorded in TP101 to 0.30m bgl.

6.3.7 Black asphalt was encountered at depth in TP109 at 2.90m bgl. In addition, a concrete obstruction was recorded at the base of TP104 at 2.40m bgl.

6.3.8 Based on the available exploratory hole information an estimated two thirds of the Made Ground is dominated with clays (Fine Made Ground) with the other third comprising sand and gravel dominant soil (Granular Made Ground).

6.3.9 The drilling records show that chiselling was undertaken in BH107 at 2.00m and 5.50m bgl. It is anticipated that the obstructions comprise large cobbles and boulders present within the Made Ground forming the embankment.

In-situ testing

6.3.10 Fourteen SPTs were carried out within the Made Ground, twelve in the Granular Made Ground and the remaining two being within the Fine Made Ground. The N_{60} values are presented in Figure 7, Appendix 1. The N_{60} values within the Fine Made Ground range between 41 and 43 with the N_{60} values within the Granular Made Ground ranging between 13 and 152. Between

ground level and 3m the SPT N_{60} values are generally between 15 and 30 indicating medium dense soils¹². It should be noted that the majority of the SPTs undertaken were within the embankment along the southern boundary; no SPTs were carried out within the Pyramid structures.

- 6.3.11 Assuming an empirical relationship of $c_u = 5 \times N_{60}$ (where C_u = undrained shear strength) the correlated undrained shear strength within the Fine Made Ground is approximately 200kPa suggesting very high strength material.

Laboratory Shear Vane Tests

- 6.3.12 Twenty-three laboratory shear vane tests (HSV) were undertaken on five samples of Fine Made Ground at varying moisture contents. A plot of the recorded undrained shear strengths vs moisture content, presented in Figure 11a, Appendix 1, indicates that the undrained shear strength generally falls below 50kPa where the moisture content is above 20% although, three tests recorded undrained shear strengths below 50kPa where the moisture content was between 15% and 20%.

Moisture Content and Atterberg Limit

- 6.3.13 A total of ten moisture content tests were undertaken on samples of the Fine Made Ground along with ten Atterberg limit determinations. The results are summarised in Table 6.2 below and schematics of the test results are presented in Figure 8 and Figure 9, Appendix 1.

Table 6.2 Summary of Atterberg limit determinations of Fine Made Ground

Soil Parameters	No. of tests	Range of results
Moisture Content (%)	14	14 to 33
Liquid Limit (%)	10	31 to 49
Plastic Limit (%)	10	19 to 24
Plasticity Index (%)	10	8 to 28
Modified Plasticity Index (%)	10	5 to 24

- 6.3.14 The modified plasticity index values suggest low to medium volume change potential in accordance with NHBC guidance¹³. When plotted on the Casagrande chart the results indicate the Made Ground to be a low to intermediate plasticity clay as shown on Figure 9, Appendix 1.
- 6.3.15 The characteristic constant volume angle of shearing resistance (ϕ'_{cv}) of the Fine Made Ground encountered during the ground investigation is estimated to be 25° based on guidance from BS 8004:2015¹⁴. Note the ϕ'_{cv} value provided is a cautious estimate as Made Ground is

¹² BS 5930:2015+A1:2020 Code of practice for ground investigations

¹³ NHBC Standards, London, 2024

¹⁴ BS 8004:2015+A1:2020 Code of practice for foundations

inheritably variable, and caution should be taken when applying characteristic parameters to this unit.

Particle Size Distribution (PSD) tests

- 6.3.16 Nine particle size distribution (PSD) tests were carried out on samples collected from the Made Ground (two being of Fine Made Ground) recording the following particle size distributions:

Table 6.3 Particle Size Distribution Results of Made Ground

	Made Ground – Fines	Made Ground – Granular
Cobbles (%)	15 to 37	0 to 47
Gravel (%)	13 to 33	34 to 81
Sand (%)	23 to 47	12 to 35
Silt (%)	17	8
Clay (%)	8	3
Fines (%)	7 to 25	2 to 14

- 6.3.17 The PSD results suggest relatively low amounts of silt and clay present within the two samples described in the field as being clay dominant. This discrepancy may be due to the high cobble content within both samples; the surrounding matrix may contain higher proportions of clays.
- 6.3.18 The PSD tests undertaken in the Granular Made Ground samples generally agree with the infield descriptions indicating sand and gravel dominant soils with minor amounts of clay and silt. The cobble content within the material is generally below 10% however it is recorded to be as high as 47% within a sample from TP01 at 0.50m bgl.
- 6.3.19 The Uniformity Coefficients (U_c) within the two samples of Fine Made Ground were calculated to be 112 and 523.
- 6.3.20 The Uniformity Coefficients (U_c) calculated from the samples of Granular Made Ground range between 58 and 567.
- 6.3.21 A characteristic constant volume angle of shearing resistance (ϕ'_{cv}) of the Granular Made Ground is estimated to be 34° based on guidance from BS 8004:2015.

Moisture Condition Value

- 6.3.22 Five Moisture Condition Value (MCV) relationship tests were undertaken on samples of the Made Ground. The results are presented in Figure 11a, Appendix 1.

Remoulded California Bearing Ratio

- 6.3.23 Five remoulded California Bearing Ratio (CBR) tests were carried out on samples of Fine Made Ground at the natural moisture content. The results are as follows:
- CBR (%): 0.5 to 1.3

- Moisture Content (%): 16 to 32
- Bulk Density (Mg/m³): 1.82 to 2.16
- Dry Density (Mg/m³): 1.38 to 1.86
- Percent Removed from 20mm sieve (%): 13 to 46

Dry Density/Moisture Content

- 6.3.24 Eight dry density/moisture content relationship tests were undertaken on samples of Made Ground using a 2.5kg rammer, five being on samples of Fine Made Ground and the remaining three tests on samples of Granular Made Ground. The results are as follows:

Table 6.4 Optimum Moisture Content Results of Made Ground

	Fine Made Ground	Granular Made Ground
Particle Density (Mg/m ³)	2.50 to 2.65	2.50 to 2.70
Maximum Dry Density (Mg/m ³)	1.66 to 1.78	1.67 to 1.92
Optimum Moisture Content (%)	15 to 19	12 to 16

- 6.3.25 Based on the moisture content results discussed above (and presented in Figure 8, Appendix 1) the natural moisture content of the Fine Made Ground material is generally above the optimum moisture content.

Organic Matter

- 6.3.26 Four organic matter content tests were carried out on samples of the Fine Made Ground. Organic matter contents (OMC) of between 1% to 4% were recorded with loss on ignition (LoI) values of 3% to 6%. The results suggest these samples contain slightly organic material¹⁵.

6.4 Glacial Deposits

- 6.4.1 Where the base of the Made Ground was determined it was found to be underlain by Glacial Deposits. The Glacial Deposits encountered across the site generally comprise either clay or fine to medium sands. The glacial soils have therefore been separated into two sub-units, Glacial Clays and Glacial Sands.
- 6.4.2 The Glacial Clays are generally described as comprising firm to stiff dark grey-brown slightly sandy slightly gravelly clay. The gravel typically consists of sub angular to sub rounded clasts of mudstone, siltstone and sandstone. Locally the clays are described as being soft to firm up to depths of 10m bgl and low content of siltstone and sandstone was recorded.
- 6.4.3 The Glacial Sands typically comprise sands with varying content of clays and gravel. In some locations the soils are described as very sandy gravel with the gravel consisting of subrounded

¹⁵ BS 5930:2015+A1:2020 Code of practice for ground investigations

to rounded clasts of various lithologies. Low to medium cobble content is also present locally, comprising siltstone and sandstone.

- 6.4.4 The drilling records show that chiselling was undertaken in the Glacial Clays in BH103 at 1.50m, BH105 at 1.20m and BH106 at 5.50m bgl. It is anticipated that the obstructions indicate large cobbles or boulders present within the Glacial Deposits.

In-situ testing

- 6.4.5 Thirty-five SPTs were carried out within the Glacial Deposits, thirty-one of which were in the Glacial Clays and the remaining four within the Glacial Sands; the results are presented in Figure 7, Appendix 1 (note, as discussed in Section 5.3 the results of five tests have been excluded from the analysis).
- 6.4.6 The N_{60} values within the Glacial Clays were recorded to be between 14 and 85. The N_{60} values within the Glacial Sands range between 18 and 24 indicating medium dense soils¹⁶.
- 6.4.7 Assuming an empirical relationship of $c_u = 5 \times N_{60}$ the correlated undrained shear strength (c_u) within the Glacial Clays ranges between 72kPa and 423kPa. A schematic of the results, plotted against depth is presented in Figure 10, Appendix 1.

Laboratory Shear Vane Tests

- 6.4.8 Thirty-three laboratory shear vane tests (HSV) were undertaken on nine samples of Glacial Clays at varying moisture contents. A plot of the recorded undrained shear strengths vs moisture content, presented in Figure 11b, Appendix 1, indicates that the undrained shear strength generally falls below 50kPa where the moisture content is above 15%.

Moisture Content and Atterberg Limit

- 6.4.9 A total of thirty-six moisture content tests and twenty-four Atterberg limit were undertaken on the Glacial Deposits. The results are summarised in Table 6.2 below and schematics of the test results are presented in Figure 8 and Figure 9, Appendix 1.

Table 6.5 Summary of Atterberg limit determinations of Glacial Deposits

Soil Parameters	No. of tests	Range of results
Moisture Content (%)	36	6 to 24
Liquid Limit (%)	23*	26 to 48
Plastic Limit (%)	23*	13 to 20
Plasticity Index (%)	23*	11 to 28
Modified Plasticity Index (%)	23*	5 to 27

* Sample from TP120 at 2.70m bgl recorded as being non plastic

¹⁶ BS 5930:2015+A1:2020 Code of practice for ground investigations

6.4.10 The modified plasticity index values indicate low volume change potential (in accordance with NHBC guidance¹⁷) in twenty-one of the twenty-four samples tested. Two of the three samples suggesting medium volume change potential recorded a Modified Plasticity Index of 21%, this is only marginally above the maximum limit for low volume change potential classification (20%) therefore, a characteristic volume change potential of low is deemed appropriate for the Glacial Clays. When plotted on the Casagrande chart the results indicate low to intermediate plasticity clay as shown on Figure 9, Appendix 1.

6.4.11 The characteristic constant volume angle of shearing resistance (ϕ'_{cv}) of the Glacial Clays is estimated to be 26° based on guidance from BS 8004:2015¹⁸.

Undrained Triaxial Compression Test

6.4.12 A single undrained triaxial compression test was carried out on a sample of the Glacial Clays collected from BH107 at 9.00m to 9.45m bgl. The test recorded a failure strength of 101kPa indicating high strength soils¹⁹. It should be noted that a coarse gravel particle was noted to be present within the sample which may have affected the test results.

6.4.13 The bulk density was measured as 2.25Mg/m³ with a dry density of 1.97Mg/m³. The natural moisture content of the sample was recorded as 14%.

Particle Size Distribution (PSD) tests

6.4.14 Eight particle size distribution (PSD) tests were carried out on samples of Glacial Deposits (two being within the Glacial Clays) recording the following particle size distribution:

Table 6.6 Particle Size Distribution Results of Glacial Deposits

	Glacial Clays	Glacial Sands
Cobbles (%)	0	0 to 10
Gravel (%)	2 to 39	4 to 75
Sand (%)	31 to 35	17 to 86
Silt (%)	-	10
Clay (%)	-	6
Fines (%)	30 to 63	4 to 17

6.4.15 The PSD results suggests that the Glacial Clay comprises sandy clay with variable content of gravel. The Glacial Sands show five of the six samples are relatively consistent indicating slightly silty slightly clayey sands and gravel with low cobble content.

6.4.16 The Uniformity Coefficient within the three samples of Glacial Sands was calculated to be between 4 to 383.

¹⁷ NHBC Standards, London, 2024

¹⁸ BS 8004:2015+A1:2020 Code of practice for foundations

¹⁹ BS 5930:2015+A1:2020 Code of practice for ground investigations

6.4.17 The Uniformity Coefficient calculated from a sample of Glacial Clays was calculated to be 13.

6.4.18 The constant volume angle of shearing resistance (ϕ'_{cv}), based on guidance from BS 8004:2015²⁰, is cautiously estimated to be 35° for the Glacial Sands.

Moisture Condition Value

6.4.19 Nine Moisture Condition Value (MCV) tests were undertaken on samples of the Glacial Deposits with eight of the tests undertaken on samples of Glacial Clays. The results are presented in Figure 11b, Appendix 1.

Remoulded California Bearing Ratio

6.4.20 One remoulded California Bearing Ratio (CBR) test was carried out on a sample of Glacial Clay, the results are as follows:

▪ CBR (%):	0.9 to 1.5
▪ Moisture Content (%):	13
▪ Bulk Density (Mg/m ³):	2.22
▪ Dry Density (Mg/m ³):	1.96
▪ Percent Retained removed from 20mm (%):	24

Dry Density/Moisture Content

6.4.21 Fourteen dry density/moisture content relationship tests were carried out on the Glacial Deposits using a 2.5kg rammer, six being undertaken on samples of Glacial Clays and the remaining eight on samples of Glacial Sands. The results are as follows:

Table 6.7: Optimum Moisture Content Results of Glacial Deposits

	Glacial Clays	Glacial Sands
Particle Density (Mg/m ³)	2.65 to 2.75	2.65 to 2.75
Maximum Dry Density (Mg/m ³)	1.85 to 2.03*	1.81 to 2.08
Optimum Moisture Content (%)	10 to 14*	9 to 14

*Anomalous results from TP103 not included

6.4.22 The results from the sample collected from TP103 at 3.00m recorded a Maximum Dry Density of 1.69Mg/m³ and an Optimum Moisture Content of 18%. These results are significantly different to the other five tests carried out on the Glacial Clays and suggests potential variability within this stratum.

6.4.23 Based on the moisture content results discussed above (and presented in Figure 8, Appendix 1) the natural moisture content of the Glacial Clays is above the optimum moisture content in nearly all samples tested.

²⁰ BS 8004:2015+A1:2020 Code of practice for foundations

6.5 Pennine Lower Coal Measures

6.5.1 The underlying mudstone bedrock is interpreted to be part of the Pennine Lower Coal Measures (PLCM). The bedrock was encountered at eight locations from 3.00m to 11.40m bgl. The top contact of the bedrock was generally recorded to be between c. 79m and 81m OD with the exception of BH102 and BH105 where the contact was found to be higher (around 82m to 84m OD).

6.5.2 The bedrock was found to comprise extremely weak to very weak blue grey Mudstone recovered as gravel in the cable percussive boreholes.

In-situ testing

6.5.3 Eleven SPTs were carried out within the Mudstone, the results are presented in Figure 7, Appendix 1. The calculated N_{60} values range between 42 and 300.

6.5.4 Assuming an empirical relationship of $UCS = 10 \times N_{60}$ the correlated unconfined compressive strength (UCS) within the Pennine Lower Coal Measure ranges between 0.45MPa and 3.00MPa suggesting extremely weak to very weak rock²¹.

Moisture Content and Atterberg Limit

6.5.5 Two moisture content tests were carried out on samples of the mudstone recording moisture contents of 11% and 13%.

6.6 Ground Aggressivity

6.6.1 Twenty-four soil samples, comprising fourteen from the Made Ground, seven from the Glacial Deposits and three from the mudstone were subjected to pH and water-soluble sulphate determinations. A summary of the results is included in Table 6.8.

Table 6.8 BRE Suite Test Results in reference to BRE SD1

Strata	No. Tests	pH	Sulphate Aqueous Extract as SO ₄ (mg/l)		Acid Soluble Sulphate (%)	Concrete Class Classification
			Range	Characteristic value		
Made Ground	10	6.7 to 10.3	40 to 974	796	0.04 to 1.16	DS-2 AC-2
Glacial Deposits	7	7.1 to 8.4	20 to 61	58	0.01 to 0.03	DS-1 AC-1
Mudstone	3	8.0 to 8.4	63 to 77	72	0.02 to 0.04	DS-1 AC-1

²¹ BS 5930:2015+A1:2020 Code of practice for ground investigations

- 6.6.2 The samples were also subjected to total sulphur and acid soluble sulphate content testing to allow an assessment to be made in relation to the potential thaumasite form of concrete attack. A summary of the results is included in the Table 6.9.

Table 6.9 Modified Concrete Class Classification in reference to BRE Digest SD1

Strata	No. Tests	Total Potential Sulphates (%)		Oxidisable Sulfides (%)	Modified Concrete Class Classification
		Range	Characteristic value		
Made Ground	10	0.09 to 1.08	0.87	0.00 to 0.78	DS-3 AC-3
Glacial Deposits	7	0.03 to 0.27	0.15	0.00 to 0.24	No modification required
Mudstone	3	0.06 to 0.09	0.09	0.02 to 0.07	No modification required

- 6.6.3 Seven groundwater samples were also tested for pH and sulphate as SO₄ concentrations. The results recorded pHs of 7.2 to 7.6 and SO₄ concentrations of 6mg/l to 180mg/l.

6.7 Groundwater Conditions

- 6.7.1 Groundwater observations during the field work and the subsequent monitoring are described in Section 5.0 and are summarised in Table 5.2.

- 6.7.2 Groundwater seepages were recorded near the surface across the area of the historical pond within the hand dug pits (HP111, HP113 to HP115 and HP117W/E) and the soakaway locations (SA101 and SA102). Photos of this area of site show the ground to be waterlogged. This may in part be due to the possible presence of a historical pond liner preventing infiltration into the ground although, no clear evidence of a pond liner was identified in the available log records.

- 6.7.3 The groundwater monitoring results suggest that, beyond the pond area, perched groundwater is present near the contact between the Made Ground and underlying Glacial Deposits. Generally, the perched water appears to lie at approximately 84.50m to 85.50m OD with local pockets of water up to 86m to 87m OD within WS05 and WS06.

- 6.7.4 Deeper groundwater, within the Glacial Deposits, lies at approximately 82m to 84m OD across the western half of site.

6.8 Permeability

- 6.8.1 Two infiltration tests were due to be undertaken in SA1 and SA2. Due to ingress of groundwater at the surface the tests were not able to be carried out.

7.0 GENERIC QUANTITATIVE RISK ASSESSMENT

7.1 Assessment Framework

7.1.1 In order to assess the risk to the identified human, controlled water and gas risk receptors the collected data have been compared against generic screening values. The guidance used to / select or calculate these values is provided in the Environmental Risk Assessment section at the rear of the report text.

7.2 Soil

7.2.1 The generic risk assessment incorporates the soil chemical data from both the enabling works ground investigation and the preliminary ground investigation conducted by CampbellReith in 2022 [4].

7.2.2 With respect to risk to end users, the soil screening values for a residential with plant uptake end use, as defined in Environment Agency Guidance SR3²², have been selected based upon the proposed mixed-use commercial and residential development which will likely include residential properties with private gardens. The assessment assumes a Soil Organic Matter (SOM) content of 6% based on average site derived SOM data from the Made Ground of 11.03%.

7.2.3 The results have been reviewed for evidence of potential zoning across the site and/or between the various soil strata, rather than screening the site in its entirety. As a consequence, the statistical assessment has treated the site as two separate Zones. Zone A incorporates the general Made Ground materials sampled from across the of the pyramid park site. Zone B incorporates the Made Ground materials sampled from within the pyramid structures. . As reprofiling of soils is anticipated as part of the site enabling works and given the raised nature of the pyramid structures, the assessment has included all samplings including those collected from >1.0m depth where Made Ground was encountered. Additional tables are presented where appropriate to reflect distinct ground characteristics relevant to the conceptual model.

7.2.4 The results were compared against the screening values and are summarised in Table 7.1. The statistical assessment methodology is based on CL:AIRE's Professional Guidance²³, as detailed in the Environmental Risk Assessment section to the rear of this report. In summary, the 95% Upper Confidence Limit (95% UCL) of the mean concentration of the sample population/s has been calculated where there were exceedances of the screening value. Where the 95%UCL exceeds the screening values, these results are highlighted and discussed. The remainder are not considered indicative of significant contamination for the proposed end use and are not discussed further. Where there are suspected outliers and this is interpreted to be localised contamination (i.e. 'hotspot'), then these were treated as a separate sample zone.

²² Environment Agency, Updated Technical Background to the CLEA Model, Science Report: SC050021/SR3, 2009

²³ CL:AIRE Comparing Soil Contamination Data with a Critical Concentration (v1.1 February 2021)

General Made Ground

Table 7.1 Summary of Soil Analysis Table Zone A – General Made Ground

Contaminant	Units	Exceeding	Max	95% UCL	GAC
Metals & Inorganics					
Arsenic	mg/kg	0 / 33	37	14.5	37 ^B
Boron	mg/kg	0 / 33	6	-	530 ^A
Beryllium	mg/kg	3 / 33	5.1	1.24	1.7 ^A
Cadmium	mg/kg	0 / 33	1	-	22 ^B
Chromium	mg/kg	0 / 33	880	-	910 ^A
Chromium - Hexavalent	mg/kg	0 / 32	<1	-	21 ^B
Copper	mg/kg	0 / 33	490	-	2900 ^A
Lead	mg/kg	1 / 33	240	72.4	200 ^B
Mercury	mg/kg	0 / 33	0.29	-	42 ^A
Nickel	mg/kg	0 / 33	82	-	140 ^A
Selenium	mg/kg	0 / 32	1.5	-	270 ^A
Vanadium	mg/kg	0 / 33	450	-	480 ^A
Zinc	mg/kg	0 / 33	400	-	4800 ^A
Cyanide	mg/kg	0 / 33	1.3	-	24 ^C
Total Petroleum Hydrocarbons					
EPH >C10-12	mg/kg	0 / 32	57	-	420 ^A
EPH >C12-16	mg/kg	0 / 33	360	-	710 ^A
EPH >C16-21	mg/kg	1 / 33	1200	162	980 ^A
EPH/TPH >C21-36	mg/kg	1 / 23	2100	385	1700 ^A
EPH/TPH >C36-40	mg/kg	0 / 23	150	-	1700 ^A
Aliphatics >C5-6	mg/kg	0 / 3	<0.01	-	160 ^A
Aliphatics >C6-8	mg/kg	0 / 3	<0.01	-	530 ^A
Aliphatics >C8-10	mg/kg	0 / 3	<0.01	-	150 ^A
Aliphatics >C10-12	mg/kg	0 / 3	5.1	-	760 ^A
Aliphatics >C12-16	mg/kg	0 / 3	42	-	4300 ^A
Aliphatics >C16-21	mg/kg	0 / 3	110	-	110000 ^A
Aliphatics >C21-35	mg/kg	0 / 3	31	-	110000 ^A
Aliphatics >C35-44	mg/kg	0 / 3	<3.4	-	110000 ^A
Aliphatics >C10-35	mg/kg	- / 3	180	-	n/a
Aromatics >C5-7	mg/kg	0 / 3	<0.01	-	350 ^A
Aromatics >C7-8	mg/kg	0 / 3	<0.01	-	790 ^A
Aromatics >C8-10	mg/kg	0 / 3	<0.01	-	200 ^A
Aromatics >C10-12	mg/kg	0 / 3	<0.9	-	420 ^A
Aromatics >C12-16	mg/kg	0 / 3	11	-	710 ^A
Aromatics >C16-21	mg/kg	0 / 3	50	-	980 ^A
Aromatics >C21-35	mg/kg	0 / 3	60	-	1700 ^A
Aromatics >C35-44	mg/kg	0 / 3	<1.4	-	1700 ^A
BTEX					
Benzene	mg/kg	0 / 4	<0.1	-	0.87 ^B
Toluene	mg/kg	0 / 4	<0.1	-	790 ^A
Ethylbenzene	mg/kg	0 / 4	<0.1	-	280 ^A
m,p xylenes	mg/kg	0 / 1	<0.01	-	320 ^A
O-Xylene	mg/kg	0 / 1	<0.01	-	350 ^A
Xylene (Total)	mg/kg	0 / 3	<0.1	-	320 ^A
Methyl tert-butyl ether	mg/kg	0 / 1	<0.01	-	220 ^D
Polycyclic Aromatic Hydrocarbons					
Naphthalene	mg/kg	0 / 35	5	-	13 ^A
Acenaphthylene	mg/kg	0 / 33	0.2	-	1000 ^A
Acenaphthene	mg/kg	0 / 34	12	-	1200 ^A
Fluorene	mg/kg	0 / 34	20	-	930 ^A
Phenanthrene	mg/kg	0 / 34	29	-	470 ^A
Anthracene	mg/kg	0 / 34	6.5	-	11000 ^A

Contaminant	Units	Exceeding	Max	95% UCL	GAC
Fluoranthene	mg/kg	0 / 34	19	-	930 ^A
Pyrene	mg/kg	0 / 34	19	-	2100 ^A
Benzo (a) anthracene	mg/kg	0 / 34	5.4	-	13 ^A
Chrysene	mg/kg	0 / 34	5.7	-	27 ^A
Benzo (b) fluoranthene	mg/kg	1 / 34	5.6	0.973	3.7 ^A
Benzo (k) fluoranthene	mg/kg	0 / 34	2	-	100 ^A
Benzo (a) pyrene	mg/kg	0 / 34	4.8	-	5 ^B
Indeno (1,2,3 - cd) pyrene	mg/kg	0 / 34	1.4	-	42 ^A
Dibenzo (ah) anthracene	mg/kg	1 / 34	0.47	0.0923	0.31 ^A
Benzo (ghi) perylene	mg/kg	0 / 34	2	-	350 ^A
Speciated Phenols					
Phenol	mg/kg	0 / 11	<0.5	-	430 ^A
2,4 - Dimethylphenol	mg/kg	0 / 1	<0.1	-	120 ^D
2-Chlorophenol	mg/kg	0 / 1	<0.1	-	14 ^A
Phenol (Monohydric)	mg/kg	0 / 23	0.9	-	430 ^A
Other Organics					
Bromodichloromethane	mg/kg	0 / 1	<0.01	-	0.084 ^D
Tribromomethane	mg/kg	0 / 1	<0.01	-	17 ^D
Carbon tetrachloride	mg/kg	0 / 1	<0.01	-	2 ^A
Vinyl chloride	mg/kg	0 / 1	<0.01	-	0.017 ^B
cis 1,2 - Dichloroethene	mg/kg	0 / 1	<0.01	-	0.52 ^D
Trans - 1,2 - Dichloroethene	mg/kg	0 / 1	<0.01	-	0.99 ^D
1,1 - Dichloroethane	mg/kg	0 / 1	<0.01	-	11 ^D
1,1 - Dichloroethene	mg/kg	0 / 1	<0.01	-	1.2 ^D
Trichloroethene	mg/kg	0 / 1	<0.01	-	0.043 ^B
1,1,2 - Trichloroethane	mg/kg	0 / 1	<0.01	-	3.7 ^D
Tetrachloroethene	mg/kg	0 / 1	<0.01	-	1.6 ^B
1,2,4 - Trimethylbenzene	mg/kg	0 / 1	<0.01	-	2.8 ^D
1,2 - Dichloropropane	mg/kg	0 / 1	<0.01	-	0.12 ^D
Styrene	mg/kg	0 / 1	<0.01	-	55 ^D
iso - Propylbenzene	mg/kg	0 / 1	<0.01	-	89 ^D
n-propylbenzene	mg/kg	0 / 1	<0.01	-	270 ^D
2 - Chloronaphthalene	mg/kg	0 / 1	<0.1	-	31 ^D
2,4 - Dinitrotoluene	mg/kg	0 / 1	<0.1	-	8.7 ^D
2,6 - Dinitrotoluene	mg/kg	0 / 1	<0.1	-	4.8 ^D
Bromobenzene	mg/kg	0 / 1	<0.01	-	6.6 ^D
Butyl benzyl phthalate	mg/kg	0 / 1	<0.1	-	8200 ^D
Diethyl phthalate	mg/kg	0 / 1	<0.1	-	700 ^D
1,2,4-Trichlorobenzene	mg/kg	0 / 2	<0.1	-	15 ^A
1,2-Dichlorobenzene	mg/kg	0 / 1	<0.01	-	130 ^A
1,3-Dichlorobenzene	mg/kg	0 / 1	<0.01	-	2.5 ^A
1,4-Dichlorobenzene	mg/kg	0 / 1	<0.01	-	350 ^A
2,4,6-Trichlorophenol	mg/kg	0 / 1	<0.1	-	39 ^A
2,4-Dichlorophenol	mg/kg	0 / 1	<0.1	-	31 ^A
Di-n-butyl phthalate	mg/kg	0 / 1	<0.1	-	76 ^D
Hexachlorobenzene (HCB)	mg/kg	0 / 1	<0.1	-	5.6 ^A
Hexachlorobutadiene (HCBd)	mg/kg	0 / 1	<0.01	-	1.9 ^A
Miscellaneous					
1,2,3 Trichlorobenzene	mg/kg	0 / 1	<0.01	-	8.8 ^A
1,2-Dichloroethane	mg/kg	0 / 1	<0.01	-	0.31 ^B
2,3,4,6-Tetrachlorophenol	mg/kg	0 / 1	<0.1	-	75 ^A
bis (2 - ethylhexyl) phthalate	mg/kg	0 / 1	<0.1	-	1400 ^D
Chlorobenzene	mg/kg	0 / 1	<0.01	-	2.4 ^A
Chloroform	mg/kg	0 / 1	<0.01	-	4.2 ^A
Di - n - octyl phthalate	mg/kg	0 / 1	<0.1	-	4300 ^D
Pentachlorophenol (PCP)	mg/kg	0 / 1	<0.1	-	14 ^A

Residential with Plant Uptake assuming 6.0% SOM Generic Assessment Criteria (GAC)

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^B Defra Category 4 Screening Levels (C4SLs)

^C Acute Risk GAC (SoBRA derived)

^D GAC derived using CLEA v1.071

^E GAC derived using CLEA v1.071 and SGV report spreadsheet

- 7.2.5 Statistical assessment indicates that there are no identified outliers within the general Made Ground dataset.

Metals and Inorganics

- 7.2.6 Exceedances of beryllium have been identified in a total of 3 no. samples of the general Made Ground retrieved from BH107, located on the access road, and TP116A and TP123 which are located within the southern edge of the former pond area and in close proximity to the northern boundary, respectively.

- 7.2.7 A single exceedance of lead was also encountered in TP110 at 0.20m bgl which is located to the north of the former pond in close proximity to the northern site boundary.

- 7.2.8 For both lead and beryllium, the calculated 95% UCL are below the relevant GAC and are therefore not indicative of widespread contamination requiring further consideration.

Polycyclic Aromatic Hydrocarbons (PAH)

- 7.2.9 Elevated concentrations of PAH compounds benzo(b)fluoranthene and dibenzo(ah)anthracene was recorded in the sample of Made Ground collected from TP110 at 0.20m. The calculated 95% UCL was below the relevant GAC for both compounds, therefore no further consideration is required.

Petroleum Hydrocarbons (TPH)

- 7.2.10 Exceedances of TPH fractions EPH >C16-21 and EPH/TPH >C21-36 have been recorded in BH101 at 0.5m bgl which is located adjacent to the pyramid structures and within the general area of the former good sheds. Again, the calculated 95% UCL was below the corresponding GAC and therefore has not been considered further.

Summary – General Made Ground

- 7.2.11 Based on the current masterplan, none of the contaminant exceedances are located within the proposed soft landscaped areas or private gardens, therefore the risk of direct exposure to end users is minimised. Additionally, there is proposed to be a programme of site enabling works prior to final development. It is anticipated that cover soils will be required in landscaped areas and for private gardens however, these will not be installed as part of the enabling works.

Pyramid Structures

Table 7.2 Summary of Soil Analysis Zone B - Pyramid Structures

Contaminant	Units	Exceeding	Max	95% UCL	GAC
Metals & Inorganics					
Arsenic	mg/kg	0 / 20	27	-	37 ^B
Boron	mg/kg	0 / 20	1.3	-	530 ^A
Beryllium	mg/kg	1 / 20	2.9	1.09	1.7 ^A
Cadmium	mg/kg	0 / 20	0.9	-	22 ^B
Chromium	mg/kg	0 / 20	32	-	910 ^A
Chromium - Hexavalent	mg/kg	0 / 20	<1	-	21 ^B
Copper	mg/kg	0 / 20	390	-	2900 ^A
Lead	mg/kg	1 / 20	850	167	200 ^B
Mercury	mg/kg	0 / 20	0.24	-	42 ^A
Nickel	mg/kg	0 / 20	42	-	140 ^A
Selenium	mg/kg	0 / 20	<0.5	-	270 ^A
Vanadium	mg/kg	0 / 20	75	-	480 ^A
Zinc	mg/kg	0 / 20	260	-	4800 ^A
Cyanide	mg/kg	0 / 20	1.4	-	24 ^C
Total Petroleum Hydrocarbons					
EPH >C10-12	mg/kg	0 / 20	39	-	420 ^A
EPH >C12-16	mg/kg	0 / 20	320	-	710 ^A
EPH >C16-21	mg/kg	2 / 20	1600	348	980 ^A
EPH/TPH >C21-36	mg/kg	2 / 17	3100	834	1700 ^A
EPH/TPH >C36-40	mg/kg	0 / 17	190	-	1700 ^A
Aliphatics >C5-6	mg/kg	0 / 4	<0.01	-	160 ^A
Aliphatics >C6-8	mg/kg	0 / 4	<0.01	-	530 ^A
Aliphatics >C8-10	mg/kg	0 / 4	<0.01	-	150 ^A
Aliphatics >C10-12	mg/kg	0 / 4	<1.5	-	760 ^A
Aliphatics >C12-16	mg/kg	0 / 4	<1.2	-	4300 ^A
Aliphatics >C16-21	mg/kg	0 / 4	6.9	-	110000 ^A
Aliphatics >C21-35	mg/kg	0 / 4	68	-	110000 ^A
Aliphatics >C35-44	mg/kg	0 / 3	<3.4	-	110000 ^A
Aliphatics >C5-35	mg/kg	0 / 1	75	-	150 ^A
Aromatics >C5-7	mg/kg	0 / 4	<0.01	-	350 ^A
Aromatics >C7-8	mg/kg	0 / 4	<0.01	-	790 ^A
Aromatics >C8-10	mg/kg	0 / 4	<0.01	-	200 ^A
Aromatics >C10-12	mg/kg	0 / 4	18	-	420 ^A
Aromatics >C12-16	mg/kg	0 / 4	32	-	710 ^A
Aromatics >C16-21	mg/kg	0 / 4	90	-	980 ^A
Aromatics >C21-35	mg/kg	0 / 4	160	-	1700 ^A
Aromatics >C35-44	mg/kg	0 / 3	<1.4	-	1700 ^A
BTEX					
Benzene	mg/kg	0 / 5	<0.01	-	0.87 ^B
Toluene	mg/kg	0 / 5	<0.01	-	790 ^A
Ethylbenzene	mg/kg	0 / 5	<0.01	-	280 ^A
m,p xylenes	mg/kg	0 / 1	<0.01	-	320 ^A
O-Xylene	mg/kg	0 / 1	<0.01	-	350 ^A
Xylene (Total)	mg/kg	0 / 4	<0.01	-	320 ^A

Contaminant	Units	Exceeding	Max	95% UCL	GAC
Methyl tert-butyl ether	mg/kg	0 / 1	<0.01	-	220 ^D
Polycyclic Aromatic Hydrocarbons					
Naphthalene	mg/kg	0 / 22	2.4	-	13 ^A
Acenaphthylene	mg/kg	0 / 21	0.1	-	1000 ^A
Acenaphthene	mg/kg	0 / 21	7.1	-	1200 ^A
Fluorene	mg/kg	0 / 21	3.9	-	930 ^A
Phenanthrene	mg/kg	0 / 21	23	-	470 ^A
Anthracene	mg/kg	0 / 21	5.2	-	11000 ^A
Fluoranthene	mg/kg	0 / 21	48	-	930 ^A
Pyrene	mg/kg	0 / 21	39	-	2100 ^A
Benzo (a) anthracene	mg/kg	0 / 21	10	-	13 ^A
Chrysene	mg/kg	0 / 21	9.2	-	27 ^A
Benzo (b) fluoranthene	mg/kg	4 / 21	10	2.64	3.7 ^A
Benzo (k) fluoranthene	mg/kg	0 / 21	3.1	-	100 ^A
Benzo (a) pyrene	mg/kg	3 / 21	7.9	2.1	5 ^B
Indeno (1,2,3 - cd) pyrene	mg/kg	0 / 21	2.8	-	42 ^A
Dibenzo (ah) anthracene	mg/kg	3 / 21	1	0.235	0.31 ^A
Benzo (ghi) perylene	mg/kg	0 / 21	3.4	-	350 ^A
Speciated Phenols					
Phenol	mg/kg	0 / 4	<0.5	-	430 ^A
2,4 - Dimethylphenol	mg/kg	0 / 1	<0.1	-	120 ^D
2-Chlorophenol	mg/kg	0 / 1	<0.1	-	14 ^A
Phenol (Monohydric)	mg/kg	0 / 17	2.2	-	430 ^A
Other Organics					
Bromodichloromethane	mg/kg	0 / 1	<0.01	-	0.084 ^D
Tribromomethane	mg/kg	0 / 1	<0.01	-	17 ^D
Carbon tetrachloride	mg/kg	0 / 1	<0.01	-	2 ^A
Vinyl chloride	mg/kg	0 / 1	<0.01	-	0.017 ^B
cis 1,2 - Dichloroethene	mg/kg	0 / 1	<0.01	-	0.52 ^D
Trans - 1,2 - Dichloroethene	mg/kg	0 / 1	<0.01	-	0.99 ^D
1,1 - Dichloroethane	mg/kg	0 / 1	<0.01	-	11 ^D
1,1 - Dichloroethene	mg/kg	0 / 1	<0.01	-	1.2 ^D
Trichloroethene	mg/kg	0 / 1	<0.01	-	0.043 ^B
1,1,2 - Trichloroethane	mg/kg	0 / 1	<0.01	-	3.7 ^D
Tetrachloroethene	mg/kg	0 / 1	<0.01	-	1.6 ^B
1,2,4 - Trimethylbenzene	mg/kg	0 / 1	<0.01	-	2.8 ^D
1,2 - Dichloropropane	mg/kg	0 / 1	<0.01	-	0.12 ^D
Styrene	mg/kg	0 / 1	<0.01	-	55 ^D
iso - Propylbenzene	mg/kg	0 / 1	<0.01	-	89 ^D
n-propylbenzene	mg/kg	0 / 1	<0.01	-	270 ^D
2 - Chloronaphthalene	mg/kg	0 / 1	<0.1	-	31 ^D
2,4 - Dinitrotoluene	mg/kg	0 / 1	<0.1	-	8.7 ^D
2,6 - Dinitrotoluene	mg/kg	0 / 1	<0.1	-	4.8 ^D
Bromobenzene	mg/kg	0 / 1	<0.01	-	6.6 ^D
Butyl benzyl phthalate	mg/kg	0 / 1	<0.1	-	8200 ^D
Diethyl phthalate	mg/kg	0 / 1	<0.1	-	700 ^D
1,2,4-Trichlorobenzene	mg/kg	0 / 2	<0.1	-	15 ^A
1,2-Dichlorobenzene	mg/kg	0 / 1	<0.01	-	130 ^A

Contaminant	Units	Exceeding	Max	95% UCL	GAC
1,3-Dichlorobenzene	mg/kg	0 / 1	<0.01	-	2.5 ^A
1,4-Dichlorobenzene	mg/kg	0 / 1	<0.01	-	350 ^A
2,4,6-Trichlorophenol	mg/kg	0 / 1	<0.1	-	39 ^A
2,4-Dichlorophenol	mg/kg	0 / 1	<0.1	-	31 ^A
Di-n-butyl phthalate	mg/kg	0 / 1	<0.1	-	76 ^D
Hexachlorobenzene (HCB)	mg/kg	0 / 1	<0.1	-	5.6 ^A
Hexachlorobutadiene (HCBd)	mg/kg	0 / 1	<0.01	-	1.9 ^A
Miscellaneous					
1,2,3 Trichlorobenzene	mg/kg	0 / 1	<0.01	-	8.8 ^A
1,2-Dichloroethane	mg/kg	0 / 1	<0.01	-	0.31 ^B
2,3,4,6-Tetrachlorophenol	mg/kg	0 / 1	<0.1	-	75 ^A
bis (2 - ethylhexyl) phthalate	mg/kg	0 / 1	<0.1	-	1400 ^D
Chlorobenzene	mg/kg	0 / 1	<0.01	-	2.4 ^A
Chloroform	mg/kg	0 / 1	<0.01	-	4.2 ^A
Di - n - octyl phthalate	mg/kg	0 / 1	<0.1	-	4300 ^D
Pentachlorophenol (PCP)	mg/kg	0 / 1	<0.1	-	14 ^A

Residential with Plant Uptake assuming 6.0% SOM Generic Assessment Criteria (GAC)

^A LQM/CIEH Suitable for use Levels (S4UL). Copyright Land Quality Management Limited reproduced with permission; Publication Number S4UL 3036. All rights reserved. Top two consumption group applied.

^B Defra Category 4 Screening Levels (C4SLs)

^C Acute Risk GAC (SoBRA derived)

^D GAC derived using CLEA v1.071

^E GAC derived using CLEA v1.071 and SGV report spreadsheet

- 7.2.12 Statistical assessment indicates that there are no outliers within the soil dataset from the pyramid structures.

Metals and Inorganics

- 7.2.13 From the samples collected from the pyramid structures, a single exceedance of beryllium has been recorded in TP108 at 0.2m bgl and a single exceedance of lead was recorded in TP107 at 3.3m bgl. The Calculated 95% UCL for both beryllium and lead were below the corresponding GAC and are therefore not considered further.

Polycyclic Aromatic Hydrocarbons (PAH)

- 7.2.14 The concentration of PAH compounds benzo(a)pyrene and dibenzo(ah)anthracene have been recorded above GAC in 3 no. soil samples and benzo(b)fluoranthene was elevated in a total of 4 no. soil samples collected from the pyramids. All calculated 95% UCL concentrations are below the corresponding GAC.

Petroleum Hydrocarbons

- 7.2.15 Exceedances of EPH >C16-21 and EPH/TPH >C21-36 have been identified in TP108 at 0.2m bgl and in TP107 at 3.3m bgl. Again, calculated 95% UCL concentrations for TPH fractions were all below GAC and are therefore not considered to be representative of significant risk.

Summary – Pyramid Structures

- 7.2.16** A total of 20 no. samples of soil were retrieved from the pyramid structures and screened for the general suite of contaminants. The volume of material within the pyramid structures, based on topographical information is approximately 6,000m³. Therefore, this equates to approximately 1 no. sample tested for every 300m³ of material within the pyramids, which is considered to present a reliable and representative dataset for the purpose of the soil screening exercise.
- 7.2.17** Typically, the chemical composition of the materials tested in the pyramids is similar to that of the General Made Ground tested from across the site.
- 7.2.18** The samples retrieved from the pyramid structures during the preliminary ground investigation (TP02 and TP03), showed no recorded exceedances when compared to the soil screening values. The soil samples retrieved from the pyramid structures during this enabling works ground investigation show no recorded exceedances of phenols, volatile organic compounds and semi-volatile organic compounds when compared to the soil screening values.
- 7.2.19** Based on the chemical test results, it is anticipated that the soils from the pyramid structures, following processing and/or treatment, will generally be suitable for use as general fill beneath roads, buildings and in landscaped areas under suitable cover.

7.3 Asbestos

- 7.3.1** It is noted that there are no UK generic quantitative assessment criteria for asbestos in soils. A summary of the results for asbestos is presented below. Additional guidance on this topic is presented in CIRIA C733²⁴.
- 7.3.2** A total of 8 no. samples of Made Ground soils were screened for the presence of asbestos as part of the preliminary ground investigation, however no asbestos was positively identified.
- 7.3.3** A further 18 no. samples were screened for the presence of asbestos during the recent ground investigation, with positive identification recorded in 8 no. samples. Subsequently, the positive samples were subjected to more detailed quantification analysis.
- 7.3.4** It should be noted that suspected asbestos containing materials were not encountered during any of the intrusive works.
- 7.3.5** A summary of the results for asbestos is presented in Table 6.3.

Table 6.3: Asbestos analysis results

Exploratory Hole	Depth (m bgl)	Asbestos Analysts Comments	Concentrations (% w/w)
TP102	0.60 – 0.90	Chrysotile bundles	<0.001
TP107	1.50 – 1.70	Chrysotile present as fibre bundles	0.002
TP108	0.20 – 0.40	Chrysotile present as fibre bundles	<0.001
TP121	2.00 – 2.30	Chrysotile present as fibre bundles	<0.001

²⁴ CIRIA - Asbestos in soil and made ground: a guide to understanding and managing risks, March 2014

Exploratory Hole	Depth (m bgl)	Asbestos Analysts Comments	Concentrations (% w/w)
TP121	3.80 – 4.00	Chrysotile present as fibre bundles	<0.001
BH102	0.50	Microscopic bundle of amosite	0.009
BH103	0.50	Bundle of amosite	0.005
BH107	0.30 – 1.20	Chrysotile present as fibre bundles	<0.001

7.3.6 Asbestos in the form of fibre bundles of amosite or chrysotile were recorded in the 8 no. samples of the variable Made Ground. Quantification analysis was undertaken on all positive samples with the recorded concentration of asbestos within these samples ranging from <0.001% to 0.009%.

7.3.7 It should be noted that the majority of the positive samples recorded concentrations <0.001% which is the limit of detection for quantification. However, the soil sample from TP107 (1.50-1.70m bgl), located on one of the pyramids, recorded a concentration of 0.002% and samples of General Made Ground from BH102 (0.50m bgl) and BH103 (0.50m bgl) recorded amosite concentrations of 0.009% and 0.005%, respectively.

7.3.8 Where asbestos was detected in soils from the pyramid structures, asbestos concentrations ranged from <0.001% to 0.002% and comprised only chrysotile.

7.3.9 Due to the occurrence of asbestos in the shallow Made Ground soils, this presents a risk to ground workers during the proposed enabling works and future site redevelopment. Any excavation works, or works that will disturb the Made Ground soils, has the potential to release asbestos fibres into the air which can then be breathed in.

7.3.10 As such, all works that will disturb the Made Ground should be undertaken in line with the requirements of the Control of Asbestos Regulations, 2012 (CAR, 2012), in accordance with the associated Approved Code of Practice (ACoP), as well as guidance prepared by CL:AIRE, the Joint Industry Working Group (JIWG) and CIRIA.

7.3.11 Practical measures such as dust suppression, wetting and reassurance air monitoring for dust and asbestos in air are recommended as minimum provisions during groundworks involving sustained periods of disturbance of the Made Ground. The moisture content of the Made Ground soils being worked is a major consideration in terms of dust and potential fibre generation and therefore simple and practical measures to avoid dust should be substantially effective in minimising the risk of asbestos release to air.

7.4 Controlled Waters

7.4.1 A controlled water risk assessment has been undertaken using as available Drinking Water Standards (DWS). The nearest surface water feature is the River Irwell, located 700m to the west. Therefore, EQS values were not used in this assessment as the risk to surface waters is considered negligible.

- 7.4.2 The site is not located within 1km of a source protection zone or groundwater abstraction license. The site is considered to have moderate sensitivity with respect to hydrogeology primarily due to the underlying Secondary A aquifers.
- 7.4.3 Groundwater samples were obtained from borehole locations BH101 to BH106 and BH108 on 24th January 2024. The installations were screened within the Glacial Till deposits and the Pennine Lower Coal Measures bedrock. No groundwater samples were retrieved during the preliminary ground investigation.
- 7.4.4 No hydrocarbon odours were noted during the groundwater monitoring and there was no evidence of free phase product in the samples retrieved.
- 7.4.5 The statistics associated with groundwater analysis are summarised in Table 7.4.

Table 7.3 Summary of Water Analysis

Contaminant	Units	Exceeding	Max	Mean	GAC
Metals & Inorganics					
Arsenic	ug/l	0/ 7	8.9	-	10 ^{w*}
Boron	ug/l	0/ 7	92	-	1000 ^w
Cadmium	ug/l	0/ 7	0.2	-	5 ^w
Chromium	ug/l	0/ 7	0.85	-	50 ^w
Chromium - Hexavalent	ug/l	- / 7	<7	-	n/a
Copper	ug/l	0/ 7	5.2	-	2000 ^w
Lead	ug/l	0/ 7	0.29	-	10 ^{w*}
Mercury	ug/l	0/ 7	<0.01	-	1 ^{w*}
Nickel	ug/l	0/ 7	6.7	-	20 ^w
Selenium	ug/l	0/ 7	0.97	-	10 ^w
Zinc	ug/l	0/ 7	100	-	3000 ^x
Cyanide	ug/l	0/ 7	1	-	50 ^w
Cyanide Free	ug/l	- / 7	1.1	-	n/a
Thiocyanate	ug/l	- / 7	35	-	n/a
Sulphate as SO4	ug/l	0/ 7	180000	-	250000 ^w
Sulphide	ug/l	- / 7	80	-	n/a
Total Petroleum Hydrocarbons					
EPH >C10-40	ug/l	- / 7	670	-	n/a
Aliphatics >C5-6	ug/l	0/ 4	<0.1	-	15000 ^y
Aliphatics >C6-8	ug/l	0/ 4	<0.1	-	15000 ^y
Aliphatics >C8-10	ug/l	0/ 4	<0.1	-	300 ^y
Aliphatics >C10-12	ug/l	0/ 4	<1	-	300 ^y
Aliphatics >C12-16	ug/l	0/ 4	<1	-	300 ^y
Aliphatics >C16-21	ug/l	0/ 4	<1	-	100 ^x
Aliphatics >C21-35	ug/l	0/ 4	<1	-	100 ^x
Aliphatics >C5-35	ug/l	0/ 4	<10	-	300 ^y
Aromatics >C5-7	ug/l	0/ 4	<0.1	-	10 ^y
Aromatics >C7-8	ug/l	0/ 4	<0.1	-	700 ^y
Aromatics >C8-10	ug/l	0/ 4	<0.1	-	300 ^y

Contaminant	Units	Exceeding	Max	Mean	GAC
Aromatics >C10-12	ug/l	0/ 4	<1	-	90 ^y
Aromatics >C12-16	ug/l	0/ 4	<1	-	90 ^y
Aromatics >C16-21	ug/l	0/ 4	<1	-	90 ^y
Aromatics >C21-35	ug/l	0/ 4	<1	-	90 ^y
BTEX					
Benzene	ug/l	0/ 2	<1	-	1 ^{w*}
Toluene	ug/l	0/ 2	<1	-	700 ^x
Ethylbenzene	ug/l	0/ 2	<1	-	300 ^{x*}
m,p xylenes	ug/l	0/ 1	<2	-	500 ^x
O-Xylene	ug/l	0/ 1	<1	-	500 ^x
Xylene (Total)	ug/l	0/ 1	<1	-	500 ^{x*}
Methyl tert-butyl ether	ug/l	0/ 1	<1	-	15 ^x
Polycyclic Aromatic Hydrocarbons					
Naphthalene	ug/l	- / 7	0.24	-	n/a
Acenaphthylene	ug/l	- / 7	<0.01	-	n/a
Acenaphthene	ug/l	- / 7	0.07	-	n/a
Fluorene	ug/l	- / 7	0.02	-	n/a
Phenanthrene	ug/l	- / 7	0.08	-	n/a
Anthracene	ug/l	- / 7	0.01	-	n/a
Fluoranthene	ug/l	- / 7	0.05	-	n/a
Pyrene	ug/l	- / 7	0.06	-	n/a
Benzo (a) anthracene	ug/l	- / 7	0.02	-	n/a
Chrysene	ug/l	- / 7	0.03	-	n/a
Benzo (b) fluoranthene	ug/l	0/ 7	0.03	-	0.1 ^{w*}
Benzo (k) fluoranthene	ug/l	0/ 7	0.02	-	0.1 ^{w*}
Benzo (a) pyrene	ug/l	1/ 7	0.02	0.01	0.01 ^{w*}
Indeno (1,2,3 - cd) pyrene	ug/l	0/ 7	0.03	-	0.1 ^{w*}
Dibenzo (ah) anthracene	ug/l	- / 7	<0.01	-	n/a
Benzo (ghi) perylene	ug/l	0/ 7	0.02	-	0.1 ^{w*}
Speciated Phenols					
Phenol	ug/l	0/ 2	<1	-	200 ^x
2,4 - Dimethylphenol	ug/l	- / 2	<1	-	n/a
Phenol (Monohydric)	ug/l	0/ 7	15	-	200 ^x
Organics					
Bromodichloromethane	ug/l	0/ 1	<4	-	100 ^w
Tribromomethane	ug/l	0/ 1	<1	-	100 ^w
Carbon tetrachloride	ug/l	0/ 1	<1	-	3 ^{w*}
Chloroethane	ug/l	- / 1	<1	-	n/a
Chloromethane	ug/l	- / 1	<1	-	n/a
Vinyl chloride	ug/l	1/ 1	<1	-	0.5 ^{w*}
cis 1,2 - Dichloroethene	ug/l	0/ 1	<1	-	50 ^x
Trans - 1,2 - Dichloroethene	ug/l	0/ 1	<1	-	100 ^y
1,1 - Dichloroethane	ug/l	- / 1	<1	-	n/a
1,1 - Dichloroethene	ug/l	- / 1	<1	-	n/a

Contaminant	Units	Exceeding	Max	Mean	GAC
Trichloroethene	ug/l	0/ 1	<1	-	10 ^{w*}
1,1,2 - Trichloroethane	ug/l	- / 1	<1	-	n/a
Tetrachloroethene	ug/l	0/ 1	<1	-	10 ^w
1,2,4 - Trimethylbenzene	ug/l	- / 1	<1	-	n/a
1,2 - Dichloropropane	ug/l	0/ 1	<1	-	40 ^{x*}
Styrene	ug/l	0/ 1	<1	-	20 ^{x*}
iso - Propylbenzene	ug/l	0/ 1	<1	-	4000 ^v
n-propylbenzene	ug/l	- / 1	<1	-	n/a
2 - Chloronaphthalene	ug/l	- / 1	<1	-	n/a
2,4 - Dinitrotoluene	ug/l	- / 1	<1	-	n/a
2,6 - Dinitrotoluene	ug/l	- / 1	<1	-	n/a
Bromobenzene	ug/l	- / 1	<1	-	n/a
Butyl benzyl phthalate	ug/l	- / 1	<1	-	n/a
Diethyl phthalate	ug/l	- / 1	<1	-	n/a
Di-n-butyl phthalate	ug/l	- / 1	<1	-	n/a
Pentachlorophenol (PCP)	ug/l	0/ 1	<1	-	9 ^{x*}
Other organics					
1,1,1,2 - Tetrachloroethane	ug/l	0/ 1	<1	-	400 ^v
1,1-Dichloropropene	ug/l	0/ 1	<1	-	20 ^x
1,2-Dichlorobenzene	ug/l	0/ 1	<1	-	1000 ^{x*}
1,2-Dichloroethane	ug/l	0/ 1	<1	-	3 ^w
1,3-Dichloropropane	ug/l	0/ 1	<1	-	20 ^{x*}
1,4-Dichlorobenzene	ug/l	0/ 1	<1	-	300 ^{x*}
2,4,6-Trichlorophenol	ug/l	0/ 2	<1	-	200 ^{x*}
Bis(2-ethylhexyl)adipate	ug/l	0/ 1	<1	-	80 ^x
bis (2 - ethylhexyl) phthalate	ug/l	0/ 1	<1	-	8 ^x
Chlorobenzene	ug/l	0/ 1	<1	-	10 ^x
Chloroform	ug/l	0/ 1	<1	-	100 ^{w*}
cis1,3-Dichloropropene	ug/l	0/ 1	<1	-	20 ^x
Dibromochloromethane	ug/l	0/ 1	<1	-	100 ^{w*}
Dichloromethane	ug/l	1/ 1	<27	-	20 ^x
Hexachlorobutadiene (HCBd)	ug/l	1/ 1	<1	-	0.6 ^{x*}
trans-1,3-Dichloropropene	ug/l	0/ 1	<1	-	20 ^x

n/a not available, '-' not calculated as fewer than 3 results or no exceedances.

Sources of Generic Assessment Criteria (GAC):

EQS - rivers and lakes

A - River Basin Districts Typology,
Standards and Groundwater threshold
values (WFD) (England & Wales)
Directions 2010

B - The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015

C - Supporting Guidance (WAT-SG-53), Environmental Quality Standards and Standards for Discharge to Surface
Waters. V6.1, SEPA, Feb 2018

D - Predicted No-Effect Concentration (Daphnia magna)

E - Predicted No-Effect Concentration (Pimephales promelas)

Contaminant	Units	Exceeding	Max	Mean	GAC
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* hazardous substance (according to Groundwater Directive 2006/118/EC)

assumes 100% bioavailability

DWS

w - The Water Supply (Water Quality) Regs, 2016

x - WHO Guidelines for Drinking Water Quality. Fourth Edition (2017)

y - Petroleum products in drinking water. World Health Organization (WHO), 2008.

z - EU drinking water standard, 2017/0332 (COD)

u - Guidance on Water Supply (Water Quality) Regs 2016 specific to PFOS and PFOA

v - US EPA Drinking Water Standard

GUIDANCE NOTES:

(i) Surface water drinking water abstraction is not included

(ii) Protection of shellfish is not included

(iii) Protection of salmon is not included (cyprinid fish only included)

7.4.6 All groundwater samples retrieved from this ground investigation show no recorded exceedances of metals, inorganics, petroleum hydrocarbons, BTEX compounds, phenols, volatile organic compounds and semi-volatile organic compounds when compared to the drinking water standards (DWS). However, an exceedance of benzo(a)pyrene was recorded in one groundwater sample, which is discussed further below.

7.4.7 It is noted that the LODs achieved for by the laboratory for VOC compounds vinyl chloride, dichloromethane and hexachlorobutadiene are slightly greater than the published DWS.

Polycyclic Aromatic Hydrocarbons

7.4.8 A single marginal exceedance of benzo(a)pyrene (0.02ug/l) was recorded in the groundwater sample retrieved from BH105 when compared to the DWS value.

7.4.9 The response zone for BH105 was placed in the Glacial Till deposits and no visual or olfactory evidence of contamination was noted in the corresponding soils or overlying Made Ground at this location. Additionally, elevated concentrations of benzo(a)pyrene were not identified in the Made Ground soils sampled from BH105 (0.05mg/kg BaP). No obvious contaminant source has been identified on-site, and therefore it could be a result of the overall poor water quality of the aquifer.

7.4.10 Given the absence of any nearby potable water abstractions and the low permeability of the Glacial Till beneath the site which will limit migration, the risk to controlled waters from benzo(a)pyrene is not considered significant.

7.5 Ground Gas

7.5.1 Following the intrusive investigation the potential sources of ground gas generation that could potentially affect the site have been assessed. These comprise:

- On-Site Sources: Ground gas generation is possible from Made Ground deposits and any areas of infill.
- Off-Site Sources: Several historical landfills are present within the vicinity of the site.

7.5.2 Gas at the site primarily presents a concern following ingress into confined spaces both during and after construction.

- 7.5.3** Made Ground was encountered across the majority of the site, with maximum depths ranging from 0.30m to 6.10m bgl. Analysis of the representative Made Ground samples recorded concentrations of total organic carbon (TOC) ranging from <0.5% to 27.0%, with an average recorded concentration of 6.4%. Organic materials such as ash, clinker and coal have been identified in the Made Ground soil which can give high TOC results that do not represent the risk of gas emissions from such material, as stated in CL:AIRE RB 17²⁵
- 7.5.4** Bury council has identified several landfill sites located within 250m of the site. This includes a landfill named as Peel College, Bury (Ref: C087) located adjacent to the south of the site and was noted to have been backfilled with unknown materials pre-licensing act (1974). Land to the west of the site is also noted to be a landfill (not identified as such within the Groundsure Report) (Ref: C078). Bury Council states that the land was filled with inert waste as part of a reclamation scheme in 1973. Based on the data and information summarised above the potential risk for ground gas generation is considered to be Low to Moderate. The monitoring data has been assessed to confirm this.
- 7.5.1** To date, six monitoring rounds have been conducted over the period of the two investigations. This comprised three visits to monitor ground gas in the window sample boreholes (WS01 to WS06) installed during the preliminary ground investigation, undertaken between the 3rd and 31st March 2022 and a further three visits to monitor ground gas in the cable percussive boreholes (BH101 to BH108), undertaken between 10th and 31st January 2024.
- 7.5.2** A worst-case Gas Screening Value (GSV) has been calculated for each monitoring location and these are presented in Table 7.5. These are based on credible worst-case concentrations and flows. Non-representative data not included in the calculations are discussed separately below the table. The data from both ground investigations has been included in the ground gas assessment.

Table 7.4 Summary Gas Screening Values

Borehole	Worst Case Concentration (%) and Flow (l/hr)			Gas Screening Value (l/hr)	
	CH ₄	CO ₂	Flow	CH ₄	CO ₂
BH101	<0.1	0.6	1.3	0.0013	0.0078
BH102	<0.1	2.7	<0.1	0.0001	0.0027
BH103	<0.1	3.0	5.5	0.0055	0.1650
BH104	0.1	2.3	0.7	0.0007	0.0161
BH106	0.1	0.7	4.8	0.0048	0.0336
BH107	<0.1	0.2	0.1	0.0001	0.0002
WS01	<0.1	0.5	<0.1	0.0001	0.0005
WS02	<0.1	0.4	<0.1	0.0001	0.0004
WS03	<0.1	4.4	<0.1	0.0001	0.0044
WS05	<0.1	6.4	0.1	0.0001	0.0064

²⁵ CL:AIRE Research Bulletin RB 17 (November 2023) ISSN 2047-6450 (online)

Borehole	Worst Case Concentration (%) and Flow (l/hr)			Gas Screening Value (l/hr)	
	CH ₄	CO ₂	Flow	CH ₄	CO ₂
WS06	<0.1	1.6	<0.1	0.0001	0.0016

All percentage figures are by measurement of volume. Concentrations and flows are based on steady state conditions + gas sample taken.

- 7.5.3 Due to the shallow groundwater levels encountered in BH105 and BH108 on all three monitoring visits, the response zones were completely submerged. As a result, maximum steady flow rates of 20.4 l/hr and 11.1 l/hr were recorded which are not considered to represent actual site conditions. Therefore, the gas screening values were not calculated at these locations.
- 7.5.4 Similarly, the deeper 33mm and 19mm monitoring wells installed in BH102, BH106 and BH107 had submerged response zones and therefore, were not used in the ground gas assessment.
- 7.5.5 The data presented are considered representative and appropriate for recommendations to be made regarding ground gas risk, however, it is noted that each set of monitoring instrumentation has only been monitored on three occasions each over the two investigations.
- 7.5.6 Steady-state gas flow rates were generally not recorded across the three rounds of gas monitoring in the preliminary ground investigation, with the single exception of WS05 on 3rd March 2022, where an average flow rate of 0.1 l/hr was recorded. However, flow rates above 0.1 l/hr were recorded in BH101, BH103, BH104, and BH106 during the monitoring in this enabling works ground investigation. A maximum steady flow rate of 5.5 l/hr was recorded in BH103 on the 31st January 2024. It should be noted that the elevated flow rates were sporadic over the three visits, with negative flow rates also recorded.
- 7.5.7 No detectable concentrations of methane were recorded across the three rounds of monitoring in the preliminary ground investigation. The maximum concentration of methane recorded in the three visits from this ground investigation was 0.1%, recorded in BH104 on 10th January 2024 and BH106 on 31st January 2024.
- 7.5.8 Elevated concentrations of carbon dioxide above 1.5% were recorded during the monitoring in WS03, WS05, and WS06 in the preliminary ground investigation and in BH102, BH103 and BH104 in this ground investigation. The maximum carbon dioxide concentration of 6.4% v/v was recorded in WS05 during the monitoring visit on the 31st March 2022.
- 7.5.9 Depressed oxygen concentrations of less than 18% v/v were recorded during the monitoring in WS03, WS05 and WS02 from the preliminary ground investigation and in BH101, BH103, BH104, and BH106 from this ground investigation. The lowest oxygen concentration of 2.8% v/v was recorded in WS05 during the monitoring visit on the 21st January 2022. Generally, the low oxygen concentrations corresponded to elevated carbon dioxide concentrations.
- 7.5.10 Carbon monoxide was detected at concentrations of 1.0ppm on 1 no. monitoring visit in WS01 and WS05 from the preliminary investigation, and in BH107 and BH106 during this ground investigation. The maximum carbon monoxide concentration was recorded in BH106 on 31st January 2024.

7.5.11 No detectable concentrations of hydrogen sulphide were detected at any of the monitoring locations across all six visits.

7.5.12 A worst-case Gas Screening Value (GSV) for the site has been calculated using the maximum recorded carbon dioxide concentration of 6.4% v/v and a flow rate of 5.5 l/hr which calculates a GSV of 0.352 l/hr.

Recommendations

7.5.13 Based upon the conceptual site model, as informed by the intrusive investigation and monitoring data, the site is currently considered to be representative of CIRIA Characteristic Situation 2 (low risk). This is mainly due to sporadic steady flow rates recorded during the enabling works ground investigation. Typically, flow rates were not recorded during monitoring of the installations fitted during the preliminary ground investigation, therefore, further gas monitoring is recommended to confirm the ground gas risk and appropriate mitigation measures following completion of the enabling works phase and based on final site development proposals.

7.5.14 Reference to Table 4 of BS8485:2015+A1:2019²⁶ presents a matrix of different building types against CIRIA Characteristic Situations that provides indicative scores for gas protection. The proposed development has not been finalised and masterplan options currently include a variety of mixed-use residential and commercial schemes. A worst-case Type A building is therefore assumed, as defined in Table 3 of BS8485:2015+A1:2019²⁷, the gas protection score required is 3.5.

7.5.15 Tables 5 - 7 of BS8485:2015+A1:2019²⁶, attribute a score for each gas protection measure proposed. As such, the following measures are appropriate to guard against potential risks arising from ground gas ingress through future building footprints:

- Passive sub floor dispersal layer (gas protection score 1.5)
- Gas resistant membrane (gas protection score 2)

7.5.16 Independent verification of the gas membrane installation must be carried out in accordance with the requirements detailed in CIRIA C735²⁷.

7.6 Volatile Organic Compounds

7.6.1 A photo ionisation detector (PID) was used to measure VOC concentrations in the ground gas installation during the visit on the 31st January 2024. Excluding the monitoring wells with groundwater in the response zones, the maximum VOC concentration recorded was 0.5ppm in BH104 and BH103 which are considered low risk.

²⁶ BS8485:2015+A1:2019 Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings

²⁷ CIRIA C735 Good practice on the testing and verification of protection systems for buildings against hazardous ground gases. 2014

8.0 WASTE SOILS

8.1 Hazardous Properties

8.1.1 A hazardous properties assessment (HPA) has been carried out in accordance with the current Environmental Agency technical guidance on classification of hazardous waste, WM3²⁸^{Error!} Bookmark not defined. The data have been assessed using the HazWasteOnline²⁹ waste classification tool and the outputs are included as Appendix 4. Asbestos is not included in the HPA and is discussed separately in Section 8.2.

8.1.2 In total, the HPA has been carried out for 13 no. samples collected from the Made Ground during the preliminary ground investigation. Of these, no samples have been identified as containing hazardous properties and thus would potentially be classified as hazardous waste.

8.1.3 In total, the HPA has been carried out for 39 no. samples from the Made Ground during this enabling works ground investigation. Of these, 5 no. samples have been identified as containing hazardous properties and thus would potentially be classified as hazardous waste. These are detailed in Table 8.1.

Table 8.1 Summary of Samples with Hazardous Properties

Exploratory Hole	Depth (m)	Hazardous Property	Contaminant
BH101	0.5	HP 3(i), HP 7, HP 11	TPH (C6 to C40) petroleum group
TP106	2.8	HP 3(i), HP 7, HP 11	TPH (C6 to C40) petroleum group
TP107	3.3	HP 3(i), HP 7, HP 11	TPH (C6 to C40) petroleum group
TP108	0.2	HP 3(i), HP 7, HP 11	TPH (C6 to C40) petroleum group
TP110	0.2	HP 3(i), HP 7, HP 11	TPH (C6 to C40) petroleum group

8.1.4 In addition, 21 no. samples were identified as 'potentially hazardous'; however, these are due to flammable liquid waste properties, which, given the nature of the materials (soils) is not considered to be appropriate. These assumptions should be confirmed with the receiving landfill.

8.2 Asbestos

8.2.1 Asbestos is not included in the HazWasteOnline²⁹ assessment. If the waste contains fibres that are free and dispersed, then the waste will be hazardous if the waste as a whole contains 0.1% or more asbestos. Also, if waste contains identifiable pieces of asbestos containing material (i.e. any particle of a size that can be identified as potentially being asbestos by a competent person if examined by the naked eye), then the waste is regarded as hazardous.

²⁸ <https://www.hazwasteonline.com/>

8.2.2 Asbestos was not visually identified during the intrusive investigations in all the exploratory holes installed. However, asbestos was identified in 8 no. out of 26 no. samples of the Made Ground scheduled for laboratory testing from both the preliminary and enabling works ground investigations by CampbellReith. These are detailed below:

- TP102 at 0.60 – 0.90m: Chrysotile – bundles, <0.001%
- TP121 at 2.00 – 2.30m: Chrysotile – fibre bundles, <0.001%
- TP121 at 3.80 – 2.30m: Chrysotile – fibre bundles, <0.001%
- TP107 at 1.50 – 1.70m: Chrysotile – fibre bundles, 0.002%
- BH107 at 0.30 – 1.20m: Chrysotile – fibre bundles, <0.001%
- TP108 at 0.20 – 0.40m: Chrysotile – fibre bundles, <0.001%
- BH102 at 0.50m: Amosite – microscopic bundle, 0.009%
- BH103 at 0.50m: Amosite – bundle, 0.005%

8.2.3 Quantification analysis was undertaken on the 8 no. samples found to contain asbestos. A total of 5 no. samples contained <0.001% chrysotile which is the limits of detection. However, 0.002% chrysotile was detected in the sample retrieved from TP107, 0.009% amosite was detected in the sample from BH102, and 0.005% amosite in the sample from BH103. The absence of any visual asbestos on site, and the quantification results suggest the Made Ground soils tested are not considered hazardous due to the presence of asbestos.

8.3 Waste Compliance: Waste Acceptance Criteria (WAC) Results

8.3.1 Waste Acceptance Criteria (WAC) analysis has not been undertaken at this time. Landfill Waste Acceptance Criteria (WAC) analysis (specifically leaching test results) must not be used for waste classification or hazardous waste assessment purposes. This is done instead via the HPA detailed in Section 8.1.

8.3.2 WAC results are instead indicative of whether soils pre-classified as non-hazardous are acceptable for disposal as inert waste; or, whether soils pre-classified as hazardous waste are suitable for disposal at a hazardous waste landfill – if not, then pre-treatment will be needed prior to disposal. There are no WAC for non-hazardous landfills.

8.3.3 It should be noted that waste regulations³⁰ state that “If the wastes are contaminated or contain other material or substances such as metals, asbestos, plastics, chemicals, etc. to an extent which increases the risk associated with the waste sufficiently to justify their disposal in other classes of landfills, they may not be accepted in a landfill for inert waste”. Topsoil and peat are also excluded from the inert waste definition.

8.3.4 Material was found to contain ash, clinker and slag and therefore confirmation of its suitability for disposal as inert waste should be obtained from the landfill as this may constitute a breach of its operating license.

³⁰ Landfill (England and Wales) Regulations 2002 (as amended), Council Decision of 19 December 2002 pursuant to Article 16 of and Annex II of Directive 1999/31/EC (2003/33/EC)

8.4 Landfill Tax

- 8.4.1 With respect to soils disposal at landfill reference should be made to HMRC Excise Notice LFT1³¹. There are two rates of tax, both of which are charged on a per weight basis: the lower rate applies to those less polluting wastes listed in the Landfill Tax (Qualifying Material) Order 2011, as amended, and the standard rate applies to all other taxable waste. The only determining factor as to whether waste is lower rated is whether it is listed in the Landfill Tax (Qualifying Material) Order 2011. Whether or not waste is considered to be inert for environmental protection purposes is not relevant to matters of tax liability and a separate assessment should be made for this as the cost differential is significant. Equally, the fact that waste is listed in the Landfill Tax (Qualifying Material) Order 2011 does not mean that the waste is inert for environmental protection purposes.

³¹ HMRC Excise Notice LFT1: a general guide to Landfill Tax

9.0 REVISED CONCEPTUAL SITE MODEL

9.1.1 The potential contamination linkages, as detailed in Table 4.2, have been investigated and assessed. The Conceptual Site Model (CSM) can now be revised to account for site-specific data, which informs the risks associated with the proposed development and, therefore, enables appropriate remedial measures to be recommended.

9.2 Classification of Risk

9.2.1 Risk is defined by the combination of two factors: i) the probability of an occurrence (expressed as a likelihood); and ii) the consequence of it happening (expressed as a severity). The definitions of these categories are included in the Environmental Risk Assessment Standards and Supporting Information section to the rear of this report, together with definitions of the classifications of probability and consequence, but the procedure for classifying risk is summarised in Table 9.1.

Table 9.1 Classification of Risk

Probability (Likelihood)		Consequence			
		Severe	Medium	Mild	Minor
	High likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

9.2.2 A qualitative risk assessment for the receptors identified in Table 4.2 is presented below in Tables 9.2 - 9.6.

Table 9.2 Groundworkers (Assuming Basic PPE)*

Pathway	Risk	Comments
Ingestion of soil/dust	Low	Redevelopment or maintenance of the site will involve ground workers coming into contact with the underlying soils and water.
Inhalation of soil/dust	Moderate	
Dermal contact with soil/dust/water	Low	
Inhalation of vapour from soil/dust	Low-Moderate	The soil chemical results are not considered indicative of significant contamination.
Inhalation of vapour from groundwater	Low	
Migration of soil gases to confined spaces	Low-Moderate	Asbestos has been identified as chrysotile and amosite bundles (<0.001% to 0.009%) which present a risk of inhalation during the disturbance of soils. Practical measures such as dust suppression, wetting and reassurance

Pathway	Risk	Comments
		air monitoring for dust and asbestos in air are recommended. Hydrocarbon odour was noted in several locations within the Made Ground soils. Concentrations of carbon dioxide above 1.5% and depleted oxygen concentrations have been recorded which poses a potential acute risk to groundworkers in excavations and confined spaces. Normal Health and Safety precautions associated with a site where potential contamination may exist (of the levels identified), will mitigate the general risk. The type of RPE required for asbestos will be defined by the JIWG decision support tool. There is a potential risk if previously unforeseen contamination is later found to be present.

* Additional assessments are required by the Contractor in relation to asbestos risk.

Table 9.3 End Users during Occupation

Pathway	Risk	Comments
Inhalation of dust	Moderate	The proposed development plans have not been finalised, however it is anticipated that communal green spaces and private residential gardens will be present.
Ingestion of soil/dust	Low	
Dermal contact with soil/dust/water	Low	
Consumption of vegetables/plants	Low	
Inhalation of vapour from soil/dust	Low-Moderate	The soil chemical results are not considered indicative of significant contamination.
Inhalation of vapour from groundwater	Low	
Migration of soil gases to confined spaces/structure	Low – Moderate	Asbestos has been identified as chrysotile and amosite bundles (<0.001% to 0.009%). Made Ground soils will require appropriate clean cover soils, which should be implemented as part of final site development. Soils impacted by hydrocarbons are not proposed for reuse on site without further risk assessment, treatment and verification. At this stage, a precautional CS2 classification has been determined due to the elevated carbon dioxide and sporadic flow rates. As positive flow
Movement of contaminants to engineered structures (e.g. water pipes)	Low – Moderate	
Uptake by flora/fauna	Low	

Pathway	Risk	Comments
		rates are sporadic, further gas monitoring is advised to determine ground gas protection measures for the final development once confirmed. A watching brief should also be maintained throughout all groundworks. There is a potential risk if previously unforeseen contamination is later found to be present.

Table 9.4 Controlled Waters

Pathway	Risk	Comments
Migration of water borne contaminants from site to surface waters	Low	Nearest surface watercourse >700m from site.
Migration of water borne contamination from off site	Low	The site is underlain by superficial and bedrock Secondary A Aquifers. The underling Aquifer has an overall poor water quality rating.
Migration of contamination from surface and/or subsurface to groundwater	Low	No significant contamination identified on site from the analysis of soils. A hydrocarbon odour was noted in the Made Ground soils and a marginal DWS exceedance in benzo(a)pyrene was identified in the groundwater retrieved from BH105. However, low permeability clay (Glacial Till) encountered across the site will limit migration of dissolved phase contaminants. The site is not located within a source protection zone.

Table 9.5 Buildings

Pathway	Risk	Comments
Movement of contaminants to engineered structures (e.g. water pipes)	Low - Moderate	Consideration will be required with respect to potable supply pipework due to the presence of Made Ground, which has been shown to contain hydrocarbons. Liaison with the water supply provider will be required to determine if remedial actions are required.
Migration and accumulation of flammable gases beneath the building footprint.	Low	No elevated concentrations of methane were encountered during the ground gas monitoring.

Table 9.6 Offsite Receptors

Pathway	Risk	Comments
Dermal contact with soil/dust/water	Low	Asbestos has been identified as chrysotile and amosite bundles (<0.001% to 0.009%) which pose a risk via inhalation due to disturbance during the construction phase.
Inhalation/ingestion of dust	Low - Moderate	
Inhalation of vapour from soil/dust	Low	
Inhalation of vapour from groundwater	Low	Off site residential properties with gardens are located in close proximity to the southern boundary, however railway land separates the parcel of land. Practical measures such as dust suppression, wetting and reassurance air monitoring for dust and asbestos in air are recommended. A hydrocarbon odour was noted in the Made Ground soils and a marginal DWS exceedance in benzo(a)pyrene was identified in the groundwater from BH105. However, the presence of low permeability clay will reduce the potential for migration of contamination to off-site receptors.
Migration of soil gases to confined spaces/structure	Low	
Movement of contaminants to engineered structures (e.g. water pipes)	Low	

10.0 GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

10.1.1 It is proposed to redevelop the site with a predominantly residential development with associated access, infrastructure, hardstanding and landscaped areas. Private gardens are anticipated for a small number of plots. Current proposals, although still at the masterplan stage, are indicated in Figure 3, Appendix 1.

10.1.2 The primary purpose of this report is to identify risk, allow design development and inform cost estimates. Further investigation will be required once proposals are fully developed, and a detailed Geotechnical Design Report should be prepared.

10.2 Key Considerations

10.2.1 The ground investigation has identified a number of geotechnical risks at the site. These are summarised below and discussed in more detail in the following sections.

- Significant thicknesses of Made Ground locally present
- Shallow groundwater
- Soft waterlogged soils in and around the historical pond area
- Possible presence of boulders in the Made Ground and Glacial Deposits
- Hard obstructions i.e. concrete in the Made Ground
- Low to medium volume change potential soils.
- Ground conditions aggressive to buried concrete.
- Large variations in site level and consequent need for earthworks

10.2.2 It should be noted that limited ground investigation was undertaken in and around the historical pond area therefore, the recommendations outlined below may not be applicable to this area of site.

10.3 Foundations

10.3.1 As described in Section 6, much of the site is underlain by Made Ground over Glacial Deposits of interbedded firm to stiff clays and medium dense sands.

10.3.2 It is anticipated that traditional shallow foundations i.e. strip and trench fill foundations may be viable where foundations are placed within the Glacial Deposits. In the current conditions the top of Glacial Deposits is generally between 1m and 2m bgl however, in areas of deep Made Ground (as discussed in Section 6.0) the top of the Glacial Deposits is likely to be too deep for shallow foundations to be viable. In addition, proposed high rise structures, with high loads, may require alternative foundation solutions.

10.3.3 Assuming foundations of up to 1m width with a founding depth of c. 1m, an allowable bearing resistance of 150kPa could be considered for strip foundations founded in medium dense sand or firm clays.

- 10.3.4 Foundation depths should be determined in accordance with Chapter 4.2 of the NHBC Standards³², based on a low volume change (shrink-swell) potential. They should also be taken below any desiccated soils and 300mm below any live roots encountered during the ground investigation or during excavation.
- 10.3.5 The foundation stratum should be carefully inspected for the presence of soft spots and to ensure the structures do not cross variable stratum to avoid differential settlement. Should ground conditions significantly differ to those described within this report, a geotechnical engineer should be notified, and the foundation design reviewed.
- 10.3.6 Following excavation of the foundation trenches, concrete should be placed as soon as possible to avoid softening/loosening of the ground. This is especially vital where shallow groundwater is present. In addition, it is recommended that an allowance for pumping of any foundation trenches is made where ingress of groundwater is likely to occur.
- 10.3.7 Where foundations depths in excess of 1.5m bgl are required to satisfy Chapter 4.2 of the NHBC Standards³², the inside faces of external foundations will require heave protection measures. The measures required should be based on those given in Chapter 4.2 of the NHBC Standards³², based on a low volume change potential, minimum void dimensions area as follows:
- 0mm against side of foundation and ground beam;
 - 50mm under ground beams, and suspended in-situ concrete
 - 200mm under suspended precast concrete and timber floors.
- 10.4 **Ground Improvement**
- 10.4.1 With respect to ground improvement options, the advice of reputable specialist contractors experienced in the ground conditions considered here should be sought. They should be responsible for the selection of appropriate equipment and the final design of the treatment.
- 10.4.2 At the time of writing, it is understood that earthworks are proposed to be carried out to re-profile the site and construct a new access ramp from Market Street (B6218). Following confirmation of these works and finalisation of the proposed re-development masterplan, ground improvement techniques could be considered should traditional foundation solutions not be viable. Given below is a discussion in relation to forms of ground treatment more commonly adopted in the UK.
- 10.4.3 Depending on the proposed upfilling of the site installation of vibro stone columns (VSCs) could be undertaken through the engineered fill (placed as part of the initial earthworks). Upon treatment, an allowable bearing capacity in the region of 100-140kN/m² would be anticipated.
- 10.4.4 Should any form of ground improvement be adopted this should be informed by a suitable design trial and the main works validated by an appropriate programme of testing.

³² NHBC Standards 2023 <https://nhbc-standards.co.uk/>

10.4.5 Should ground improvement be implemented then it should be possible to adopt pad or strip footings or a 'semi-raft' foundation, depending on the nature and degree of treatment.

10.5 Piles

10.5.1 The advice of reputable piling specialists, experienced in the ground conditions considered here, should be sought. They should be responsible for the selection of appropriate piling equipment and the final design of the piles. Given below are some initial comments and preliminary design resistances.

10.5.2 The potential for obstructions in the Made Ground and Glacial Deposits will require consideration in determining the most appropriate approach to piling operations and the selection of appropriate equipment. This may require consideration to be given to pre-excavation/pre boring of such features.

10.5.3 It is envisaged that the piles would extend to suitable depths into competent bedrock of the PLCM. It is anticipated that high bearing capacities will be achieved by either bearing on, or rock socketing into the mudstone. The safe working load achievable by piled foundations will be highly dependent on the pile installation technique utilised.

10.5.4 Bored piles would potentially require casing to support the pile bore through the Made Ground and underlying Glacial Deposits.

10.5.5 Due to the presence of shrinkable soils at shallow depths across some of the site, the specialist pile designer should consider the impact of shrinking/swelling and desiccation within their pile design. Note where pile caps are placed in granular dominated soils (i.e. sands) void formers to mitigate shrink/swell action are not required.

10.5.6 Preliminary safe working loads have been made as per methods outlined in Tomlinson³³ for bored and cast in place of continuous flight auger (CFA) piles, considering various diameter piles. It should be noted that the mudstone recovered in the ground investigation was highly disturbed by the cable percussive borehole techniques. As such, the nature of the rock quality is not known. It is advised that rotary cored boreholes are undertaken should piled foundations be considered.

10.5.7 Table 10.1 below provides indicative safe working loads for individual piles.

Table 10.1 Safe Working Loads for Rotary Bored or CFA piles

Pile Diameter (mm)	Safe Working Load (kN) Pile length (m)		
	8m	12m	16m
300	515	845	1,175
450	600	1,095	1,590
600	680	1,340	2,000

³³ Pile Design and Construction Practice, Tomlinson and Woodward, 5th ed: 2008.

10.5.8 It is noted that these calculations are for preliminary design purposes only and further investigation will be required. In addition, the final design will ultimately require consideration against appropriately factored design actions as detailed in EC0 and EC7.

10.5.9 Table 10.1 is based on the following assumptions:

- Proposed installed from existing ground level.
- Ground model as follows:
 - 0.00 – 2.00: Made Ground - No resistance provided
 - 2.00 – 4.00: Glacial Clay – $C_u = 120\text{kN/m}^2$, $\alpha = 0.5$
 - 4.00 – 6.00: Glacial Clay – $C_u = 200\text{kN/m}^2$, $\alpha = 0.5$
 - 6.00+: Mudstone – $UCS = 750\text{kN/m}^2$, $\alpha = 0.35$
- The self-weight of the pile and the weight of soil removed/displaced during pile construction approximately cancel each other.
- The potential for negative skin friction not taken into account.
- Smearing of rock socket caused by dragdown of clay or degradation of the rock not taken into account.
- No load testing of working or preliminary piles.
- A Factor of Safety of 3 on the ultimate working load.
- Pile spacing of at least 3 x pile diameter.
- Structural design check on pile slenderness and reinforcement not undertaken.

10.5.10 The adoption of maintained load tests in accordance with EC7 would enable increased capacities or shorter piles to be adopted. The piling specialist may choose to adopt alternative parameters to those outlined above however, their suitability should be verified by an experienced geotechnical engineer.

10.5.11 Note that should levels be built up then pile design should also take into account the long-term settlement or collapse of potential metastable materials, including associated negative skin friction within the Made Ground.

10.6 Floor slabs

10.6.1 Floor slabs should be suspended on the foundations placed over areas underlain by clays of Made Ground or Glacial Deposits owing to them having up to medium volume change potential. The void dimensions to accommodate the occurrence of heave associated with any suspended floor slabs should be determined in accordance with the NHBC Standards¹³.

10.6.2 Within the zone of influence of trees previously removed, to be retained or removed as part of the development, suspended floor slabs are recommended because of the potential for heave. Void formers are required in accordance with Chapter 4.2 of the NHBC Standards¹³.

based on medium volume change potential where placed in Made Ground or low volume change potential when placed in Glacial Clays.

- 10.6.3 Any soft spots identified should be excavated and replaced with compacted granular fill or lean mix concrete.

10.7 Earthworks

- 10.7.1 Earthworks are proposed to re-profile the site and construct a new access ramp leading from Market Street. At the time of writing the re-profiling proposal has not yet been finalised.

- 10.7.2 It is assumed that a large proportion of the earthworks will involve distributing the material currently within the pyramid features situated in the western area of site. The log records suggest these structures comprise a mix of Granular Made Ground and Fine Made Ground material. Due to the inherent variability of Made Ground it is anticipated that, should the soil be used as site won material for the earthworks, it will require sorting and screening. In addition, any oversize particles or unacceptable materials will need to be removed.

- 10.7.3 Based on the available information it is anticipated that the Fine Made Ground material will be classified as a 2A, wet cohesive, or 2C, stony cohesive, fill material in accordance with SHW 600³⁴.

- 10.7.4 The natural moisture content results within the top 1m of the soils indicate that they are above the optimum moisture content (OMC) as shown in Figure 8, Appendix 1 and drying of the soils is likely to be required.

- 10.7.5 The particle size distribution tests of the Granular Made Ground suggest it would generally be classified as a 1A well graded granular material.

- 10.7.6 Based on the available data the Glacial Sands are also anticipated to largely comprise class 1A well graded granular material although locally may fall within 1B uniformly graded granular material. The Glacial Clay typically comprises soil that falls within class 2A wet cohesive material. However, it is not anticipated that significant volumes of Glacial Deposits will be won from excavations.

- 10.7.7 Due to issues with water ingress, only limited investigation was undertaken within the historical pond, and as such there is limited information on the depth and nature of the soils contained within it. Further investigation is required to ascertain the suitability of these soils for reuse. It is assumed that the soils will likely be waterlogged and would not be suitable for reuse without ground treatment and/or conditioning.

- 10.7.8 Note an Earthwork Specification for the site has been undertaken under a separate cover.

10.8 Road Pavements

- 10.8.1 Based on the understanding of the proposed earthworks strategy at the time of writing it is understood that pavements will likely be founded within the existing Made Ground, the Glacial Deposits and on engineered fill placed to locally rise site levels. Due to the variable formation

³⁴ Specification for Highway Works Series 600 Earthworks

conditions, pavement surfaces should be constructed in flexible materials such as bituminous compounds or block paving.

10.8.2 Laboratory CBR tests undertaken at the natural moisture content presented CBR values of around 1% (with some values as low as 0.5%). It is recommended that in situ CBR tests (e.g. dynamic cone penetrometer tests) are undertaken along the route of proposed pavements to confirm the CBR value to be adopted for design.

10.8.3 The CBR value to be adopted would depend on the nature of the fill specification adopted and the as built quality of the fill. Based on the current test results, a CBR value of 1% could be adopted for preliminary design, however CBR correlation tests could be undertaken to ascertain the likely CBR to be achieved following placement of the fill.

10.8.4 Additional testing of the fill just prior to road construction is recommended so as to confirm matters.

10.8.5 Laboratory test results are indicative of frost susceptibility.

10.9 Buried Concrete

10.9.1 In the consideration of sulphate attack on buried concrete, reference has been made to BRE Special Digest 1³⁵, which classifies the site as a brownfield site with mobile groundwater conditions. Additionally, as Pennine Lower Coal Measures can be pyrite bearing, it has also been necessary to assess the potential for the thaumasite form of attack. The results of the concrete classification tests received have indicated a DS-3 classification in the Made Ground, together with the pH values indicates that an ACEC AC-3 should be adopted.

10.9.2 DS-1 classification with ACEC AC-1 could be considered where foundations are placed within the Glacial Deposits however, if these are placed through any significant thickness of Made Ground DS-3 AC-3 concrete should be used.

10.9.3 Should deeper foundations (i.e. piles) be considered within the underlying mudstone bedrock it is recommended that additional testing is carried out.

10.10 Drainage

10.10.1 It is not considered likely that drainage will have to be suspended, although this will depend on the magnitude of settlements that are expected once the design has been developed further.

10.10.2 Any proposed drainage and other services will likely be affected by heave resulting from the presence of low to medium volume change potential of soils, which will be pronounced in areas of vegetation. Consequently, consideration should be given to laying drainage with increased falls and flexible service connections as per NHBC Chapter 4.2.

10.10.3 Frost susceptible soils are present on site therefore drainage should be placed at sufficient depth to avoid the impacts of frost heave where appropriate.

³⁵ BRE Special Digest 1: 2005 Concrete in aggressive ground

10.10.4 Due to the cohesive soils, drainage infrastructure should be wrapped in geotextile to prevent the ingress of fines and silting up of drainage systems. Scour protection should also be considered on site particularly within drainage channels, swales or ditches.

10.11 Soakaway Drainage

10.11.1 The soakaway tests were not able to be undertaken due to water ingress within the trial pits. It has therefore been concluded that large-scale soakaway drainage is not likely to be feasible and that an alternative drainage strategy may be required.

10.12 Excavations

10.12.1 As described above, shallow groundwater was encountered across the central area of the site. Thus, provisions for pumping may be required.

10.12.2 Spalling of the trial pits was recorded locally, and the stability of excavation faces within the Made Ground and Glacial Sands cannot be relied on. Allowance should be made for battering faces back to a safe angle of repose or providing shuttering. Support or battering of the excavation faces to a safe angle of repose will be required for all excavations where man entry is necessary, the nature and extent of which will need to be evaluated under CDM regulations.

10.13 General Construction Advice

10.13.1 It should be possible to use conventional excavators to form excavations in the soils encountered during the investigation. However, obstructions may be encountered locally within the Made Ground and Glacial Deposits.

10.13.2 For any load bearing formations, careful inspection should be undertaken to ensure placement in competent natural strata unless ground treatment has been carried out and properly validated. Any soft spots identified should be excavated and replaced with compacted granular fill or lean mix concrete. Concrete should be placed as soon as possible following excavation to avoid softening of the ground. A similar recommendation is also made for road pavement formations, although compacted granular fill could be used instead of concrete.

10.13.3 Any relict foundations or other subterranean structures beneath the footprint of the proposed buildings should be fully grubbed out. Such excavations should be surveyed and backfilled with an acceptable granular fill, placed and compacted to an engineering specification. The same recommendations are made for excavations that may be required to remove soil contamination.

10.13.4 In areas of road pavements and hard standing, relict subterranean structures should be broken down to around 1m below finished site level to minimise the risk of differential settlement due to the presence of hard spots. In soft landscaped areas, it may be possible to limit such operations to 0.50m bgl.

10.14 Recommendations for Further Work

10.14.1 The preceding sections have attempted to establish the general ground conditions across the site and provide broad recommendations for the proposed development.

- 10.14.2 It is proposed that further investigations are undertaken to establish the depth and nature of the soils within the historical pond. This is likely to comprise machine excavated trial pits with geotechnical sampling and testing.
- 10.14.3 It is also recommended that in situ CBR tests are undertaken along the route of proposed pavements.

11.0 ENVIRONMENTAL CONCLUSIONS AND RECOMMENDATIONS

Desk study and subsequent site investigation information have confirmed the respective levels of risk to receptors (future residents, groundwater, etc.) associated with the proposed predominantly residential development. The risks and any remedial requirements are summarised for the long-term receptors in Sections 11.2 – 11.5. Sections 11.6 – 11.7 summarise the risks and remedial requirements for groundworkers and services. Sections 11.8 - 11.10 then detail the requirements for further investigation and/or assessment, reporting, and waste soils management.

11.1.1 Remedial recommendations, primarily based on the proposed enabling works package rather than the final development, are provided based on the current understanding of the site. These requirements should be re-assessed following any additional investigations /assessments that are may be carried out since these could lead to their modification. Detailed remedial works should be finalised in a Groundworks/ Remediation Specification.

11.2 Data Uncertainties

11.2.1 Additional monitoring for bulk gases is recommended to confirm the requirements for ground gas protection measures once the development plans have been finalised. Currently the site has been classified as Characteristic Situation 2. However, sporadic high and negative flow rates were recorded on the last three monitoring visits. A number of monitoring wells had flooded response zones and therefore these were excluded from the assessment.

11.3 Summary of Risk and Remedial Requirements – Soils / End Users

11.3.1 The assessment generally identified a LOW-MODERATE risk to future residents of the site due to the potential release of asbestos fibres from the soils.

11.3.2 Asbestos was detected in 8 no. samples of shallow Made Ground as bundles of chrysotile and amosite with concentrations ranging from <0.001% to 0.009%.

11.3.3 The primary exposure pathway relates to the inhalation of fugitive asbestos fibres. In order to mitigate risks to end users it is recommended that a clean cover system of chemically validated soils is installed within all areas of soft landscaped areas. The thickness of this capping layer should be 600mm in private garden areas and 450mm in communal landscaped areas. A break or marker layer such as geotextile should be placed at the base of the capping layer to indicate the presence of asbestos, if present. Alternatively, placing building footprints or areas of hardstanding (e.g., roads, car parks) over the asbestos impacted soils will mitigate the risk of exposure to end users. It is anticipated that cover soils will be placed and validated as part of the site redevelopment works and not during the proposed enabling works.

11.3.4 In addition, any excavations should be backfilled with soils which are suitable for use and in accordance with the appropriate Remediation and/or Groundworks Specification compiled by the Engineer.

11.3.5 Based on the chemical test results, it is anticipated that the soils from the pyramid structures, following processing and/or treatment, will generally be suitable for use as general fill beneath

roads, buildings and in landscaped areas under suitable cover. Compliance testing of the Made Ground will be required to confirm its suitability.

11.3.6 Made Ground materials encountered in several locations were also found to contain coal, ash, clinker and slag. Hydrocarbon odours were also reported during the intrusive works. It is not proposed to reuse hydrocarbon impacted materials within areas of proposed buildings without further risk assessment, compliance sampling and testing, noting that the proposed excavation and processing of the Made Ground will result in a degree of degradation of organic contaminants.

11.3.7 Imported materials for soft landscaped areas will require provision for testing in accordance with the Remediation Specification and compliance with an agreed set of limiting values will be required. Records as detailed within the Remediation Specification and/or Groundworks Specification should be maintained to certify the source, chemical suitability and appropriate placement of the soils.

11.4 Summary of Risk and Remedial Requirements – Controlled Waters

11.4.1 The qualitative assessment identified a LOW RISK for groundwater due to the presence of low permeability Glacial Till overlying the bedrock Secondary A Aquifer and the site is not located within 1km of a source protection zone

11.4.2 The qualitative assessment identified a LOW RISK for surface waters as the site is located >700m from the nearest surface water course.

11.4.3 A marginal groundwater exceedance in benzo(a)pyrene (0.02ug/l) has been detected at one borehole location when compared to the conservative drinking water standard value. However, no significant contamination was encountered during the ground investigation which may pose a risk to controlled waters.

11.4.4 Therefore, based on the investigations undertaken to date, remedial works are not required at this stage for controlled waters.

11.5 Summary of Risk and Remedial Requirements – Ground Gas / Vapours

11.5.1 The risk from ground gas is LOW and the site has been preliminarily classified as CIRIA Characteristic Situation 2 (CS2). The Made Ground was proven to a maximum depth of 6.10m bgl, however, this was in the location of the existing ramp for the access track, the organic load of the Made Ground is likely elevated due to the presence of ash, clinker and coal. Elevated concentrations of carbon dioxide above 1.5% and sporadic flow rates were recorded during the monitoring.

11.5.2 Based on the current data, the requirement for ground gas protection measures should be confirmed following confirmation of final development plans and completion of additional monitoring post completion of the enabling works phase.

11.5.3 Elevated concentrations of VOCs were not detected during the monitoring or within the samples of soil and groundwater.

11.6 Additional Remedial Recommendations

11.6.1 In addition to the requirements noted above, a watching brief should be maintained throughout the groundworks in order to identify any previously undetected areas of contamination, such as asbestos containing materials and/or stained/odorous soils. These should be assessed by an Environmental Consultant if identified.

11.6.2 Hydrocarbon odours were encountered in the Made Ground soils at 5 no. locations within the vicinity of the pyramid structures and northern boundary. Hydrocarbon stained soils and a sheen on perched groundwater was also encountered in TP103. It is recommended that impacted soils are excavated and stockpiled for testing prior to reuse if suitable or off site removal if deemed unacceptable material.

11.7 Groundworkers

11.7.1 The qualitative assessment identified a potentially LOW-MODERATE risk to groundworkers who may come into contact with contaminated soils and waters. The primary exposure pathway relates to the inhalation of fugitive asbestos fibres.

11.7.2 The Contractor should prepare risk assessments and method statements in view of the identified and foreseeable ground conditions and include these within the Health and Safety Plan: for example, these should consider worker protection from skin contact, ingestion and inhalation of contaminants, asbestos in soils and ground gas. In order to achieve satisfactory control, CampbellReith recommend that Health and Safety provisions in accordance with HSE Publication HS(G) 66³⁶ and CIRIA Report 132³⁷ are considered. The Contractor must also control matters such as any contracted CDM responsibilities.

11.7.3 In relation to presence of asbestos in soils, the Contractor should formulate their working arrangements in view of the requirements of the Control of Asbestos Regulations (2012)³⁸ and the associated ACoP (L143)³⁹. Additional interpretation on the application of these regulations is presented in publications prepared by CL:AIRE (CAR-SOILTM)⁴⁰ and additional guidance is provided in CIRIA C765⁴¹.

11.7.4 It is advised that practical measures such as dust suppression, wetting and reassurance air monitoring for dust and asbestos in air are put in place as minimum provisions during groundworks involving sustained periods of disturbance of the Made Ground.

11.8 Services

11.8.1 The presence of TPH and PAH concentrations in the soil indicates a possible need for protection of public water supply pipework, such as the use of organic resistant pipework. The infrastructure designer should assess requirements for pipework with respect to soil

³⁶ HSG 66 Protection of workers and the general public during the development of contaminated land. 1991

³⁷ CIRIA REP R 132 Guide for safe working on contaminated sites. 1996

³⁸ HSE Control of Asbestos Regulations, 2012

³⁹ HSE Managing and Working with Asbestos, L143. 2013

⁴⁰ CL:AIRE. Joint Industry Working Group. Control of Asbestos Regulations 2012, Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials, 2016; and the associated JIWG decision support tool, 2017

⁴¹ CIRIA C765 Asbestos in Soil and Made Ground Good Practice Site Guide, 2017

contamination and consult statutory utility companies and relevant guidance as necessary. Guidance on this topic is presented in UKWIR Report 'Publication UKWIR Report'⁴².

11.9 Additional Site Investigation/Assessment

11.9.1 Consideration should be given to undertaking additional monitoring for bulk gases to confirm requirements for ground gas protection measures once the development plans are finalised. This should include monitoring of the existing installations, if they remain following completion of the enabling works, however it should be noted that ground conditions may vary significantly following these works. Should any elevated concentrations of bulk gases be encountered, sampling and analysis of gas should be undertaken to provide confirmation of the concentrations recorded.

11.9.2 There is the potential for impacted Made Ground to be present beneath the existing pyramid structures. Therefore, the nature and composition of the soils beneath the pyramid structures will need to be assessed appropriately to a minimum depth of 2.0m from existing ground level (i.e. the ground level currently surrounding the pyramids). This recommendation may need to be updated following confirmation of proposed site levels.

11.9.3 An invasive species specialist should be consulted to confirm the best approach to remediate the area of the current Japanese Knotweed stand in the east of the site.

11.10 Remediation and Verification Documents

11.10.1 A Remediation/Groundworks Specification should be produced to ensure that the recommendations made in this report are correctly carried out and recorded during the site works. The Specification should:

- detail the requirements associated with remedial works, such as hot spot removal dimensions, frequency of soil testing etc.;
- specify the necessary requirement for inspections/ record keeping/ actions for unforeseen contamination and Contractor's method statements, together with appropriate validation);
- detail the requirements for the control of imported material;
- provide appropriate guidance on the production of method statements relating to health and safety, work with asbestos containing materials, etc.;
- provide details regarding waste soil management; and,
- provide details of what is required in the Verification Report.

11.10.2 On completion of the remedial works and / or earthworks, a Verification Report should be produced to demonstrate that the works have been successfully carried out in accordance with the Remediation Specification such that the site is suitable for its proposed end use. As well as being a likely requirement of the planning process, the report can also be used to provide assurance to funders and / or future site purchasers that the site has been successfully remediated.

⁴² Publication UKWIR Report Ref 10/WM/03/21: Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites - Final Project Report, as amended by the Contaminated Land Assessment Guidance (Water UK, January 2014)

11.10.3 The Remediation Specification and Verification Report will require submission to the Local Authority for review and approval as part of the planning process, to fulfil the requirements of the anticipated land quality planning condition. Failure to submit the required documentation could result in refusal to discharge associated Land Quality Planning Conditions, and discussions should be held with the relevant Officer at an early stage to ensure all necessary information is obtained and collated for their review and approval. Additional discussions may be required with the NHBC if the final proposed scheme involve a residential end use and/or Building Control; such matters are not detailed herein. Once the Remediation Specification is approved, it will be the Contractor's obligation to fulfil the agreed requirements and to produce the Verification Report.

11.11 Waste Management

11.11.1 A hazardous properties assessment (HPA) of waste soils has been undertaken as part of a preliminary waste assessment. Of the 52 no. samples analysed from both investigations, 5 no. would be classified as hazardous waste if excavated for disposal.

11.11.2 The hazardous waste is generally restricted to the western section of the site within or adjacent the existing pyramid structures. Another hazardous sample was located towards the northern boundary. The HPA does not include the presence of asbestos. Asbestos was detected in 8 no. samples of Made Ground as bundles of chrysotile and amosite. Quantification results were all below 0.1% and no visual asbestos was identified on site, therefore the samples can remain non-hazardous where indicated by the assessment.

11.11.3 The soil results can be used for information by the Contractor as a basis for waste soil classification and disposal purposes; however, additional testing may be required, particularly if non-representative soils are uncovered such as those that are stained, odorous or containing asbestos.

11.11.4 All waste related activities must be undertaken in accordance with the Waste Management and Landfill Regulations. Any proposed reuse of materials must be in accordance with the Waste (England and Wales) Regulations 2011 (as amended) and will likely require one or more of the following: Environmental Permit, Exemption, Materials Management Plan.

11.11.5 With respect to waste soils disposal, as a minimum, the following information should be collected and retained by the Contractor for subsequent validation:

- source and origin of the waste;
- information on the process producing the waste;
- European Waste Catalogue code and characteristics of material;
- for hazardous waste, definition of the relevant properties according to the Hazardous Waste Directive (Annex III 91/689/EC);
- confirmation that waste is not prohibited waste;
- appearance of the waste;
- landfill class; and,
- Duty of Care records including full and completed chain of custody documentation.

- 11.11.6 The final waste classification is the responsibility of the Contractor and should be determined in conjunction with the receiving landfill and in liaison with the Environment Agency (and their technical guidance). It is noted that, depending on the landfill selected, additional soils testing information and independent verification of the materials of the materials being received by the landfill may be required.
- 11.11.7 As the correct classification of waste may have a significant impact on the redevelopment budget, the waste classification should be reviewed independently at an early stage in the project management stage. In addition, contractors should be asked to confirm that their tenders consider the full requirements of the Landfill Directive and associated waste legislation. This is to ensure waste is correctly classified and costed at the inception of the project.
- 11.11.8 A separate assessment should be made for the rate of Landfill Tax (where applicable) in accordance with HMRC Excise Notice LFT1³¹.

ENVIRONMENTAL RISK ASSESSMENT STANDARDS AND SUPPORTING INFORMATION

Normative Standards

Contamination

The report has been produced in general accordance with the procedures for ground investigation, interpretation and reporting set out in Land Contamination Risk Management (LCRM) (England) BS 5930:2015 (+A1:2020), BS 10175:2011 (+A2:2017) and BS EN 1997 (Eurocode 7).

This assessment considers the objectives of the National Planning Policy Framework which requires information to demonstrate that a site is suitable for its new use (taking account of ground conditions and land instability) and not capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990 (after remediation). The NPPF requires adequate site investigation information, prepared by a competent person.

Geotechnics

The geotechnical appraisal has been carried out in accordance with Eurocode 7. Sections 2, 3, 5 and 6, together with Appendix C, comprise the Ground Investigation Report. Preliminary geotechnical recommendations are presented in Section 10 and these should be verified in a Geotechnical Design Report once structural details of the proposed development are confirmed.

Soil Screening Values

The Environment Agency (EA) has published non-statutory technical guidance for Regulators and their advisors to assess the chronic risk posed to human health from land contamination, known as the Contaminated Land Exposure Assessment (CLEA) Framework. Following a number of updates, CLEA v1.071 is the current version of the EA's risk assessment software.

Soil Guideline Values (SGVs) were produced by DEFRA/EA and Generic Assessment Criteria (GACs) have been produced by CampbellReith and others. These are based on the CLEA model and supporting guidance (SR2⁴³ and SR3²²). With respect to toxicity, SGV/S4UL/in-house GAC are based on health criteria values (HCV), as defined in SR2, which represent a tolerable/minimal level of risk.

In 2014 DEFRA released C4SL (Category 4 Screening Levels) for 6 No. contaminants (As, benzene, BaP, Cd, Cr (VI) and Pb), along with the associated Policy Companion Document and an Erratum⁴⁴. They are based on a low level of toxicological concern (LLTC) and are, by definition, less conservative than HCV. They represent contaminant soil concentrations, which present a low level of risk within the context of Part 2A, i.e. they are representative of Category 4 sites. In the Contaminated Land Statutory Guidance⁴⁵, sites under Part 2A assessments are categorised 1 - 4, with Category 1 being definitely Part 2A and Category 4 definitely not Part 2A ('where there is no risk or the level of risk posed is low').

⁴³ Environment Agency Report Ref: SC050021/SR2 – Human Health Toxicological Assessment of Contaminants in Soil. January 2009

⁴⁴ SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Revision 2. September 2014

⁴⁵ Environmental Protection Act 1990: Part 2A, Contaminated Land Statutory Guidance, April 2012

DEFRA have confirmed that C4SLs can be used in the planning regime and DCLG (Department for Communities and Local Government) amended Planning Practice Guidance (PPG) on Land Affected by Contamination (12 June 2014)⁴⁶ which stated that C4SLs provide a simple test for deciding when land is suitable for use and definitely not contaminated land'. On 03 September 2014 the Secretary for the Environment, Lord de Mauley, issued a letter to all Local Authorities, which references DCLG's PPG and confirms that C4SLs could be used in planning and provide a simple test for establishing when sites are suitable for use. The LCRM also states 'Where an SGV and a C4SL are available for the same contaminant, we expect you to use the C4SL'.

LQM/CIEH issued S4ULs in December 2014 for 89 contaminants (metals, BTEX, banded TPH, speciated PAH, chlorinated solvents, phenols, chlorophenols, chlorobenzenes, pesticides and a number of miscellaneous others). The S4ULs have generally adopted the revisions to the exposure modelling that were developed in the production of the C4SLs. Critically, however, they are based on HCVs to produce concentrations, which are indicative of a minimal/tolerable level of risk. CampbellReith have produced GACs which use the same approach to that taken by LQM but also uses the top two approach to homegrown produce that was developed for the C4SLs. CampbellReith's GACs (and S4ULs) are therefore used as the preliminary stage of soil assessments since they are indicative of minimal/tolerable level of risk. If these are exceeded, then the C4SLs are used (if available and shown to be appropriate for the particular assessment) to determine if the risk could be described as low.

Selection of Appropriate [Tier 2] Soil Screening Values

The CLEA model is based upon defined exposure scenarios and six generic land uses have been established for the C4SLs and S4ULs. These set out a discrete set of circumstances where exposure may occur, including a source, the pathways, and the exposed population.

The three generic land use scenarios used in the development of SGVs are:

- commercial/industrial;
- allotments; and,
- residential with plant uptake;
- residential without plant uptake;
- public open space (residential);
- public open space (parks)

It is noted that the CLEA screening values are generic and not always applicable. Where the CLEA conceptual model is not appropriate it will be necessary to develop site-specific Detailed Quantitative Risk Assessment screening values as a further stage of assessment.

It is noted that the CLEA model does not consider risks from contaminated waters beneath the site to human health and the model also assumes that no free product is present. Should such conditions exist at the subject site the requirement for application of an alternative risk assessment model should be

⁴⁶ <http://planningguidance.planningportal.gov.uk/blog/guidance/land-affected-by-contamination/land-affected-by-contamination-guidance/>

assessed. Alternatively, construction workers are potentially exposed to acute risk and therefore require separate consideration.

Statistical Analysis of Soil Analytical Results

Statistical analysis of soil sample analytical results has been undertaken in accordance with CL:AIRE Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration (v1.1 February 2021).

This approach emphasises the use of summary statistics - primarily the use of confidence intervals around mean soil contaminant concentrations - as only one tool in assessing soil contamination data. Key questions being asked are:

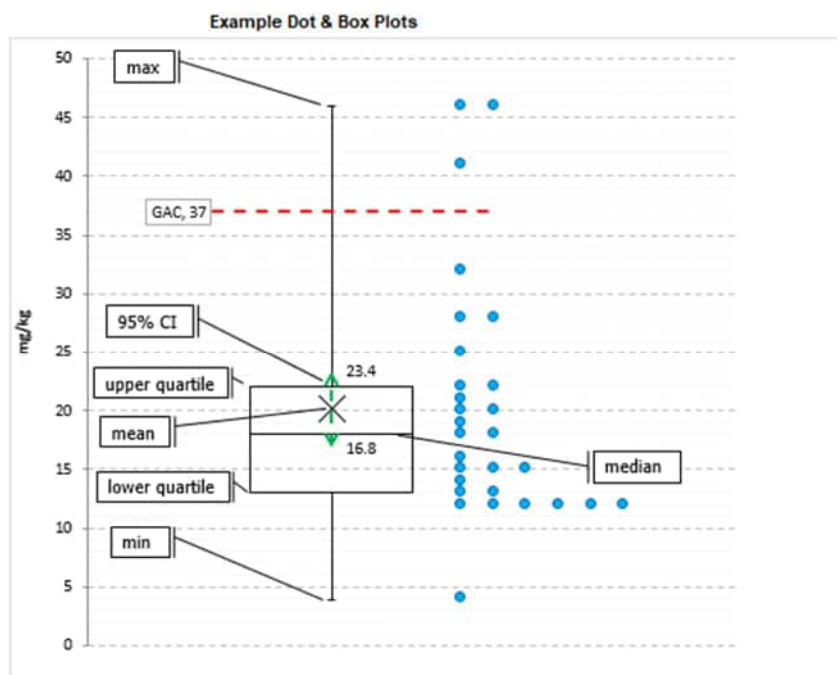
1 - what is the true mean contaminant concentration for the averaging zone or area being sampled?; and,

2 - does our sampling strategy and Conceptual Site Model (CSM) allow us to answer the first question?

For a planning scenario, when the distribution of the contaminant concentration data is well understood by the CSM, the question is then asked 'can we confidently say that the mean concentration is below the critical concentration?'; while for a Part 2A scenario the question is 'can we say on the balance of probabilities that the mean concentration is above the critical concentration'.

Site information is reviewed to determine if zoning of the site is appropriate. This includes assessment of: history and differing land uses, known areas of infilling, anecdotal information, exploratory hole logging and images of soil profiles, and looking for any discernible pattern in the results themselves. Additional summary tables are presented where appropriate to reflect distinct zones relevant to the CSM. The soil results may also be assessed as an averaging area where the end use dictates, for example for an area of proposed residential housing with gardens and a separate area of public open space.

An example is shown below of dot and box plots and summary statistics from assessment of the soil sample analysis results. This summary aids in interpreting the results and checking that they 'make sense' in relation to the CSM. For example, if the mean and upper confidence interval are below the critical concentration, yet there are results that still exceed, are these results from the expected distribution, or is there a separate zone or soil layer which these results represent? Looking at all of the site information and always trying to better understand the CSM is essential to interpreting the results. It may be that insufficient information has been gathered in order to confidently answer the key questions posed.



Example Summary Statistics

Sample number	29
Maximum	46
Upper Quartile	22
Median	18
Lower Quartile	13
Minimum	3.9
GAC value	37
Number exceeding	3 / 29
Mean 'X'	20.1
Standard deviation	10.3
Interquartile range	9.0
95% Confidence Interval	
	16.8 23.4

The 95% confidence intervals are adopted under planning scenarios in order to be risk conservative and aid in decision making. Use of a narrower confidence interval i.e. 80%, or even the mean may be used, if deemed appropriate by the Local Authority, under a Part 2A scenario. The use of confidence intervals in our assessments is underpinned by the Central Limit Theorem, which can be briefly stated as 'The distribution of sample means converge to a normal distribution as the sample size increases'. The confidence intervals are calculated:

- Lower confidence limit (LCL) = Sample Mean – T × Standard Error
- Upper confidence limit (UCL) = Sample Mean + T × Standard Error

Where T is the T-statistic as derived from the Student T distribution based on the desired confidence level C% and the number of degrees of freedom (sample size -1).

The confidence intervals calculated in this way assume that the sample mean comes from a normal distribution regardless of what distribution the individual samples themselves come from. However, the Central Limit Theorem, and therefore this assumption, only holds if the sample size is sufficiently large. How many samples is 'sufficient' varies from site to site, and the sampling strategy must take into account the sampling pattern and frequency that will be required.

There are three main types of sample result distribution: symmetric (following a normal distribution); log-symmetric (log-transformed values follow a normal distribution); or, fat-tailed (with one or more extreme values in the results). While the confidence intervals may be applied to the mean for all three types of distribution, it is apparent that this may be increasingly skewed towards either very small or very large values within the results.

In addition to visually assessing the distribution, a potential outlier test is applied. This is calculated as values that are greater than 1.5 times the interquartile range. These values are flagged for further assessment. The CSM is revisited to see if there is either evidence of diffuse contamination poorly mixed

with 'cleaner' soils, or there is the potential for 'hotspot/s'. If the latter, then the results are assessed separately and further delineation of the hotspot could be carried out.

Water Screening Values

This assessment considers potential risks to controlled waters (groundwater and surface waters) in relation to risks from any historical contamination. The most stringent test is that defined for Contaminated Land under Part 2A of the Environmental Protection Act, 1990. However, it should be recognised that a wider evaluation of risk is considered within the planning regime and EA's Land Contamination Risk Management.

The Environment Agency has a wider policy agenda for the protection of controlled waters that will impinge upon judgements in relation to land contamination issues. This includes those for the Water Framework Directive and Groundwater Directive and wider legislation for both groundwater, surface water and associated elements (such as fisheries)⁴⁷.

The results of water analysis have been compared to screening values selected to assess the potential risk to the identified controlled water receptors in the Conceptual Model. The specific standards utilised for this purpose are considered in the assessment table footnotes and typically comprise: Environmental Quality Standards for the protection of aquatic life; Surface Water Standards; EC, UK and WHO Drinking Water Standards; or Background water quality (where no applicable standard exists).

The initial assessment considers the sensitivity of the receptor in the selection of the screening value. Advice for this purpose has been obtained principally from Environment Agency Technical Advice to Third Parties on Pollution of Controlled Waters for Part 2A of the Environmental Protection Act 1990, No 07/02, EA, 2002 (INFO-RA2-3e), as informed by the EA's GP3.

Where a viable potential contaminant linkage is considered to be present and the screening criteria exceeded, a Qualitative Risk Assessment is presented with associated recommendations. Depending on the specific objectives, policy and practice of the Environment Agency, discussion of water screening values may be subsequently required.

The water quality standards have been chosen in accordance with section 4.2 of the EA's Remedial Targets Methodology as informed by the EA's Groundwater Protection Guides (2017).

Generic Screening Values

The sources of the screening values and associated guidance are provided below.

	Key Guidance
Soil	LQM/CIEH S4ULs for Human Health Risk Assessment.*
	Defra Development of Category 4 Screening Levels Main Report and associated documents
	GAC derived in-house using Environment Agency CLEA Version 1.071 software, Environment Agency Science Reports SC050021 SR2/SR3, LQM/CIEH S4UL, and application of the top two approach to homegrown produce.
	CIRIA - Asbestos in soil and made ground: a guide to understanding and managing risks, March 2014
Water	EA Groundwater Protection Guides, March 2017.

⁴⁷ Refer to Environmental Agency Publications for Groundwater Protection Policy and Practice (GP3)

	Key Guidance
	The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015
	Water Environment (Water Framework Directive) (England and Wales) (Amendment) Regulations 2015
	EC and UK Drinking Water Standards.
	WHO Drinking Water Standards.
	Background Water Quality.
Gas	CIRIA C748, 'Guidance on the use of plastic membranes as VOC vapour barriers'.
	CIRIA C735, 'Good practice on the testing and verification of protection systems for buildings against hazardous ground gases'.
	BS 8576:2013, 'Guidance on investigations for ground gas – permanent gases and VOCs'
	CIRIA Report C665, 'Assessing Risks Posed by Hazardous Ground Gases to Buildings'
	CIRIA Report C682, 'VOCs Handbook: investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination'
	British Standard BS:8485+A1:2019, 2015, 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'.
	CIRIA Report 150 'Methane Investigation Strategies'.
	BRE 414 'Protective Measures for Housing on Gas Contaminated Land', 2001.
	The Building Regulations 2000, Approved Document C, Section 2. Updated 2004.
	BR211, 'Radon: Guidance on Protective Measures for New Buildings', 2015.
	Health Protection Agency Publication HPA RPD-033, 2007, 'Indicative Atlas of Radon in England and Wales.

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DEFINITIONS OF CONSEQUENCE, PROBABILITY AND RISK

The categories of risk have been based upon those defined in the Guidance for the Safe Development of Housing on Land Affected by Contamination, R&D66: 2008 Volume 1 (Environment Agency, NHBC and CIEH). The classification process is shown in the table below. In summary, risk is defined by the combination of two factors: i) the probability of an occurrence (expressed as a likelihood); and ii) the consequence of it happening (expressed as a severity).

Classification of Risk

Probability (Likelihood)		Consequence			
		Severe	Medium	Mild	Minor
	High likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

The key to the classification is that the designation of risk is based upon the consideration of both:

- the magnitude of the potential consequence (i.e. severity).
[takes into account both the potential severity of the hazard and the sensitivity of the receptor]
- the magnitude of probability (i.e. likelihood).
[takes into account both the presence of the hazard and receptor and the integrity of the pathway]

Classification of Consequence

Classification	Definition	Examples
Severe	Highly elevated concentrations likely to result in "significant harm" to human health as defined by the EPA 1990, Part 2A, if exposure occurs. Equivalent to EA Category 1 pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce.	Significant harm to humans is defined in circular 01.2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Major fish kill in surface water from large spillage of contaminants from site. Highly elevated concentrations of List I and II substances present in groundwater close to small potable abstraction (high sensitivity).

Classification	Definition	Examples
	Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Catastrophic damage to crops, buildings or property.	Explosion, causing building collapse (can also equate to immediate human health risk if buildings are occupied).
Medium	Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990, Part 2A if exposure occurs. Equivalent to EA Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Damage to building rendering it unsafe to occupy e.g. foundation damage resulting in instability. Ingress of contaminants through plastic potable water pipes.
Mild	Exposure to human health unlikely to lead to "significant harm". Equivalent to EA Category 3 pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population. Minor damage to crops, buildings or property.	Exposure could lead to slight short-term effects (e.g. mild skin rash). Surface spalling of concrete.

Classification	Definition	Examples
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.	The loss of plants in a landscaping scheme. Discoloration of concrete.

Classification of Probability

Classification	Definition	Examples
High likelihood	There is potential contaminant linkage and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.	a) <i>Elevated concentrations of toxic contaminants are present in soils in the top 0.5m in a residential garden.</i> b) <i>Ground/groundwater contamination could be present from chemical works, containing a number of USTs, having been in operation on the same site for over 50 years.</i>
Likely	There is potential contaminant linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.	a) <i>Elevated concentrations of toxic contaminants are present in soils at depths of 0.5-1.0m in a residential garden, or the top 0.5m in public open space.</i> b) <i>Ground/groundwater contamination could be present from an industrial site containing a UST present between 1970 and 1990. The tank is known to be single skin. There is no evidence of leakage although there are no records of integrity tests.</i>
Low likelihood	There is potential contaminant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place, and is less likely in the shorter term.	a) <i>Elevated concentrations of toxic contaminants are present in soils at depths >1m in a residential garden, or 0.5-1.0m in public open space.</i> b) <i>Ground/groundwater contamination could be present on a light industrial unit constructed in the 1990s containing a UST in operation over the last 10 years – the tank is double skinned but there is no integrity testing or evidence of leakage.</i>

Classification	Definition	Examples
Unlikely	There is potential contaminant linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.	a) <i>Elevated concentrations of toxic contaminants are present below hardstanding.</i> b) <i>Light industrial units <10 yrs old containing a double-skinned UST with annual integrity testing results available.</i>

Note: A potential contaminant linkage must first be established before probability is classified. If there is no pollution linkage then there is no potential risk. If there is no potential contaminant linkage then there is no need to apply tests for probability and consequence.

For example, if there is surface contamination and a principal aquifer is present at depth, but this principal aquifer is overlain by an aquiclude of significant thickness then there is no pollution linkage and the risks to the principal aquifer are not assessed. The report should identify both the source and the receptor but state that because there is no linkage there are no potential risks.

Description of the Classified Risks

Very high risk

There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action OR there is evidence that severe harm to a designated receptor is already occurring. Realisation of that risk is likely to present a substantial liability to be site owner/or occupier. Investigation is required as a matter of urgency and remediation works likely to follow in the short-term.

High risk

Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short-term and are likely over the longer term.

Moderate risk

It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term.

Low risk

It is possible that harm could arise to a designated receptor from identified hazard, but it is likely at worst, that this harm if realised would normally be mild. It is unlikely that the site owner/or occupier would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.

Very low risk

It is a low possibility that harm could arise to a designated receptor, but it is likely at worst, that the harm if realised would normally be mild or minor.

No potential risk

There is no potential risk if no pollution linkage has been established.

LIMITATIONS

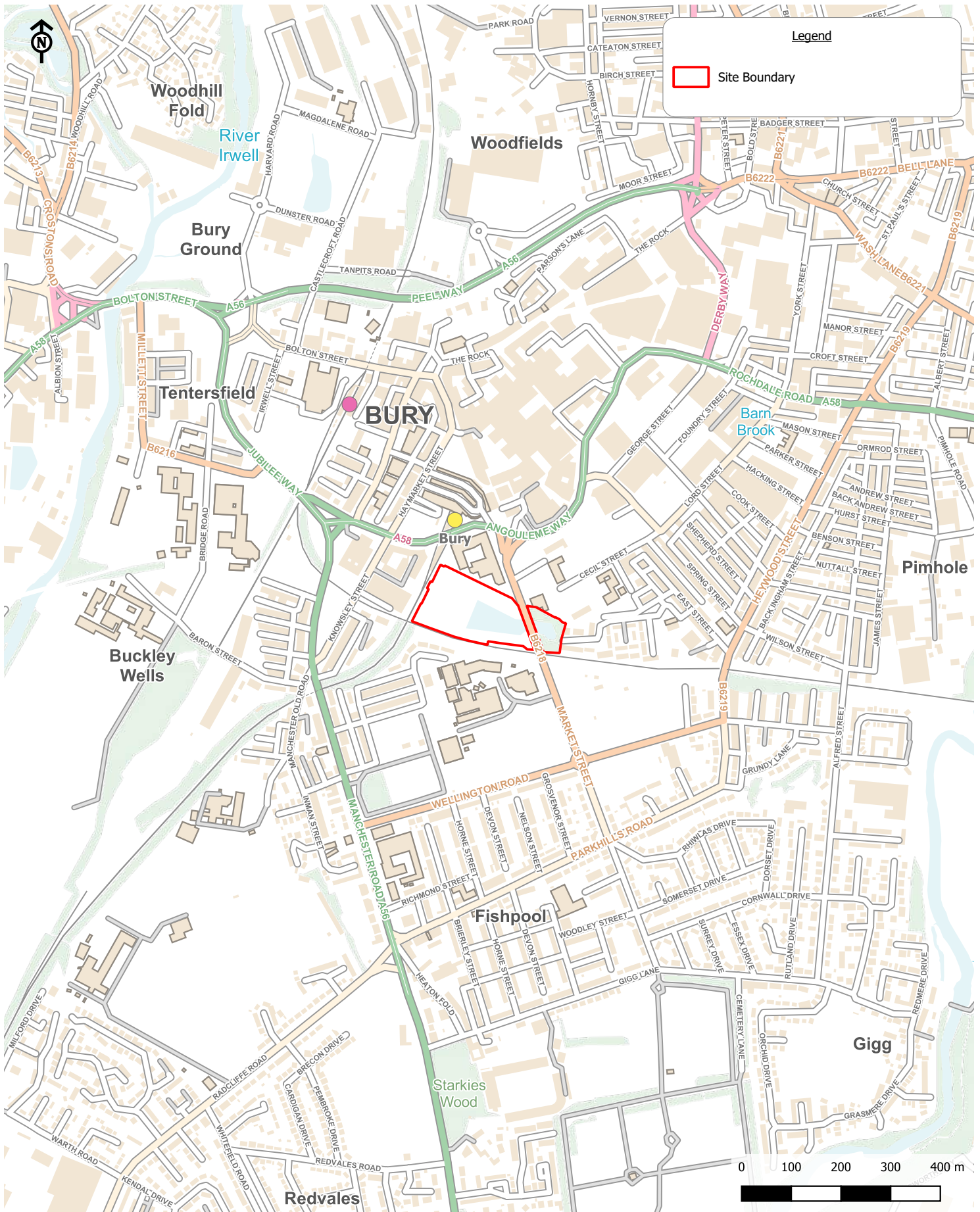
Environmental & Geotechnical Interpretative Reports

1. This report provides available factual data for the site obtained only from the sources described in the text and related to the site on the basis of the location information provided by the client.
2. Where any data or information supplied by the client or other external source, including that from previous studies, has been used, it has been assumed that the information is correct. No responsibility can be accepted by CampbellReith for inaccuracies within this data or information. In relation to historic maps the accuracy of maps cannot be guaranteed and it should be recognized that different conditions on site may have existed between and subsequent to the various map surveys
3. This report is limited to those aspects of historical land use and enquiries related to environmental matters reported on and no liability is accepted for any other aspects. The opinions expressed cannot be absolute due to the limit of time and resources implicit within the agreed brief and the possibility of unrecorded previous uses of the site and adjacent land.
4. The material encountered and samples obtained during on-site investigations represent only a small proportion of the materials present on the site. There may be other conditions prevailing at the site which have not been revealed and which have therefore not been taken into account in this report. These risks can be minimised and reduced by additional investigations. If significant variations become evident, additional specialist advice should be sought to assess the implications of these few findings.
5. The generalised soil conditions described in the text are intended to convey trends in subsurface conditions. The boundaries between strata are approximate and have been developed on interpretations of the exploration locations and samples collected.
6. Water level and gas readings have been taken at times and under conditions stated on the exploration logs. It must be noted that fluctuations in the level of groundwater or gas may occur due to a variety of factors, which may differ from those prevailing at the time the measurements were taken.
7. Please note that CampbellReith cannot accept any liability for observations or opinions expressed regarding the absence or presence of asbestos or on any product or waste that may contain asbestos. We recommend that an asbestos specialist, with appropriate professional indemnity insurance, is employed directly by the client in every case where asbestos may be present on the site or within the buildings or installations. Any comments made in this report with respect to asbestos, or asbestos containing materials, are only included to assist the client with the initial appraisal of the project and should not be relied upon in any way.
8. The findings and opinions expressed are relevant to those dates of the reported site work and should not be relied upon to represent conditions at substantially later dates.
9. This report is produced solely for the benefit of the client, and no liability is accepted for any reliance placed upon it by any other party unless specifically agreed in writing.

Appendix 1

Figures

- Figure 1: Site Location
- Figure 2: Annotated Site Layout
- Figure 3: Proposed Masterplan Options
- Figure 4a: Artificial and Superficial Geology
- Figure 4b: Bedrock Geology
- Figure 5: Exploratory Hole Location Plan
- Figure 6: Ground Model
- Figure 7: SPT vs Depth Plot
- Figure 8: Moisture Content & OMC vs Depth
- Figure 9: Casagrande Chart
- Figure 10: Undrained Shear Strength
- Figure 11a: MCV results - Made Ground
- Figure 11b: MCV results - Glacial Deposits



Pyramid Park Enabling Works
Client: Homes England

Figure 1:
Site Location

Scale: 1:10000@A4
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Job Number: 14111
Drawn by - Checked by: RLF - RA
Drg No - Status/Revision: 14111-CRH-XX-XX-FG-G-7010 - P1
File location: N:\14000 - 14249\14111 M - Pyramid Park Enabling Works\Project_Workspaces\LQS (pdf in Outputs)
Date (Revision History): 07/03/2024 (P1, First Issue, 07/03/24, RLF)

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Legend

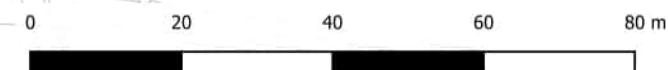
Site Boundary

Pyramid structures

Market Street overpass running over the site

Historical pond

Existing access ramp from Market Street



Pyramid Park Enabling Works

Client: Homes England

Figure 2:
Site Layout

Scale: 1:1000@A3
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InoRail - Topographical Survey: P-223-090-SUR-DWG-0001 (Feb 2022)
Job Number: 14111
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Drg No - Status/Revision: 14111-CRH-XX-XX-FG-G-7011 - P1
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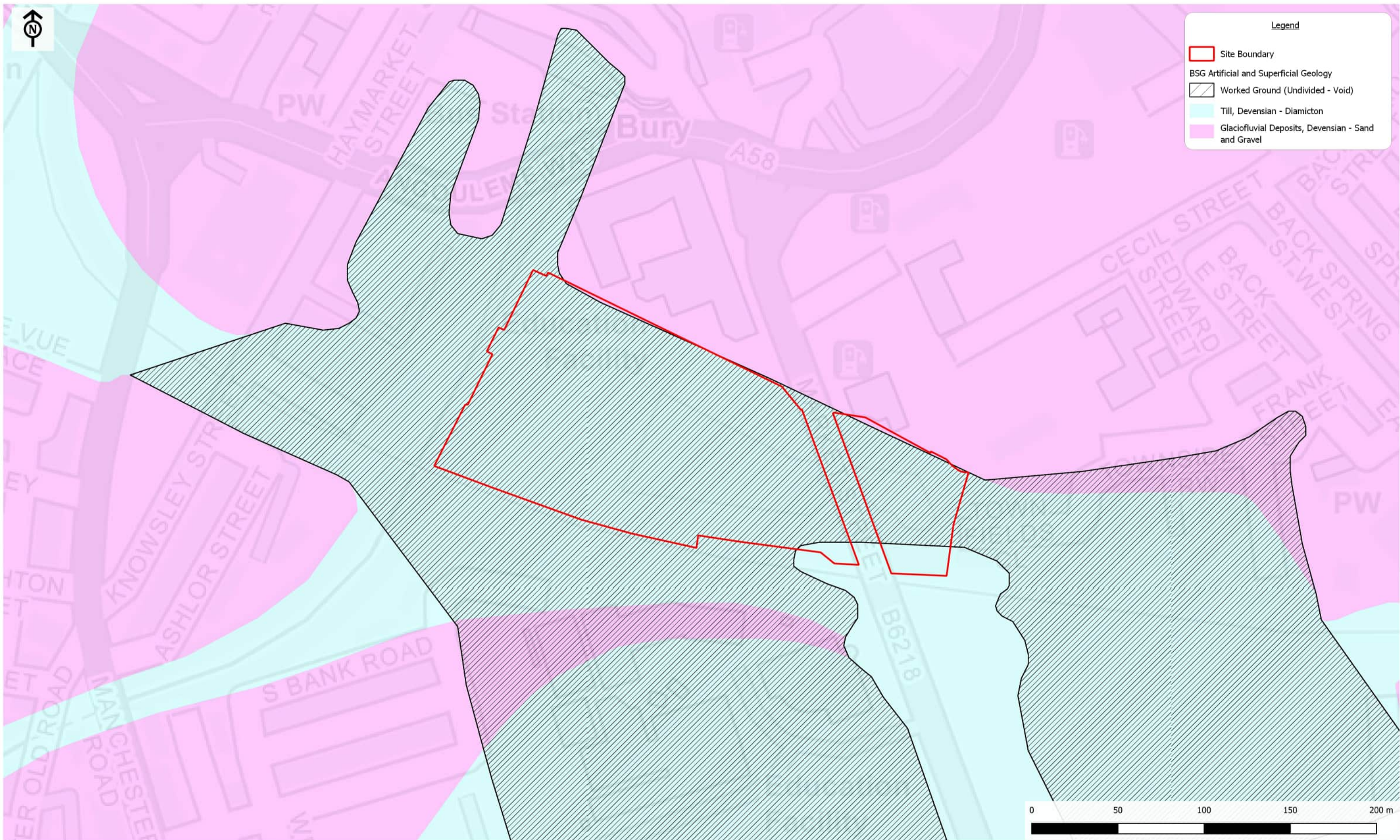
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Figure 3:
Proposed Layout



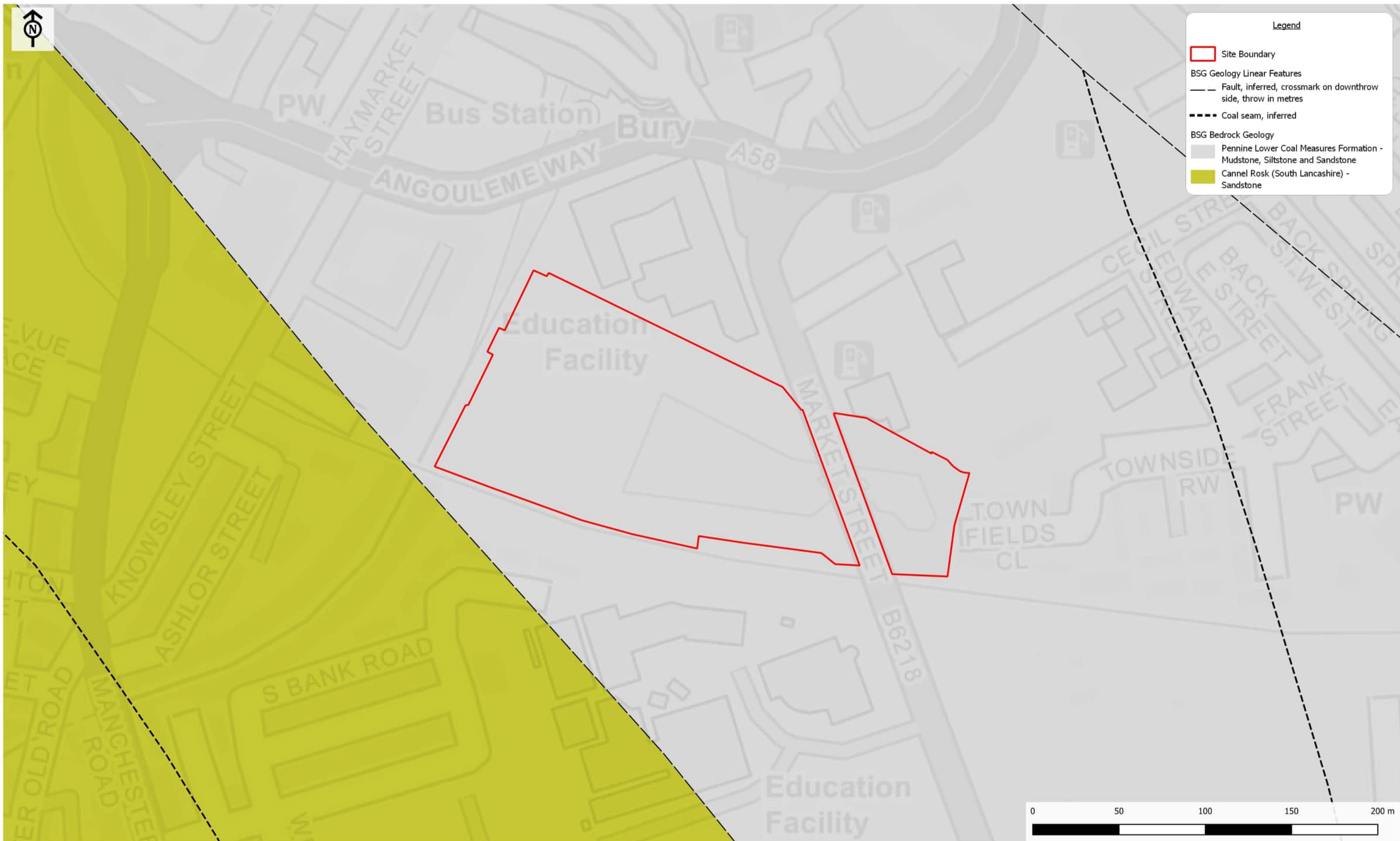
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Figure 4a:
Artificial and Superficial Geology as indicated by BGS

Scale: 1:2000@A3
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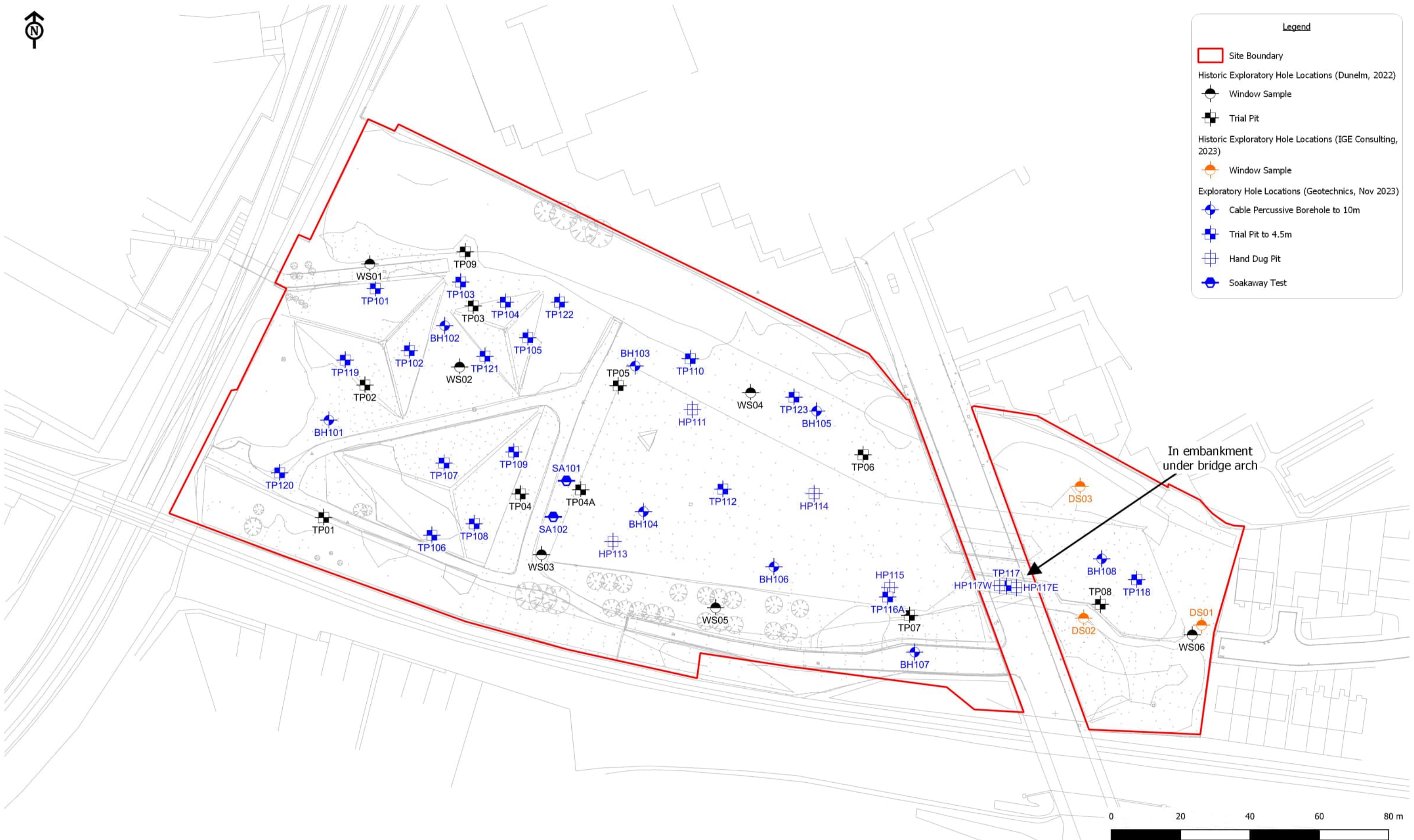
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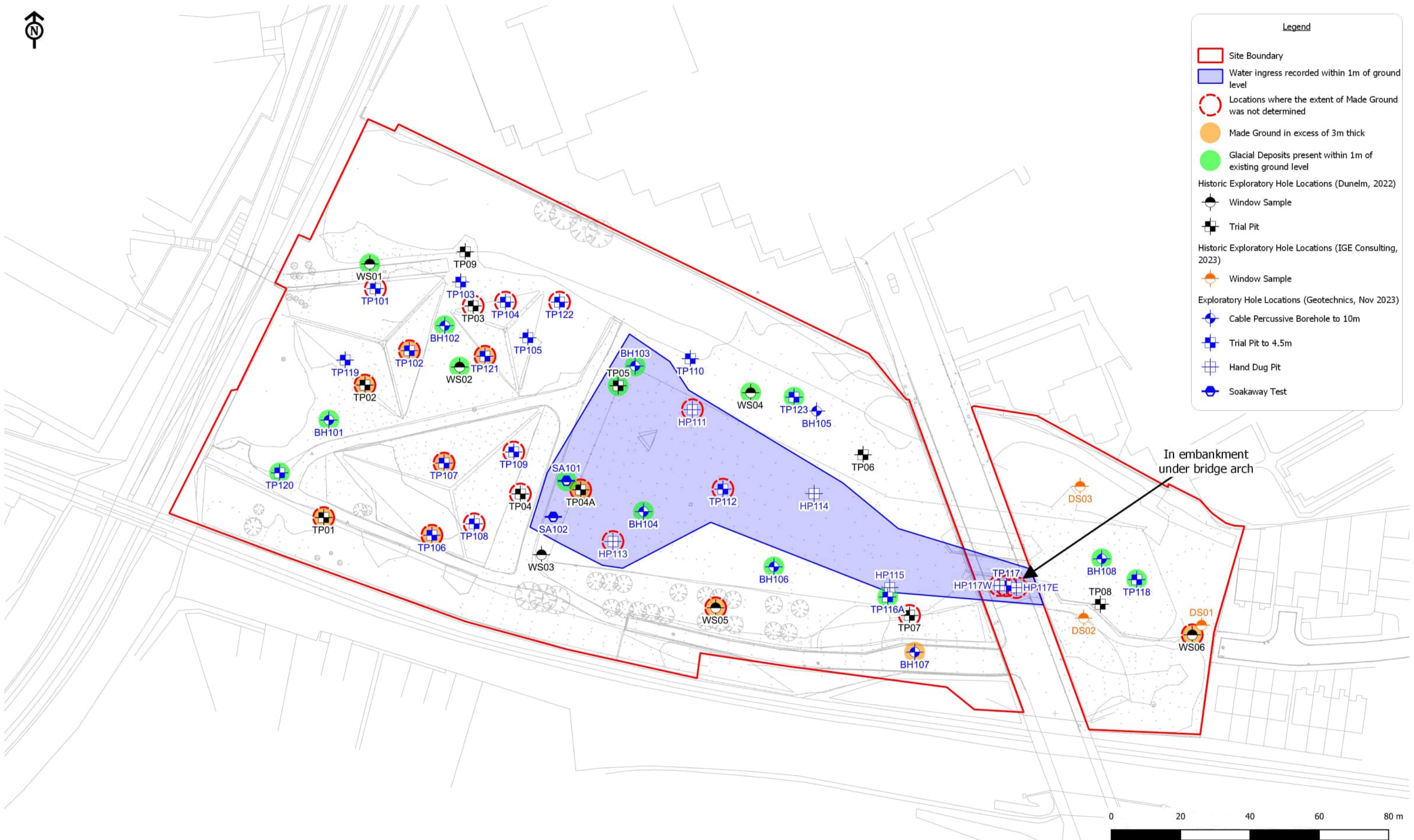
Figure 4b:
Bedrock Geology as indicated by BGS



Pyramid Park Enabling Works

Client: Homes England

Figure 5:
As Built Exploratory Hole Location Plan



Pyramid Park Enabling Works

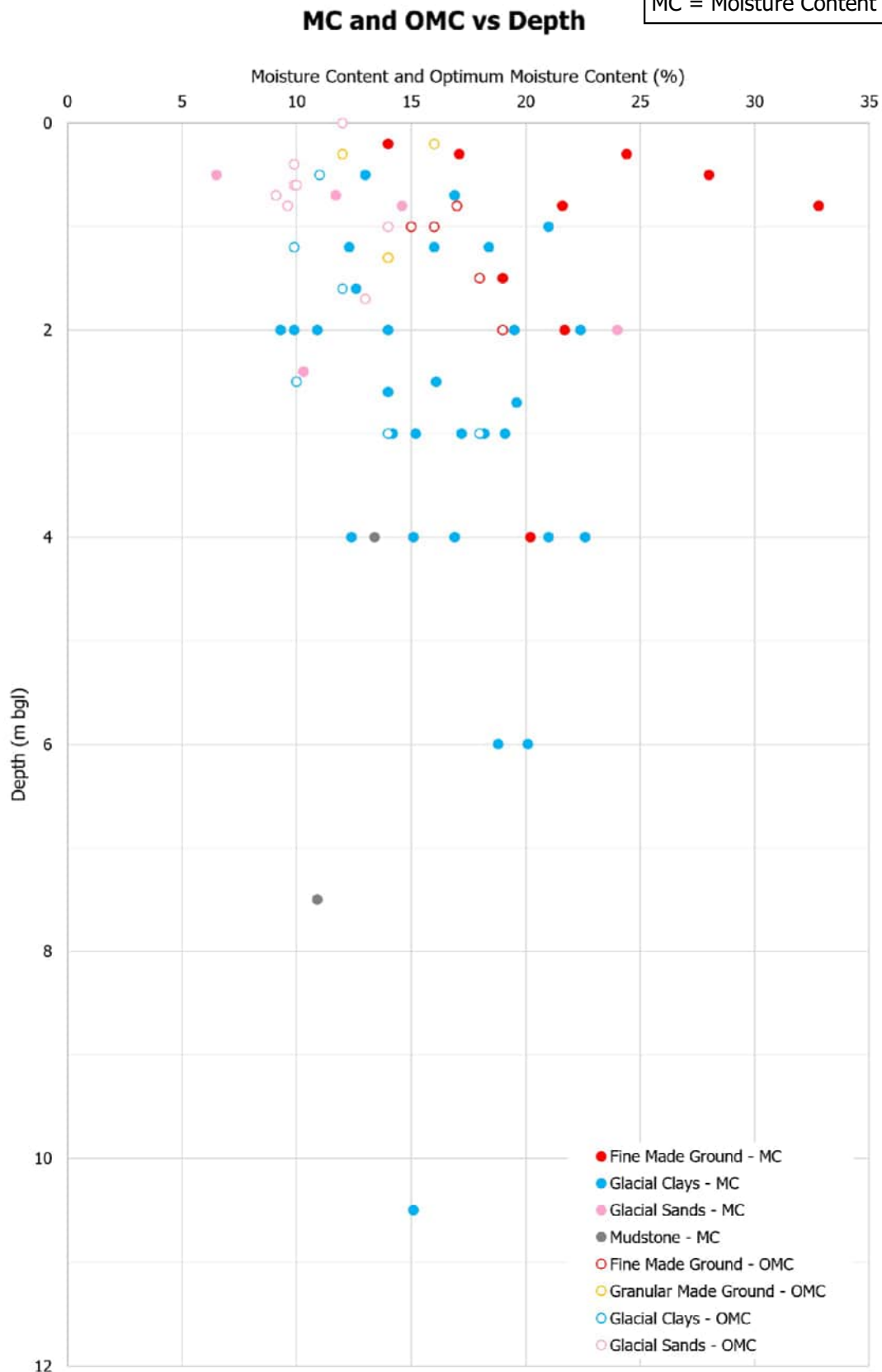
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Figure 6:
Ground Model

SPT N_{60} Value (blows/300mm)



Note:
 OMC = Optimum Moisture Content
 MC = Moisture Content



Pyramid Park Enabling Works

Client: Homes England

Figure 8:
 Moisture Content & OMC vs Depth

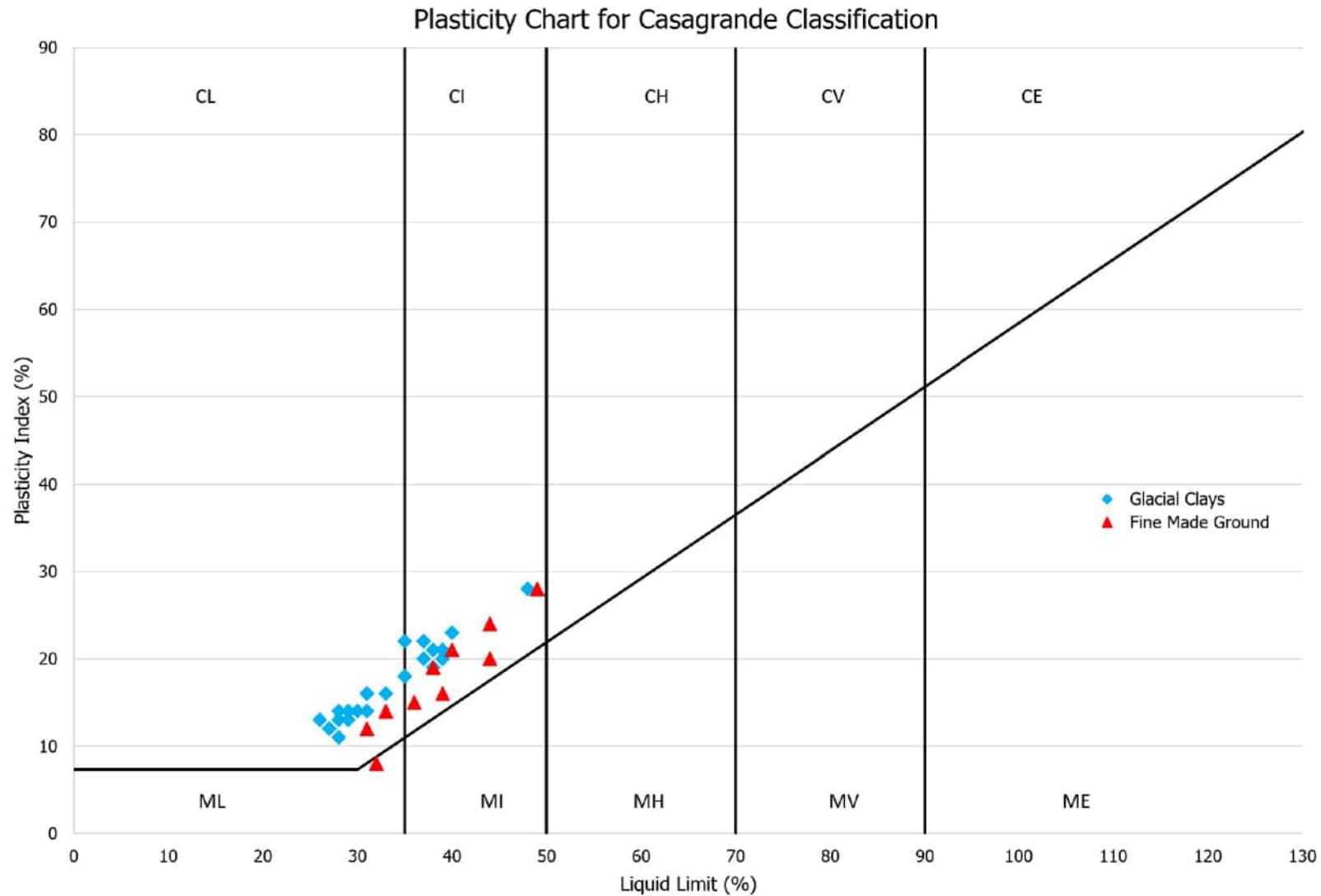
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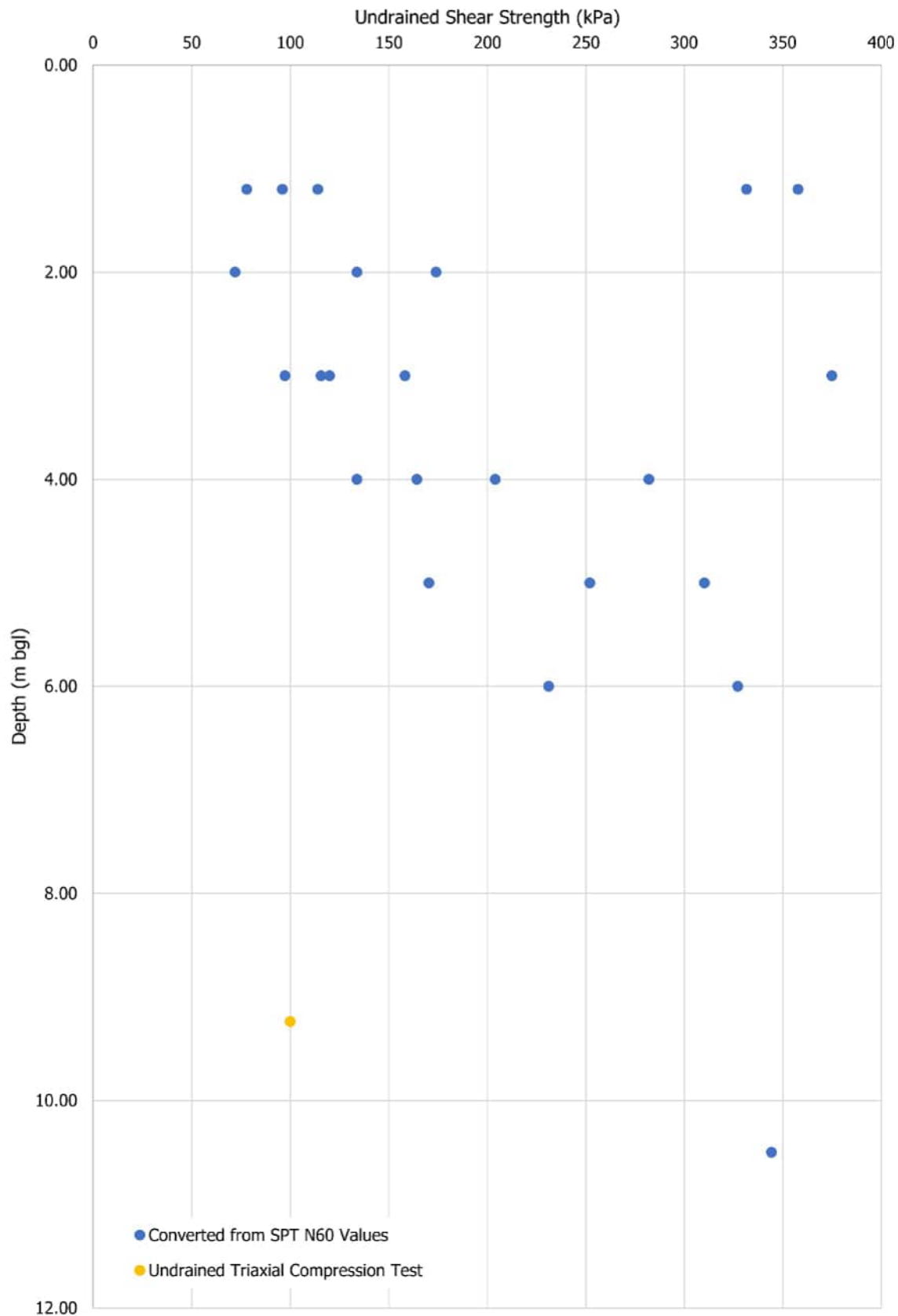
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Undrained Shear Strength of Glacial Clays



Pyramid Park Enabling Works

Client: Homes England

Figure 10:

Glacial Clays Undrained Shear Strength Results

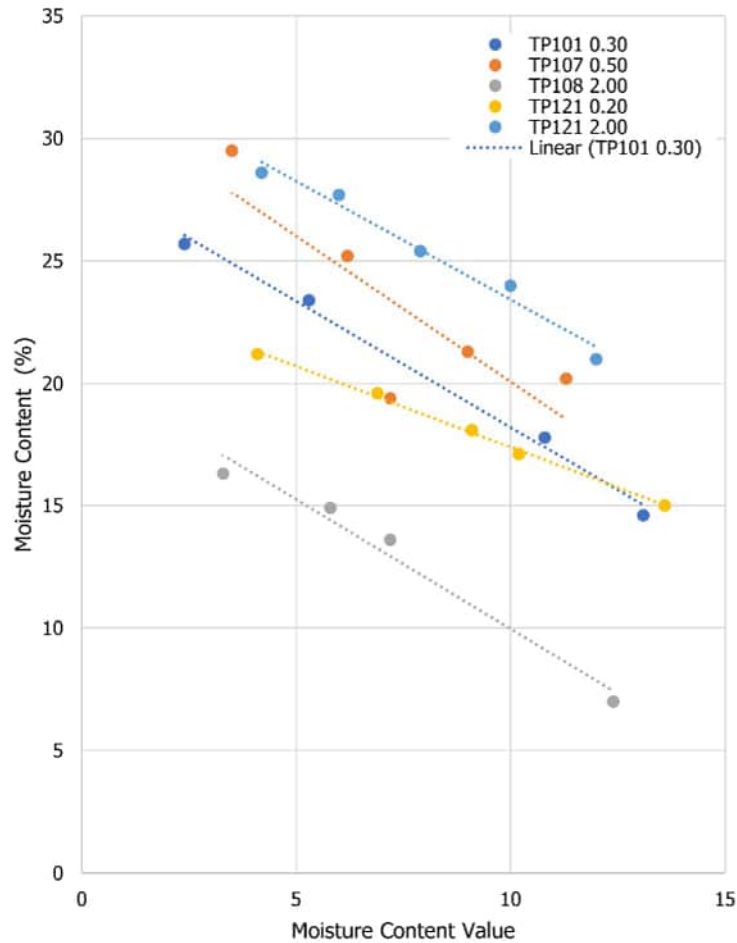
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CampbellReith OS Copyright: © Crown copyright. All rights reserved. Licence number AC0000812907

Job Number: 14111
Drawn by - Checked by: RLF - RA
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Date (Revision History): 25/03/2024 (P1, First Issue, 25/03/24, RLF)

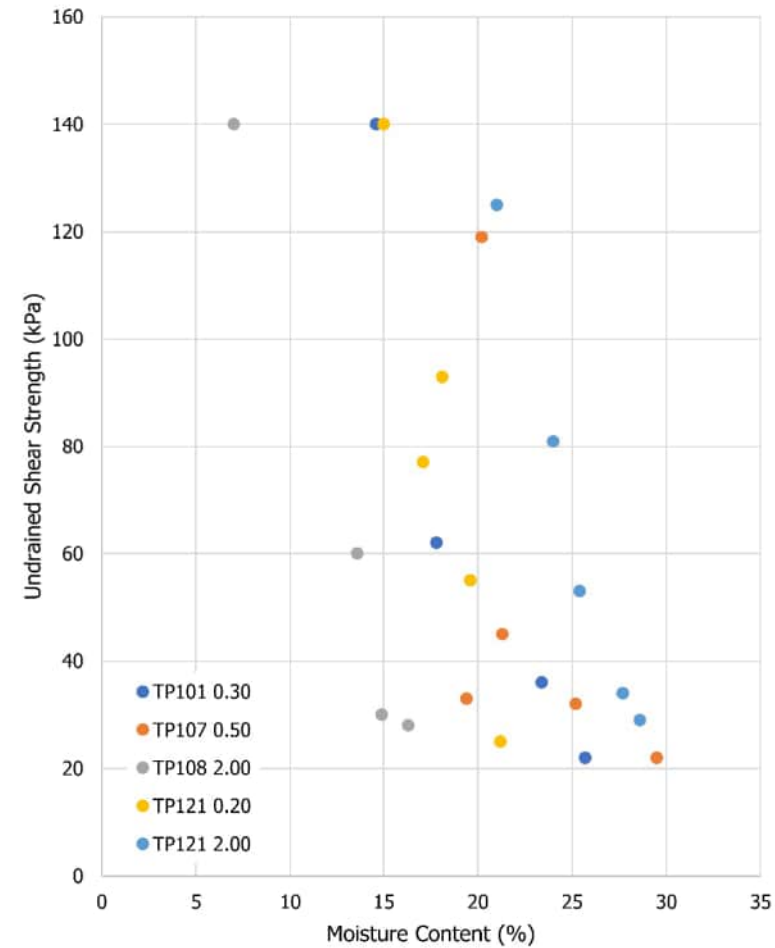
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BRISTOL 0117 916 1066 □ BIRMINGHAM 01675 467 484
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**MCV vs Moisture Content
(Made Ground)**



**Moisture Content vs Shear Vane Test
(Made Ground)**



Pyramid Park Enabling Works

Client: Homes England

Figure 11a:
Made Ground MCV Results

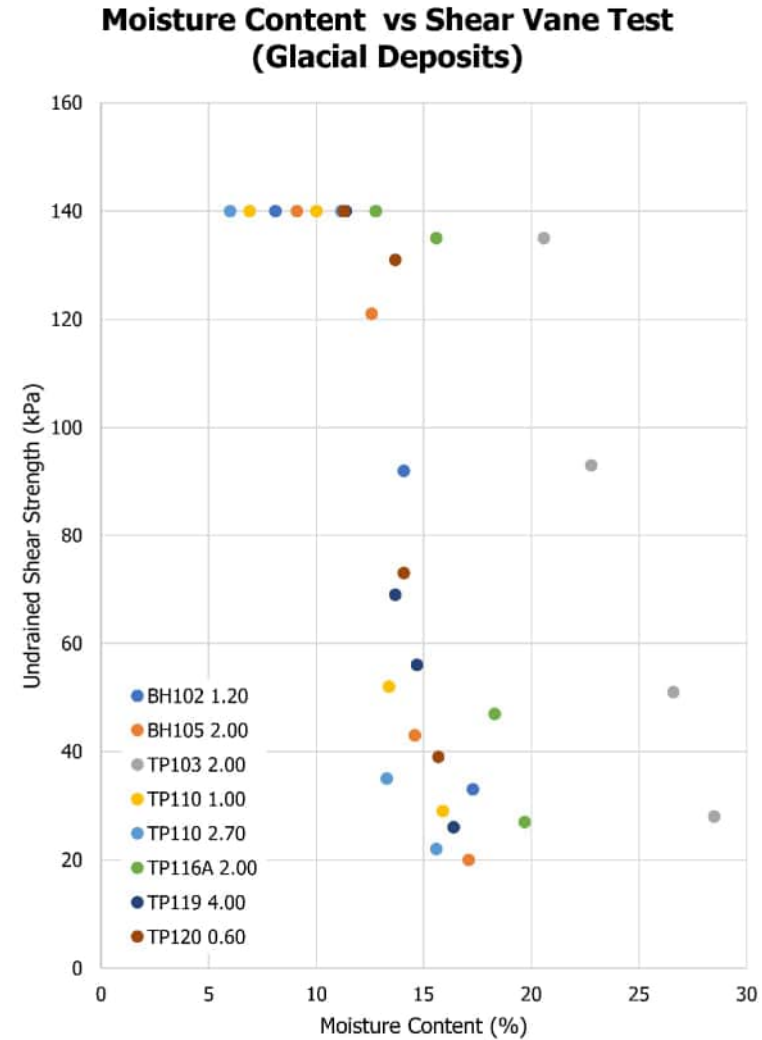
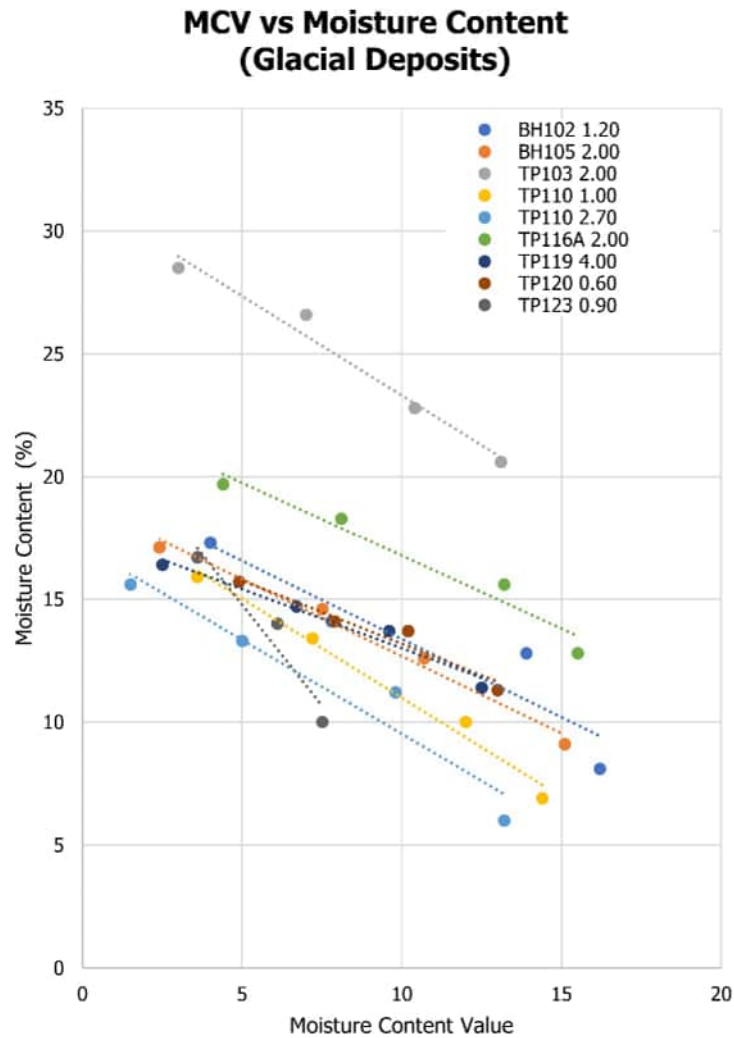
Scale: NTS@A4
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Job Number: 14111
Drawn by - Checked by: RLF - RA
Drg No - Status/Revision: 14111-CRH-XX-XX-FG-G-7021 - P1
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Date (Revision History): 25/03/2024 (P1, First Issue, 25/03/24, RLF)

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Pyramid Park Enabling Works

Client: Homes England

Figure 11b:
Glacial Deposit MCV Results

Scale: NTS@A4
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Job Number: 14111
Drawn by - Checked by: RLF - RA
Drg No - Status/Revision: 14111-CRH-XX-XX-FG-G-7022 - P1
File location: N:\14000 - 14249\14111 M - Pyramid Park Enabling Works\Project_Workspaces\LQS (pdf in Outputs)
Date (Revision History): 25/03/2024 (P1, First Issue, 25/03/24, RLF)

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Appendix 2

Desk Study Information

Bury Council Environmental Search Report
(Ref: ES859.120122.1), dated January 2022

Geoff Little OBE
Chief Executive



Our Ref ES859.120122.1
Your Ref EH390824503
Date 12 January 2022
Please ask for Judith Scott
Direct Line 0161 253 5581
Direct Fax 0161 253 5563
E-mail j.scott@bury.gov.uk

Donna Ball
Executive Director, Operations

Peter Kenny
Campbell Reith
No 1 Marsden Street
Manchester
M2 1HW

Dear Peter

ENVIRONMENTAL SEARCH REQUEST
Townside Fields, Market Street, Bury

Further to your recent enquiry regarding the above site, the Environment Section holds the following information:

The site is approximately 3 hectares in area and is located at National Grid Reference 380503 410331. The current OS plan is attached showing its location.

Please be careful to check the approximate scales on each plan enclosed as some will vary depending on the search parameters.

Contamination issues at or immediately adjacent to the site

This Section does not hold any information relating to the ground conditions at the site. It is not known what, if any ground contamination exists at the site.

The site has historically been in use a railway line, railway sidings, a goods shed, a goods station, and was later developed as a lake and area of open space. Please see attached historical maps and aerial photographs attached.

If the site is to be redeveloped, it is likely that as a minimum a preliminary risk assessment and characterisation of ground conditions including sampling of the soils will be required along with a watching brief during ground works under the planning regime.

This Section holds the following information relating to the ground conditions adjacent to the site. The location of these reports is shown on the attached plan.

CL001b Southbank Road, Bury

The following report was submitted in support of a planning application for a housing development:

Privacy Policy

Please visit www.bury.gov.uk/privacy to read our recently updated Privacy Policy which explains how Bury Council uses and shares your personal data to give you the best possible experience across our services.

Electronic or fax service of Legal documents is not accepted

Town Hall, Knowsley Street, Bury, BL9 0SW
www.bury.gov.uk

- Ground Investigation Ltd, South Bank Road, Bury, Norwest Holst Soil Engineering Limited, Reference: MAN/TW/F9732, May 1993.

A site investigation was carried out in 1993 in support of the planning application for the housing development. The investigation concluded that gas protection measures would be required in the development. No ground sampling was carried out.

CL262 Townside Fields, Knowsley Street, Bury Council

The following reports were submitted in support of planning applications (47200, 49423, 51022 for a mixed use residential, offices and commercial development:

- Geo-Environmental Interpretive Report, Volume 1, Townside Fields, Faber Maunsell, December 2005.
- Remediation Strategy Report, Townside Fields, Faber Maunsell, Reference 53328IALE/001, July 2007.
- Remediation & preparatory Works Verification Report, Townside Fields, Reference:SS/017080/RVR-01, Capita Symonds, December 2009.
- Site Verification Report, Townside Fields, Angouleme Way, PCT and BMBC Buildings, Alderburgh Ltd, Report: 2874/LS, December 2009.
- Letter Report and Design and Installation Drawings, Faber Maunsell, Carillion, 8 January 2010.

Exceedances of contaminants were found and slightly elevated levels of ground gas. Remedial measures including gas protection measures were completed and planning conditions discharged.

CL589 Bury College Woodbury Centre, Market Street Bury

The site was investigation on support of planning application 53857 for the demolition of the building and the development of a 5 storey building.

- Phase I Appraisal, Desk Study Report, Bury College, Woodbury Centre, GRM, Reference: GRM/P5368/DS.1 December 2010.
- Phase II Appraisal, Ground Investigation Report, Bury College, Woodbury Centre, GRM, Reference: GRM/P5368/F.3, May 2011.

Soil cover system in landscaped areas and gas protection measures in the building were required. A Validation Report has not been received.

CL702 Bury Times Ltd, Market Street, Bury

The site was investigated in support of planning application 56106 for a five storey extension to the existing Enterprise Centre.

- Short Form Site Assessment for Bury Times Building, Bury, GRM, Reference: GRM/P4874/IA.1, May 2009.
- Letter Report – Additional Investigation Works, Bury College (Former Bury Times Building) Extension, GRM, Reference: P4874-BT2, 21 January 2013.

No remedial measures were required for the development.

Landfill Sites within 250 metres

The site is located within 250 of five known landfill sites, locations of which can be found on the attached plan:

Landfill Name: Pyramid Park

File reference: C078 Grid Ref.: 380750 410250

The site was filled with inert subsoil as part of a Reclamation scheme with material imported from Moss Lane, Whitefield and Porritt Street, Freetown. The site is pre – licensing and was filled in 1973. The site is currently split into car parking and open space.

Site investigations carried out in 2005 and 2006 show generally reworked natural clays over shallow demolition wastes possibly from previous land uses.

The entire landfill site was redeveloped in late 2000s and early 2010s as commercial development comprising a hotel, offices and car park under Planning Application 47200. Remedial measures were carried out which included significant earthworks, gas protection measures and clean cover in soft landscaped areas.

Landfill Name: Wellington Road, Bury

File reference: C085 Grid Ref.: 380750 410000

A relatively small landfill filled with mainly domestic waste with some underlying peat. The site is pre waste management licensing and is currently owned by Bury MBC and in use as public open space. Filled between 1970 and 1972. Planning Permission was granted in 1954 for tipping. Gas venting boreholes have been installed to 6.5m deep at 3m intervals linked by a shallow gravel filled trench along the west and south boundaries. A site investigation and carried out under Part 2A of the EPA 1990 in 2012 found that gas production at the site was now low and that the risk of gas migrating laterally off site was very low. Site investigation reports are available for the site which can be viewed if requested.

Landfill Name: Peel College, Bury

File reference: C087 Grid Ref.: 380500 410240

The site is an infilled railway cutting. It is not known what the landfill was filled with. The site is pre – licensing act.

Landfill Name: Disused Railway Cutting, Bridge Road, or (Belle Vue)

File reference: C093 Grid Ref.: 380072 410400

The site is an infilled railway cutting which is now in use as a car park. The site was filled with inert waste under Licence No. RD/LIC/650/90 first issued 1991 and surrendered in 1993. The site is owned by Bury MBC.

Landfill Name: Railway Cuttings East and West of Manchester Road, Bury

File reference: RD/LIC/503/ Grid Ref.: 380135 410417
88

The site is filled with inert and construction waste types. This waste was deposited by Bury MBC under licence No. RD/LIC/503/88 first issued in 1988. Most of the fill was removed to re-open a railway line now used by the East Lancashire Railway.

Please note that the boundaries indicated on the enclosed plan are approximate only and may not reflect the actual extent of fill.

Local areas of landfilling at or within influencing distance of the site may have been carried out for which we hold no records. Please consult historical maps and other sources of information to identify potential areas of filling.

Further information on landfills may be available from the Environment Agency by telephoning 08708 506 506 or visiting their Website: www.environment-agency.gov.uk and completing any on-line enquiry form. Note that the Environment Agency may make a reasonable charge for supplying this information.

Sites determined as statutory contaminated land within 250 metres

No areas of land at or near the site have been determined as Contaminated Land under Part 2A of the Environmental Protection Act (EPA) 1990.

As the site has had a previous potentially contaminating land use, the site is considered a potential site of concern. However, due to the current use of the site the site is not considered a high priority for further investigation under Part 2A of the EPA 1990 and it is considered very unlikely that the site will be investigated in the near future, unless additional evidence that there may be a significant contaminated land issue at the site comes to light.

However, if the site is to be redeveloped for a sensitive end use, it is likely that a minimum preliminary risk assessment and characterisation of ground conditions including sampling of the soils will be required along with a watching brief during ground works under the planning regime.

It would be considered prudent to conduct the above assessments and sampling to indicate potential problems which may require further investigations and / or remedial action. Extracts from historical mapping have been included for your information.

Historical maps for the site

Extracts from Ordnance Survey historical maps 1848, 1893, 1910, 1930, 1937, 1958, 1959, and 1984 are enclosed. Please refer to the maps for details of past uses at the site and surrounding land.

Aerial Photographs for the site

Aerial photography of the site from the 1940s, 1979, 1989, 1997-9, 2000, 2005 and 2011 surveys are enclosed for your information.

Please note that the quality of the earlier photography is limited, however, they do provide an extra source of information which is generally useful for the site and surrounding land.

Solid & Drift Geology for the site

The following information has been taken from the British Geological Survey 1:50000 scale digital map:

DRIFT	GLACIALFLUVIAL DEPOSITS Sand and Gravel
SOLID	LOWER COAL MEASURES

Please note that the 1:50 000 scale data may be used as a guide to the geology at a local level, but should not be relied on for site specific geology. If more-detailed information is required then the 1:10000 scale maps, which provide the most-detailed interpretations available, should be consulted.

Aquifers and groundwater vulnerability classification at the site

The Environment Agency designate aquifers based on the Water Framework Directive. The designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems. The aquifer designation data is based on geological mapping provided by the British Geological Survey. Both the bedrock and superficial deposits are classified on the same scale.

Based on these designations, the bedrock beneath the site is classified as **Secondary A** (Lower Coal Measures) and the Drift Geology is **Secondary (undifferentiated)**. Please see below for the descriptions of these classifications:

Secondary A - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

Secondary (Undifferentiated) - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

Radon Affected Areas at the site

The site is not located within a Radon Affected Area as less than 1 percent of homes are likely to be above the Action Level.

The PHE recommends a radon 'Action Level' of 200 Becquerels per cubic metre for the annual average of radon gas concentration in a home. Where 1% or more of homes are estimated to exceed the Action Level, the area should be regarded as a Radon Affected Area.

Further information on Radon can be obtained from the Health Protection Agency, from the British Geological Survey or at www.ukradon.org.

Environmental Permits at the site

We are not aware of any sites with Integrated Pollution Prevention Control (IPPC) Part A1, or Local Authority Integrated Pollution Prevention and Control (LAIPPC) Part A2 or Part B within 250m of the site.

Please note that other processes that do not fall under these regulations or are exempt may exist within influencing distance of the site of interest and may cause pollution and/or nuisance to new receptors

Statutory nuisance notices in force at the site

We have searched the Environmental Services Authority database for nuisance and pollution incidents.

No nuisance incidents have been logged against the address supplied within the last 12 months.

No pollution incidents have been logged against the address supplied within the last 12 months.

No Statutory Notices for nuisance have been served against the address supplied or the immediate area within the last 12 months.

Other information on pollution incidents may be held by the Environment Agency (contact details given above), Health & Safety Executive on www.hse.gov.uk or by contacting the Manchester office on 0161 952 8200, Greater Manchester Fire Brigade on www.manchesterfire.gov.uk and Greater Manchester Police on 0161 872 5050 or their website: www.gmp.police.uk.

Ecological designations within 250 metres

We have records of one Sites of Biological Importance (SBIs) situated on the site and no SBIs or Sites of Special Scientific Interest (SSSI) within 250m of the site.

Map ref.	Site Name	Grid Reference	Site Grade
C55	Townside	SD805103	B

Private Water Supplies within 1000 metres

We are not aware of any private water abstractions regulated under the Private Water Supplies (England) Regulations 2016 within 1000m of the site.

Air Quality Management Area (AQMA) at the site

The site is located adjacent to an area predicted to exceed the national Air Quality Objectives for Nitrogen Dioxide (NO₂) as detailed in the Air Quality (England) Regulations 2015.

It is therefore important that the site does not lead to, or significantly add to, predicted exceedences of any of the objectives detailed in the Air Quality (England) Regulations 2015. Should this be the case, we advise that an appropriate air quality impact assessment be carried out if the site were to be redeveloped.

Additionally, in line with the principles of Good Practice set out in the EPUK Guidance, we would welcome proposals to mitigate any potential impact of any redevelopment on local air quality through the provision of electric vehicle charging points to encourage the use of low emission vehicles.

Environmental Information Regulations 2004

The Environmental Information Regulations enable individuals and organisations to request environmental information held by public bodies. In the majority of cases, we will endeavour to respond to your request within 20 working days, extended to a maximum of 40 working days should the request be complex or voluminous. Public Bodies are allowed to make a reasonable charge for supplying the information requested, and we will contact you if a charge is applicable.

You are welcome to have access to any public registers or to examine the information free of charge. If you wish to do so, please contact the Council to arrange viewing.

If you are dissatisfied with your response, you have the right to complain to the Local Authority, who will conduct an internal review to try and resolve any issues or problems. Please complete a 'Report a Problem' complaint form available from our website: www.bury.gov.uk or by contacting customer services on 0161 253 5353. Should you still not be satisfied with your response, you may then appeal to the Information Commissioner. Details can be found on the following website: www.informationcommissioner.gov.uk or by contacting 01625 545 700.

Payment Receipt

I acknowledge your payment of £125.00.

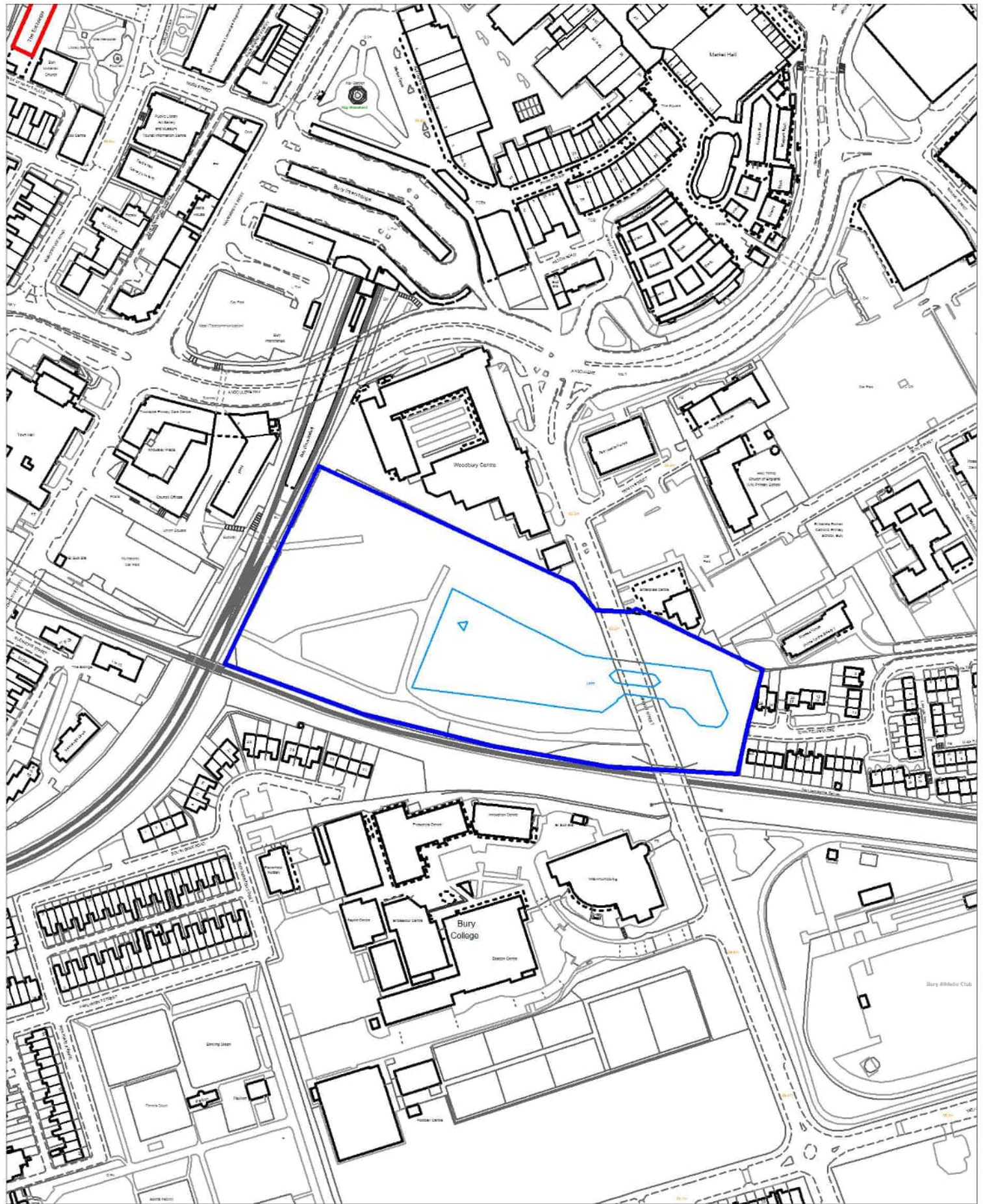
Should you require any further information please contact me on the number given above.

Yours sincerely

A handwritten signature in black ink, appearing to read 'J Scott', written in a cursive style.

Judith Scott
Environmental Protection Officer

The above details are based upon records currently held by the Environment Section and are believed to be accurate at the time of printing. However, this Division can accept no responsibility for their accuracy or completeness.



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 Site Boundary

TITLE: Townside Fields, Market Street,
 Bury

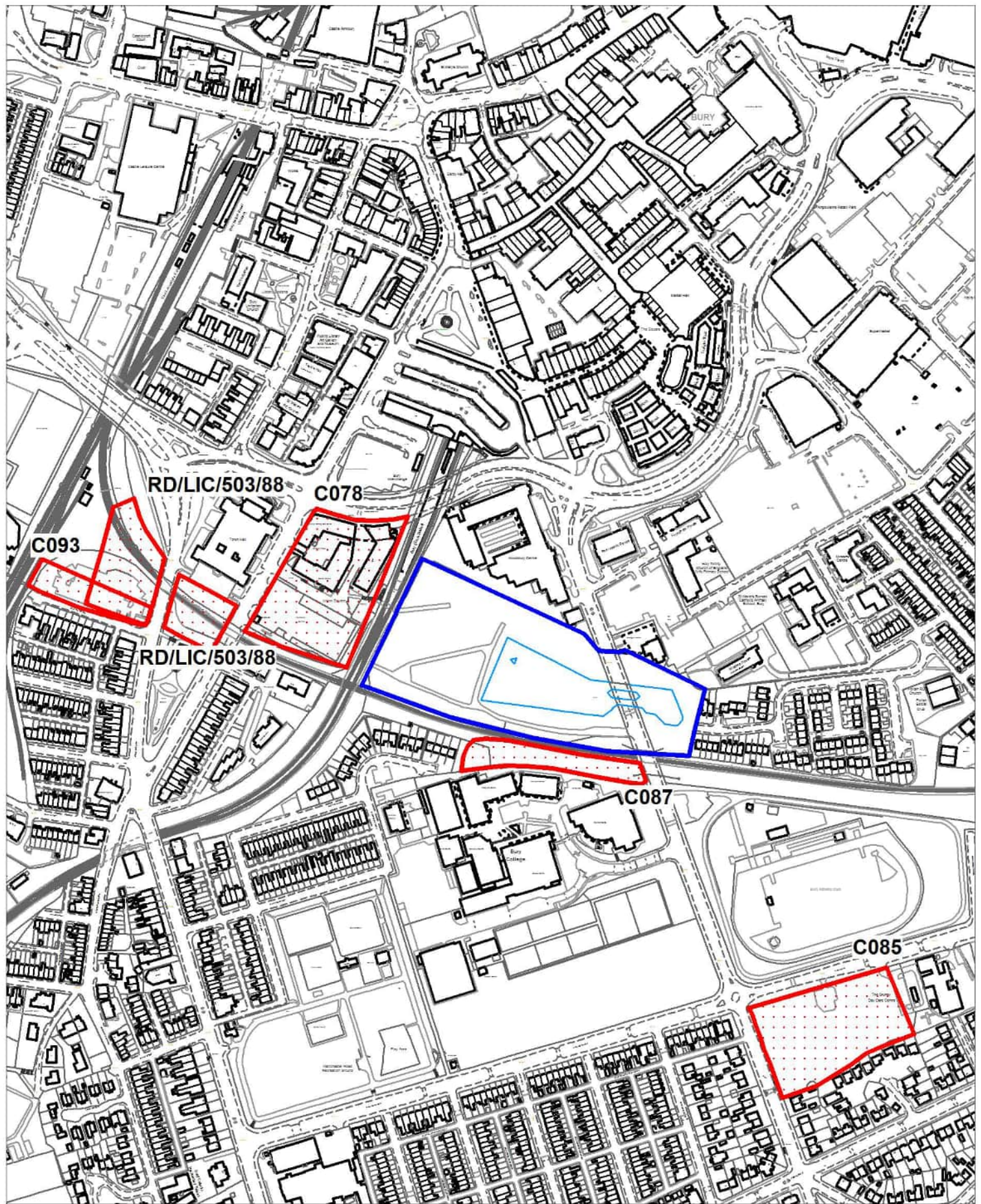
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Bury
 COUNCIL



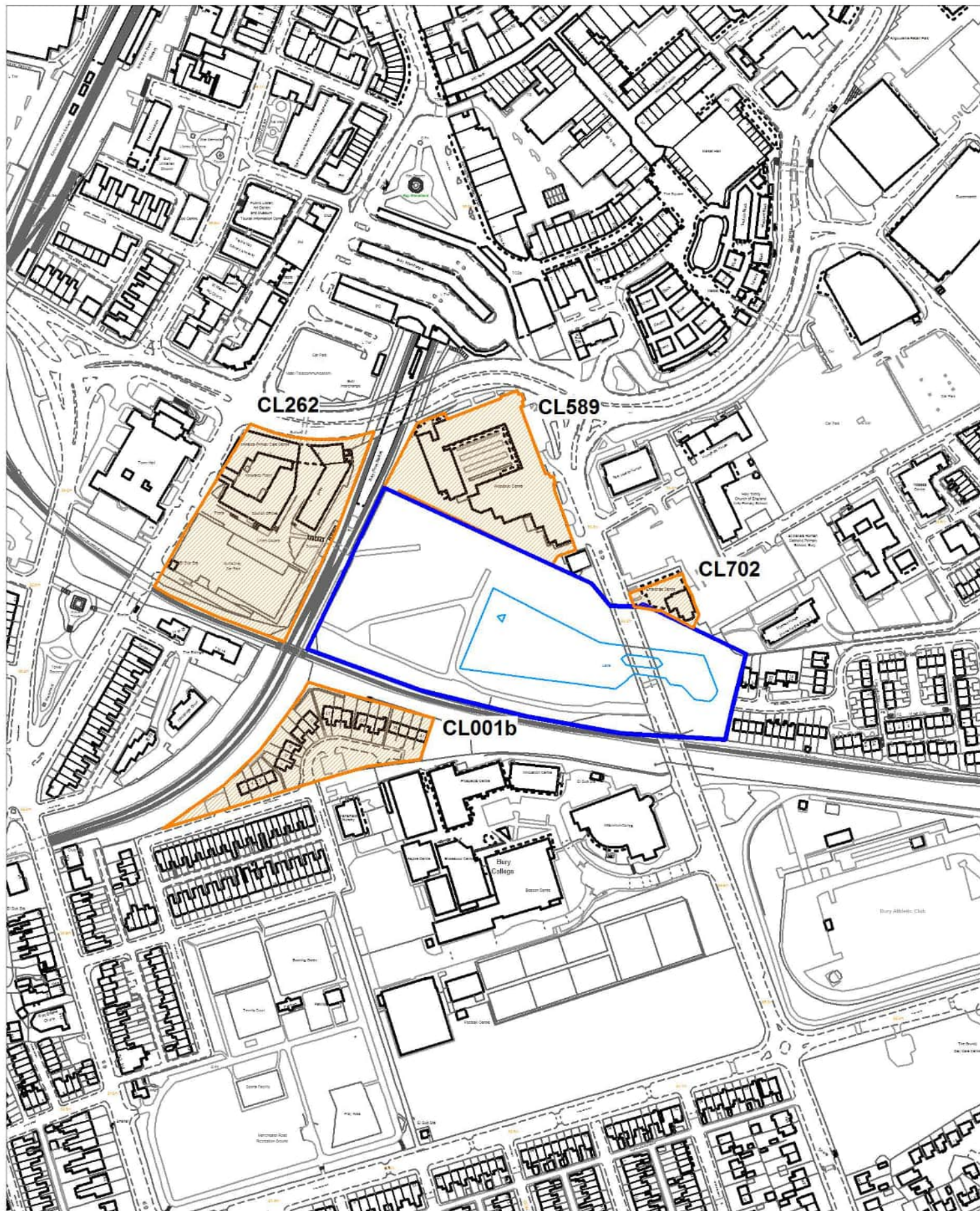
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	Landfill Sites

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Bury
Landfill Sites



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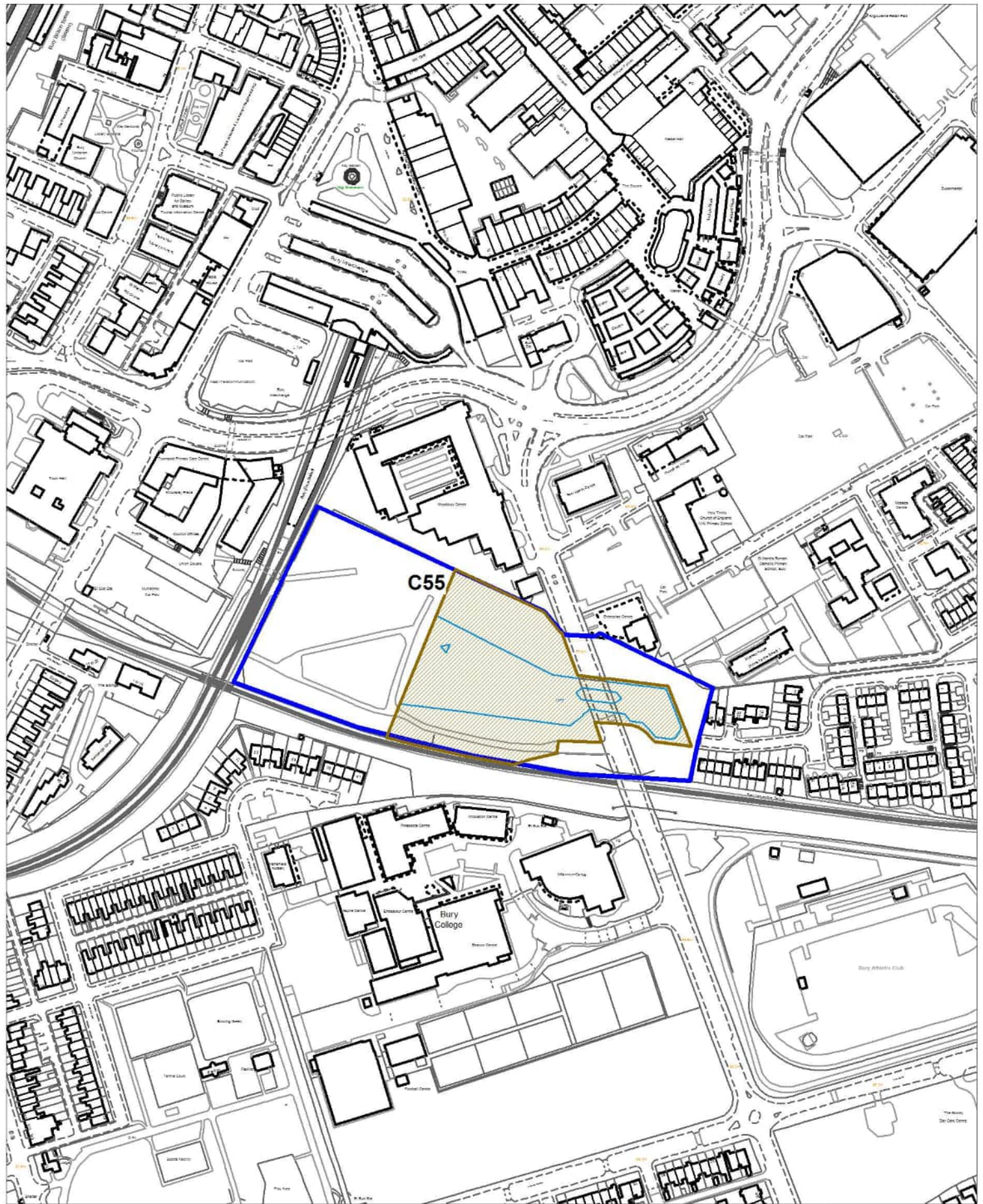
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 Contaminated Land Files

TITLE: Townside Fields, Market Street
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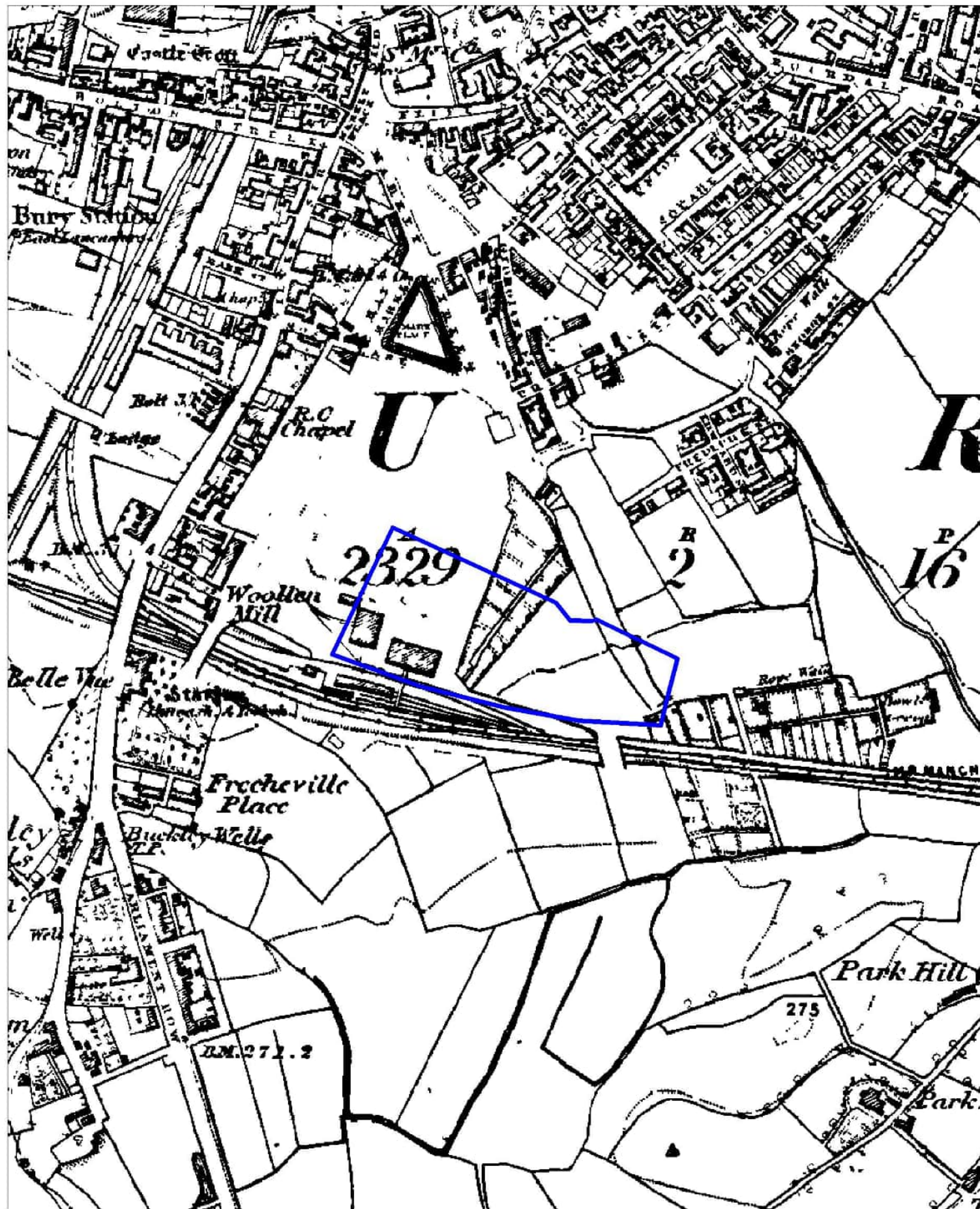
KEY:
 Site Boundary
 SBI

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 Ordnance Survey 100023063.

TITLE: Townside Fields, Market Street
 Bury
 Site of Biological Importance (SBI) and
 Sites of Special Scientific Interest (SSSI)

NGR: 805 103
 SCALE: 1:2600 @ A4 Date: 11 01 2022

Bury
 COUNCIL



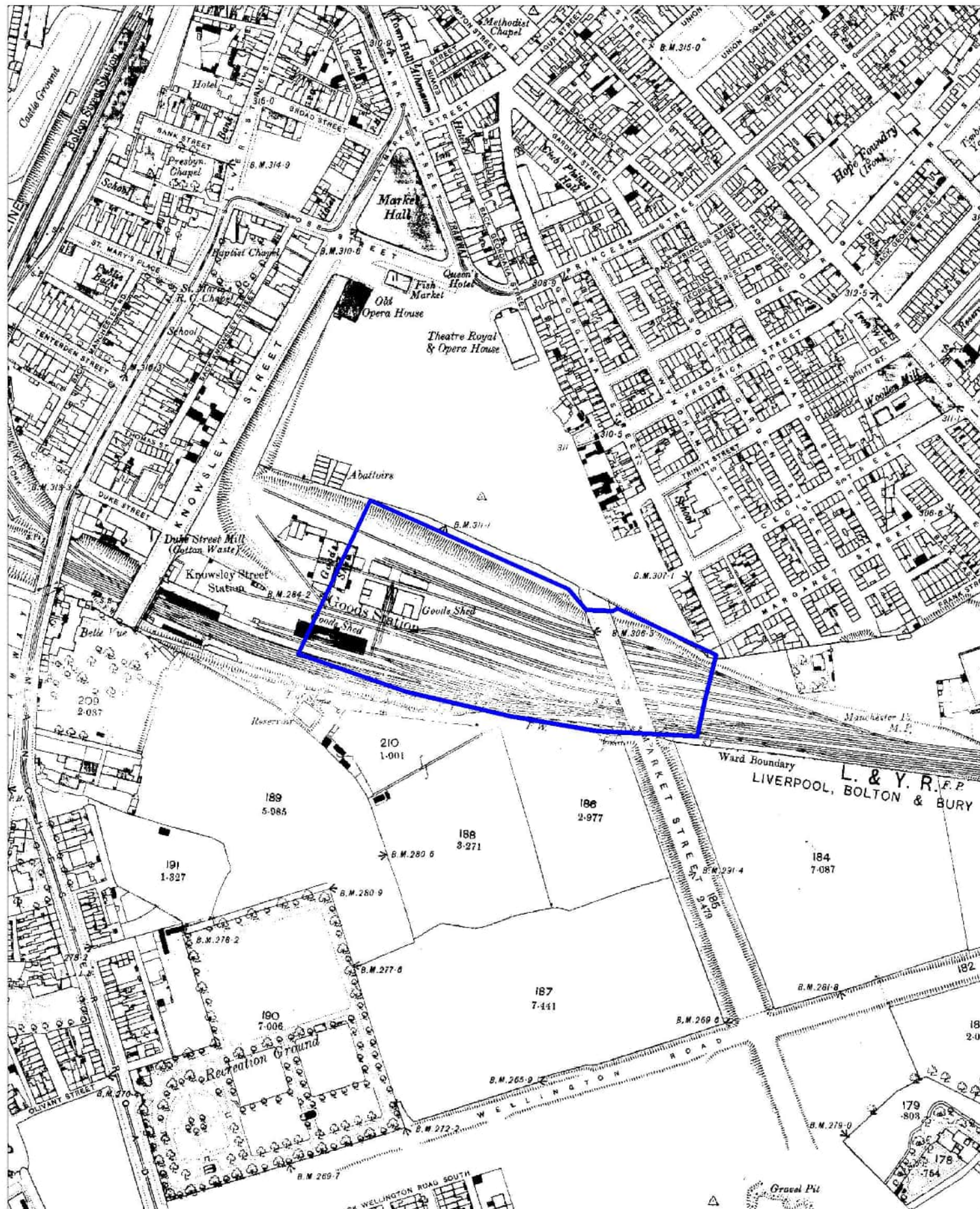
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TITLE: Townside Fields, Market Street
 Bury
 1848 Historical Map

Bury
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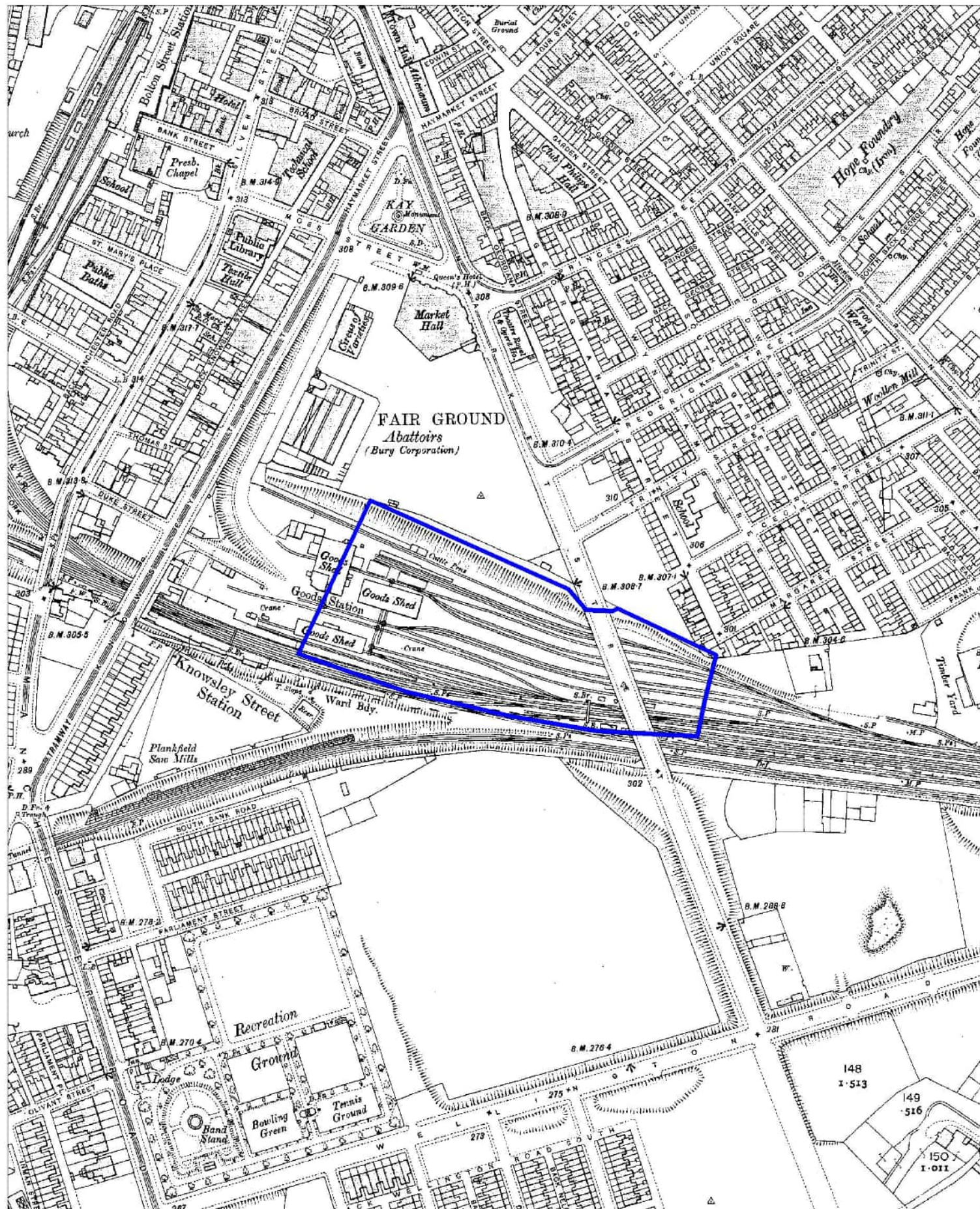
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 1893 Historical Map

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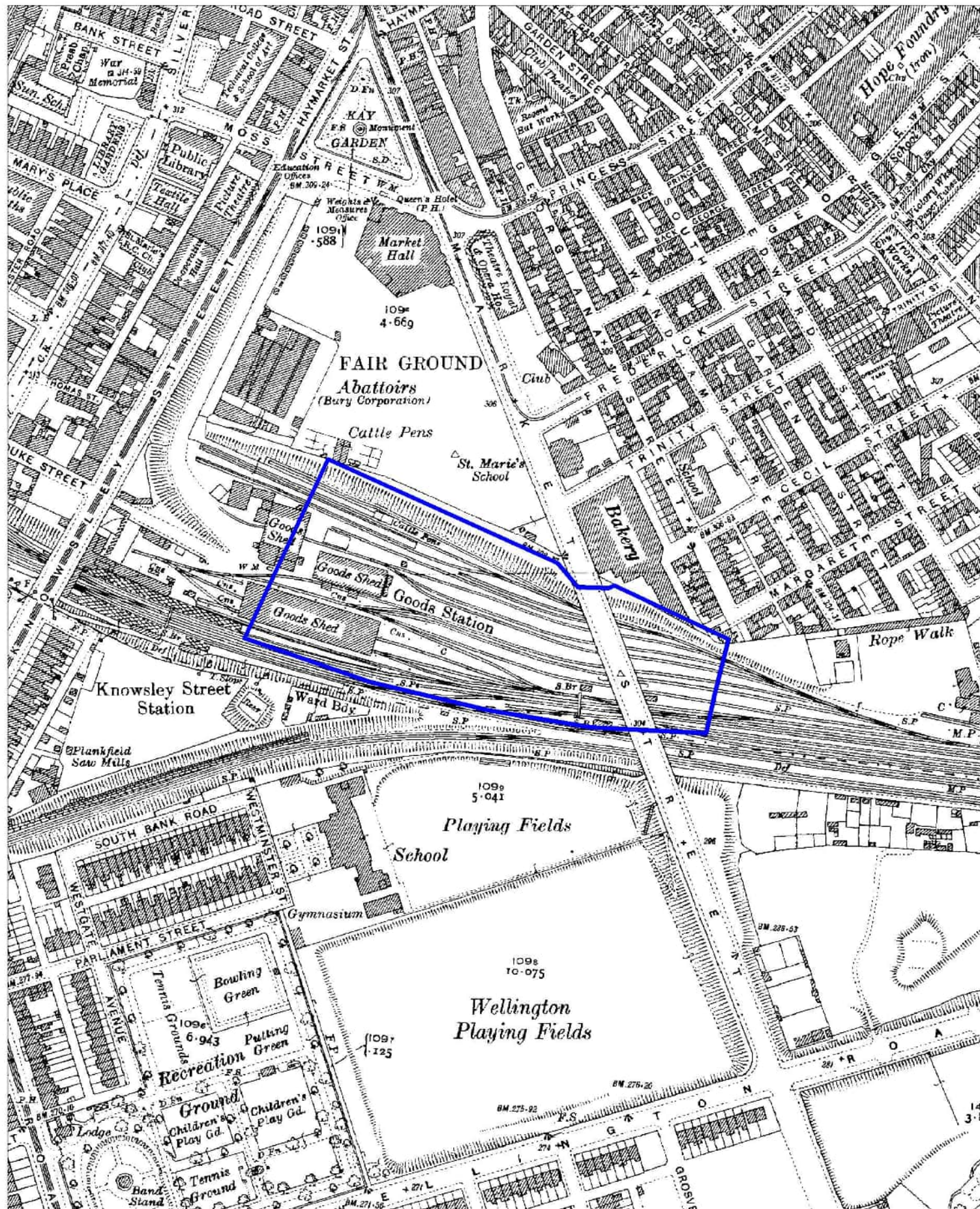
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TITLE: Townside Fields, Market Street
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 1910 Historical Map

Bury
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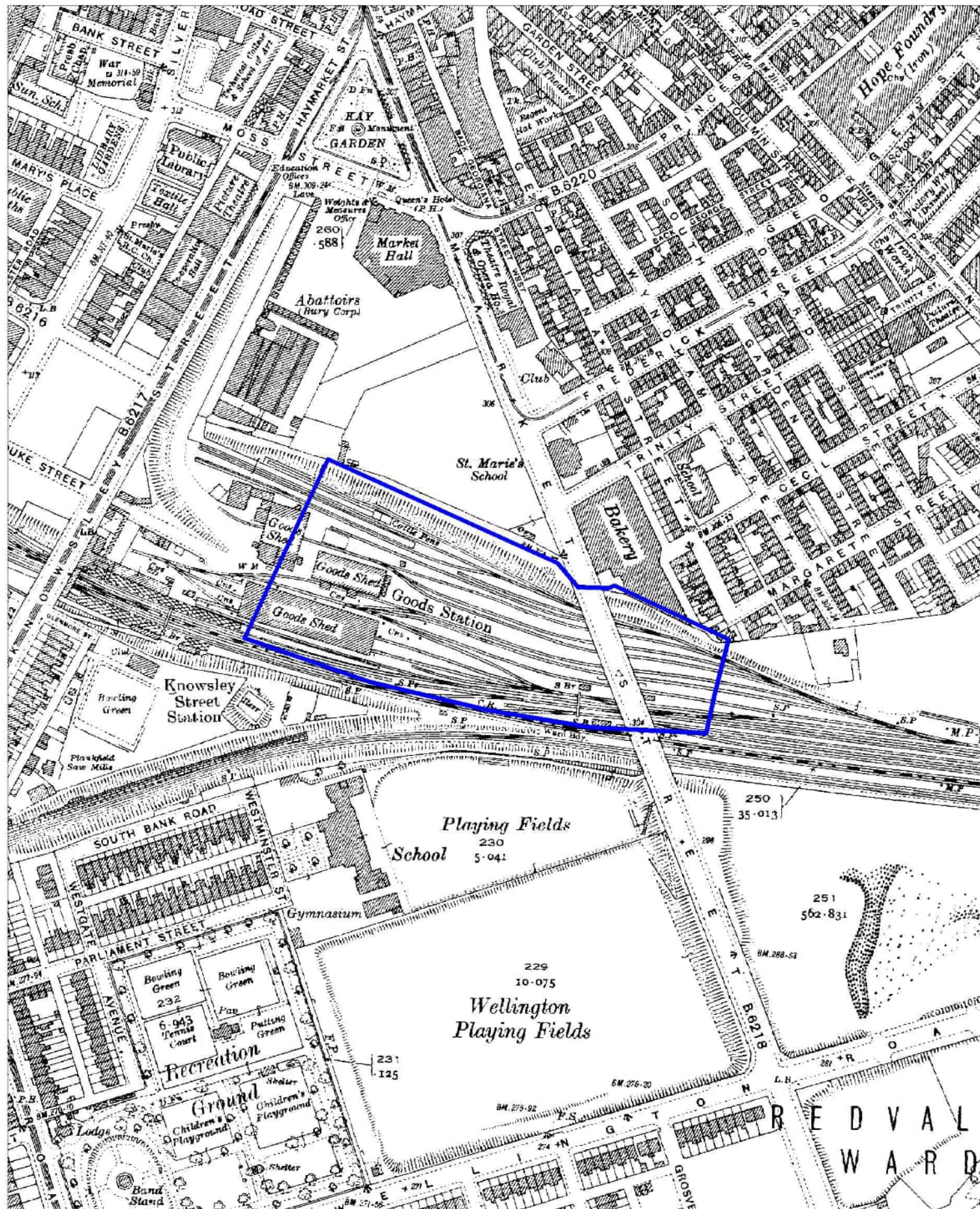
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 1930 Historical Map

Bury
 COUNCIL

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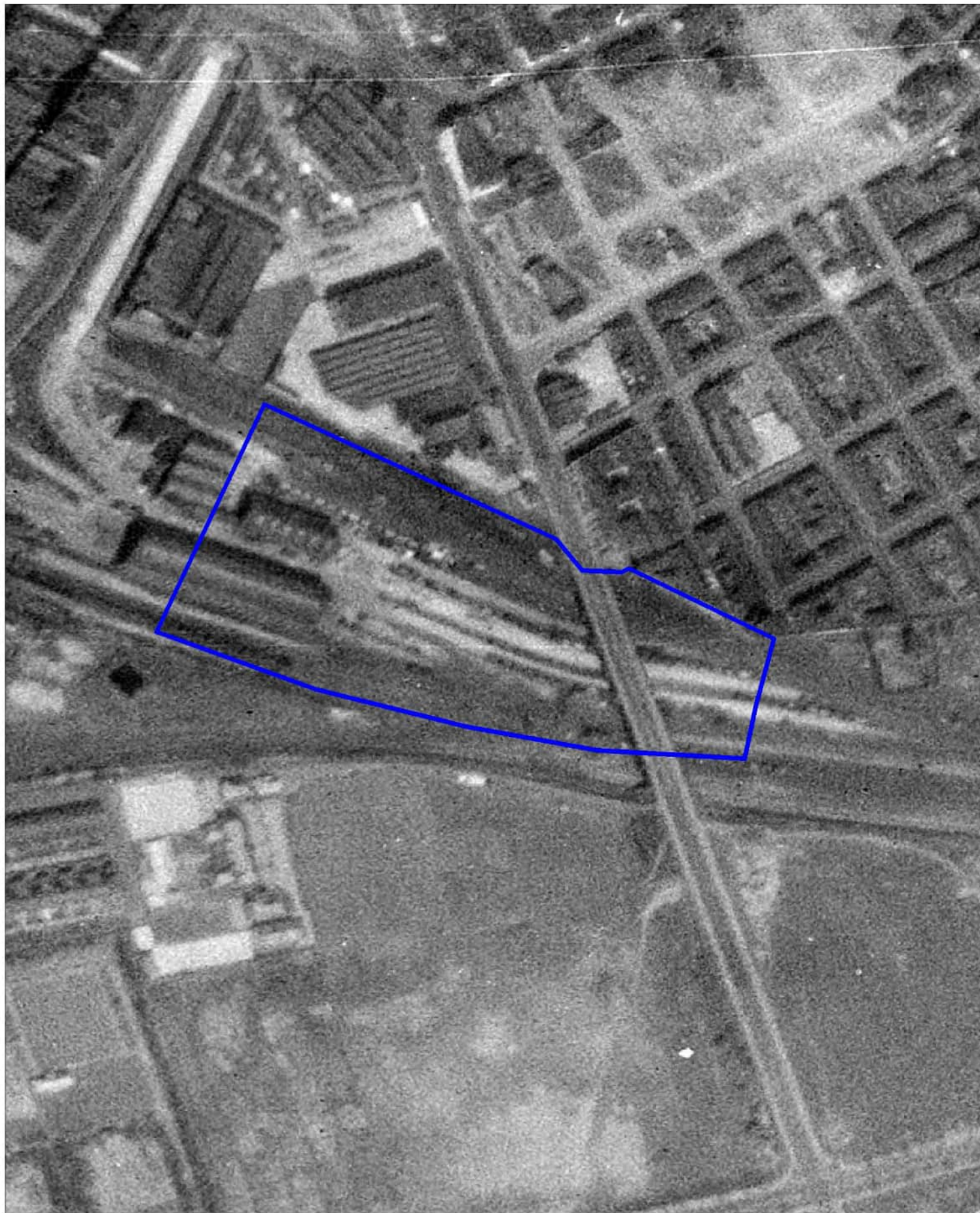
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TITLE: Townside Fields, Market Street
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 1937 Historical Map

Bury
 COUNCIL

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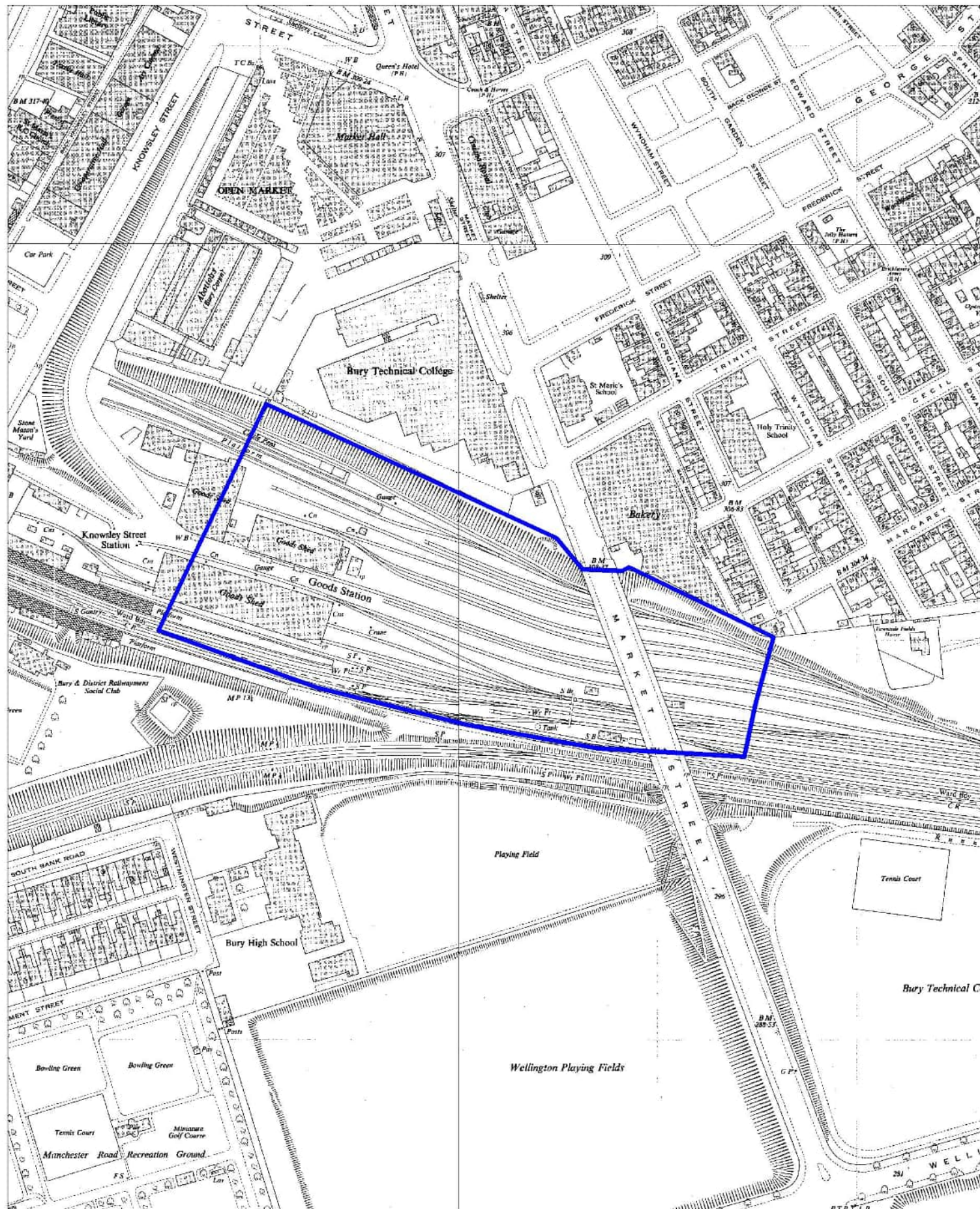
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TITLE: Townside Fields, Market Street
Bury
1940s Aerial Photo

Bury
COUNCIL

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Ordnance Survey 100023063.

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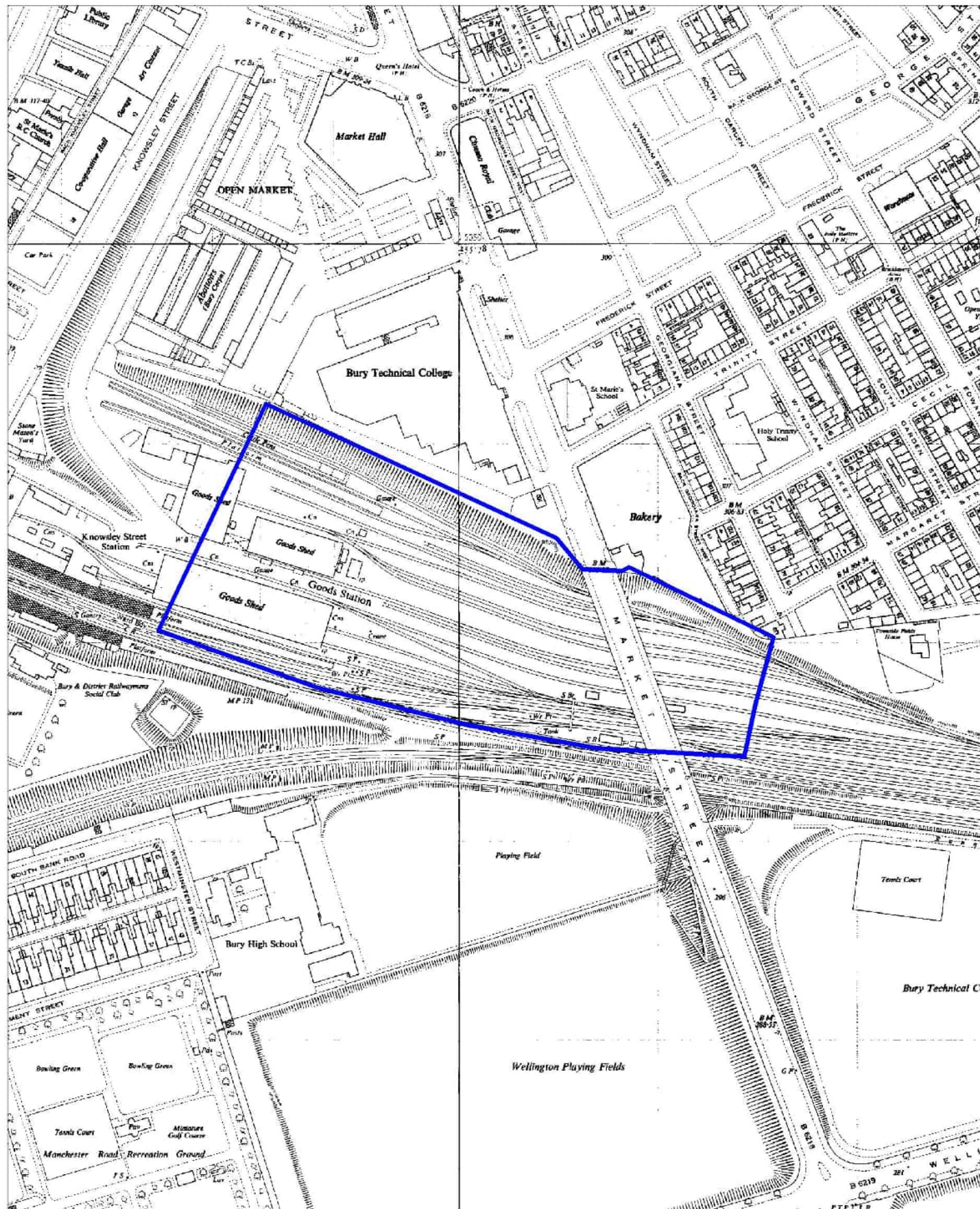
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TITLE: Townside Fields, Market Street
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 1958 Historical Map



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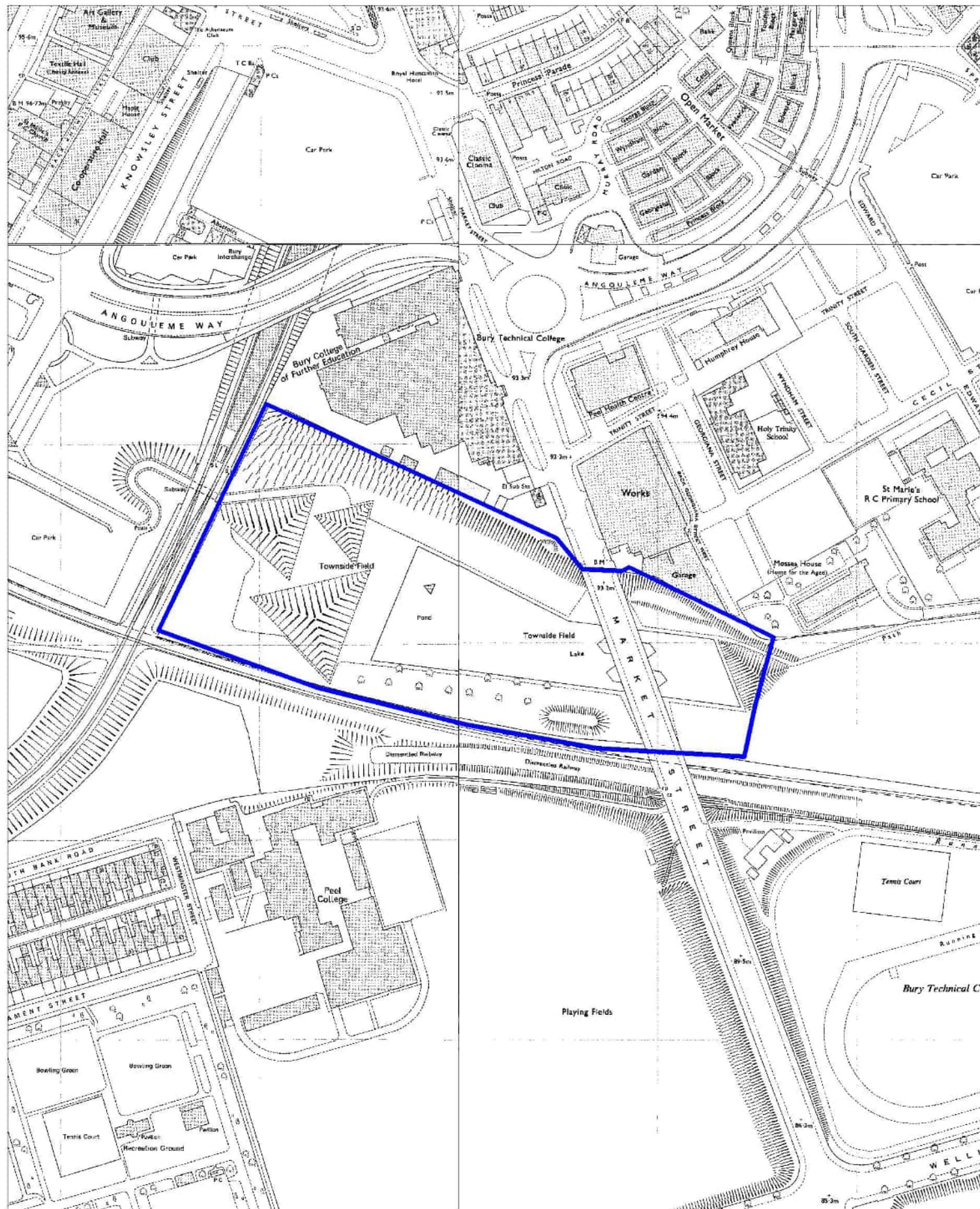
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 1959 Historical Map



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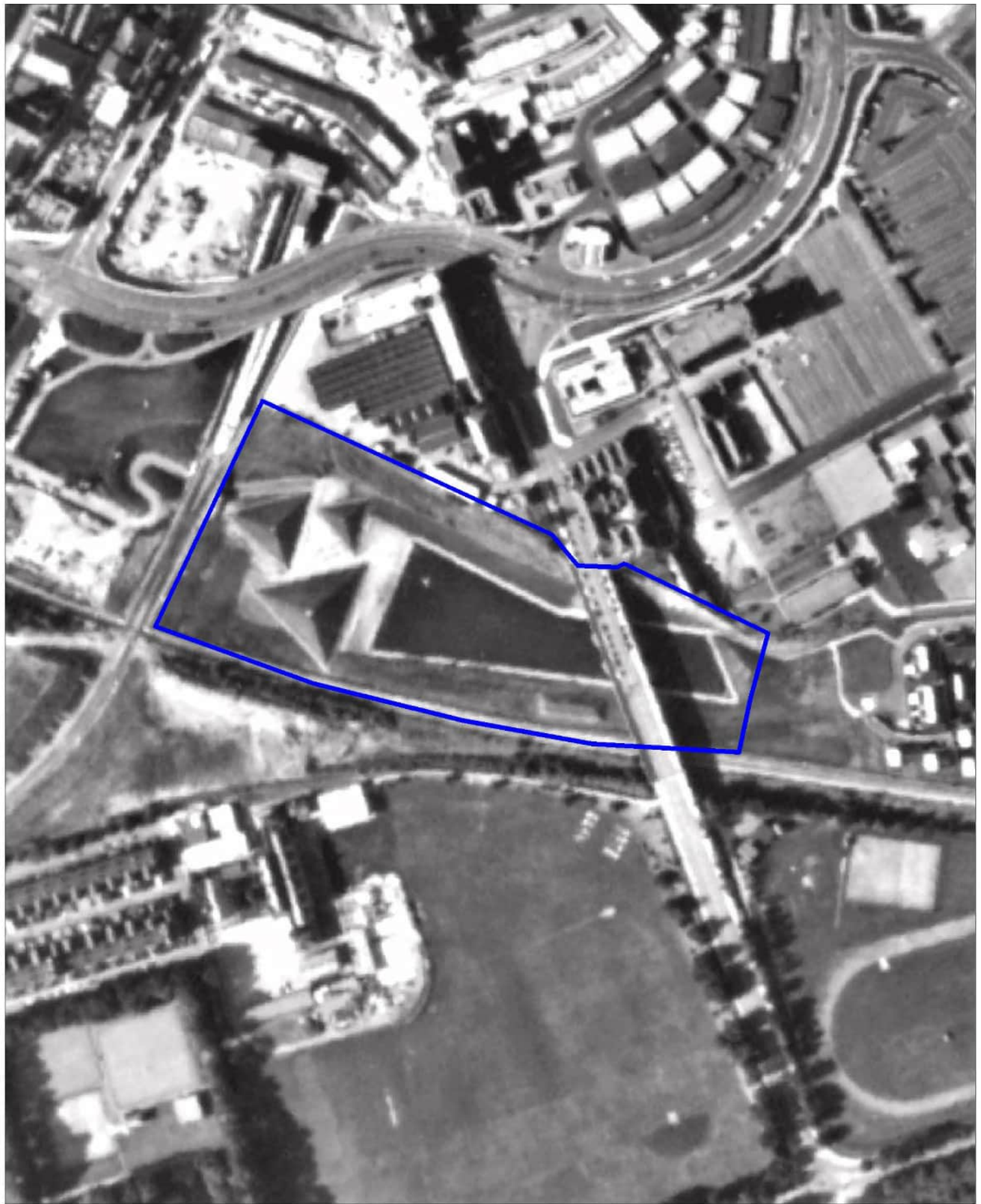
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 Site Boundary

TITLE: Townside Fields, Market Street
 Bury
 1984 Historical Map

Bury
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KEY:
 Site Boundary

TITLE: Townside Fields, Market Street
 Bury
 1979 Aerial Photo

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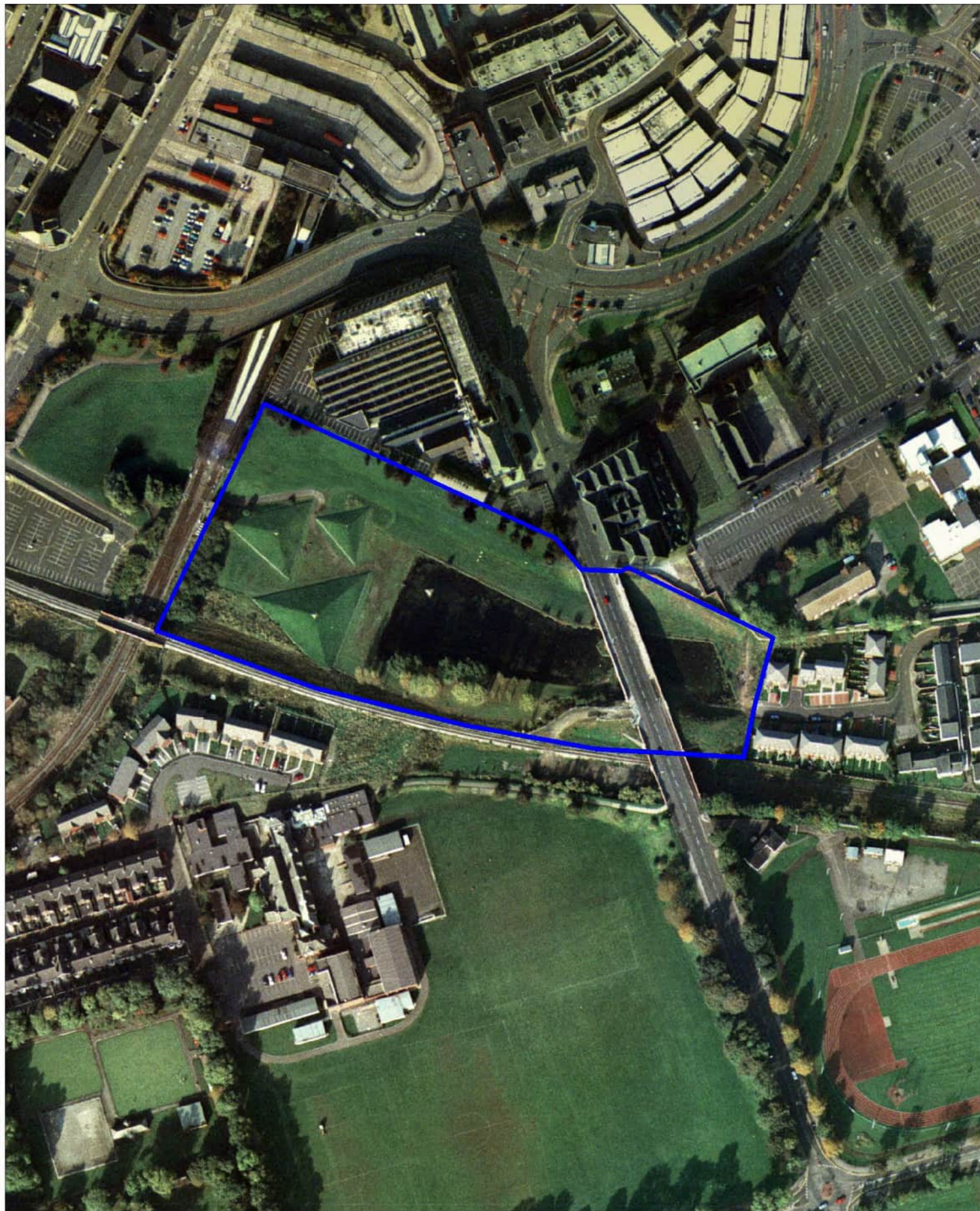
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TITLE: Townside Fields, Market Street
 Bury
 1989 Aerial Photo

Bury
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KEY:
 Site Boundary

TITLE: Townside Fields, Market Street
 Bury
 1997-9 Aerial Photo

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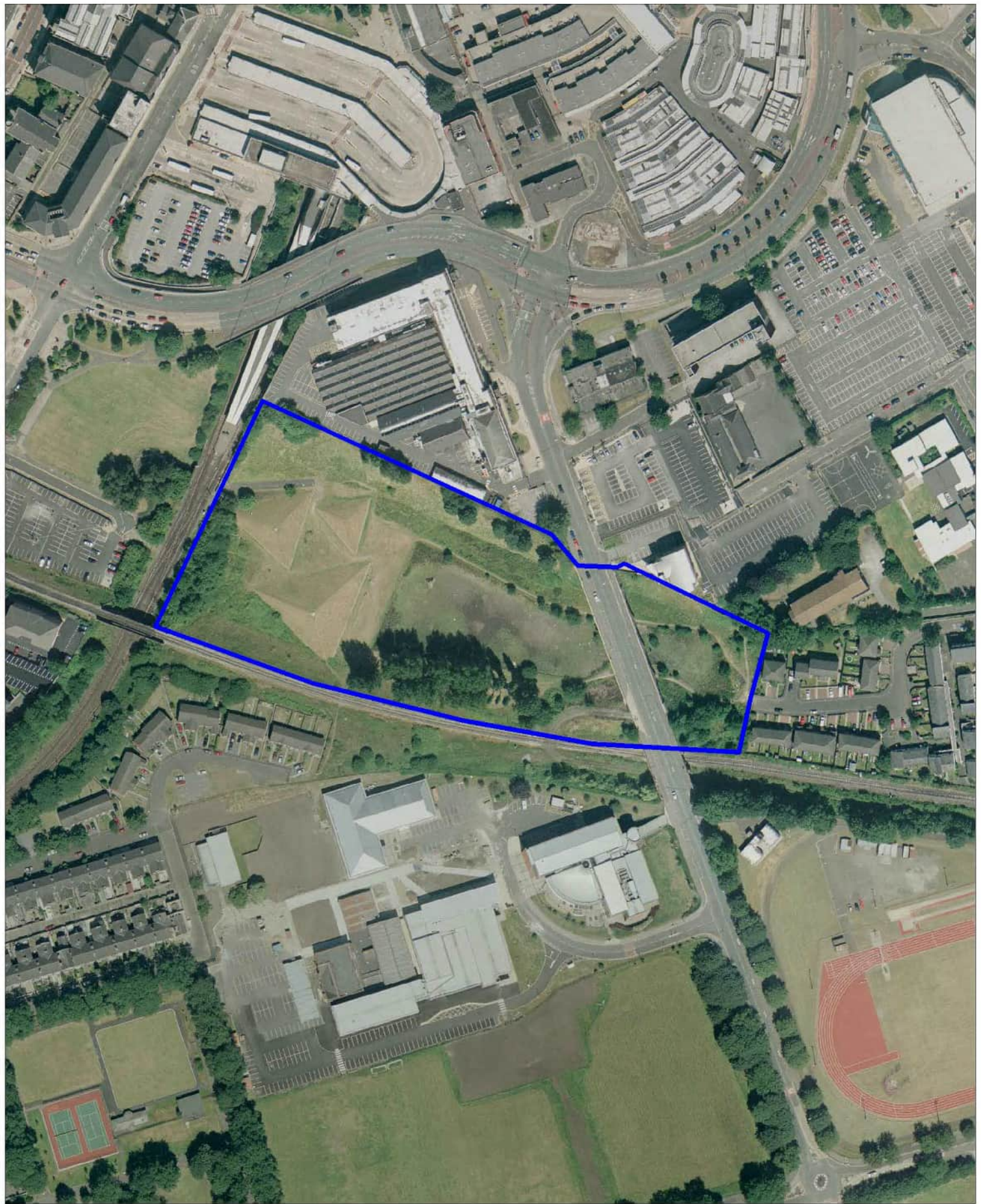
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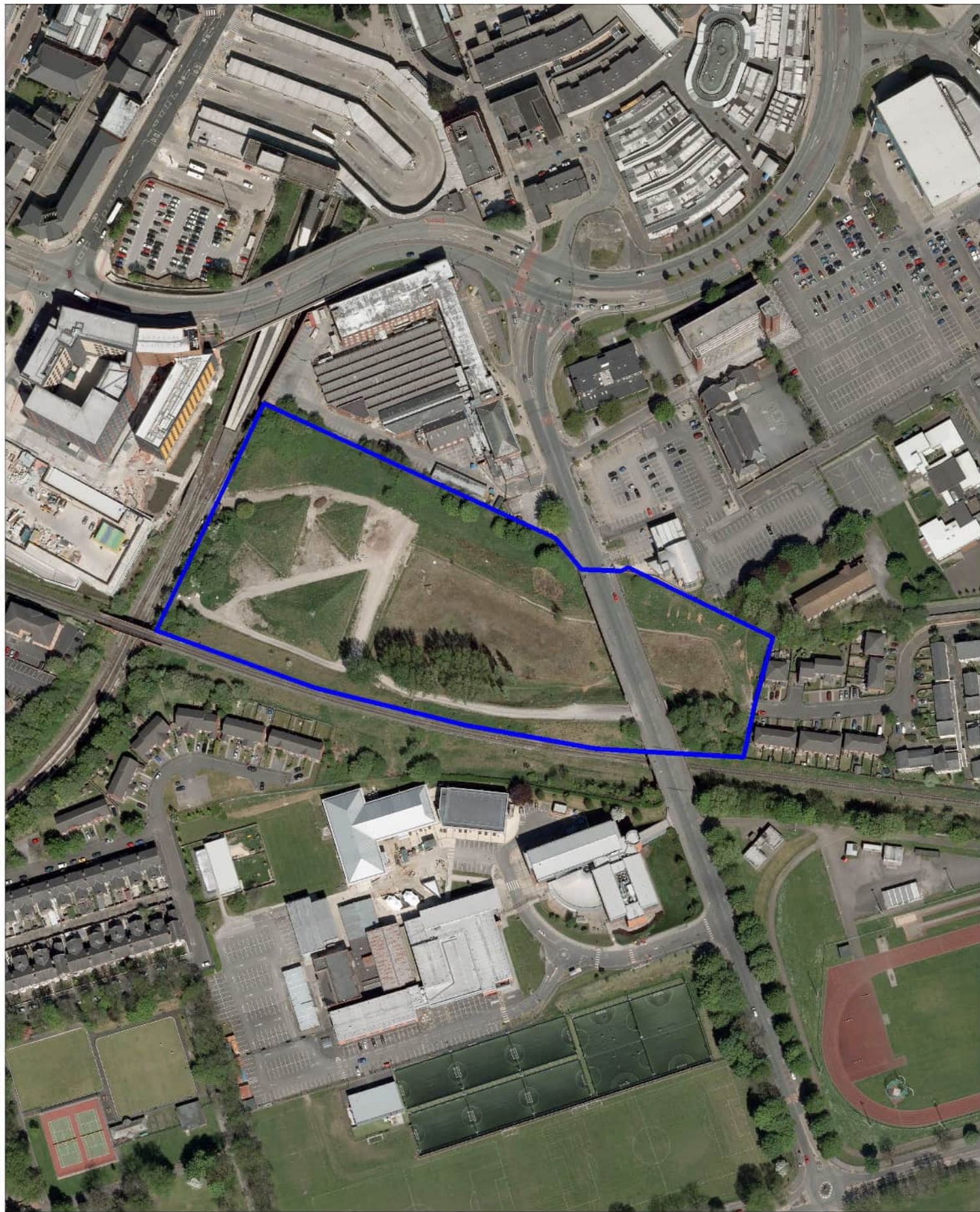
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 2005 Aerial Photo

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KEY:
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TITLE: Townside Fields, Market Street
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 2011 Aerial Photo

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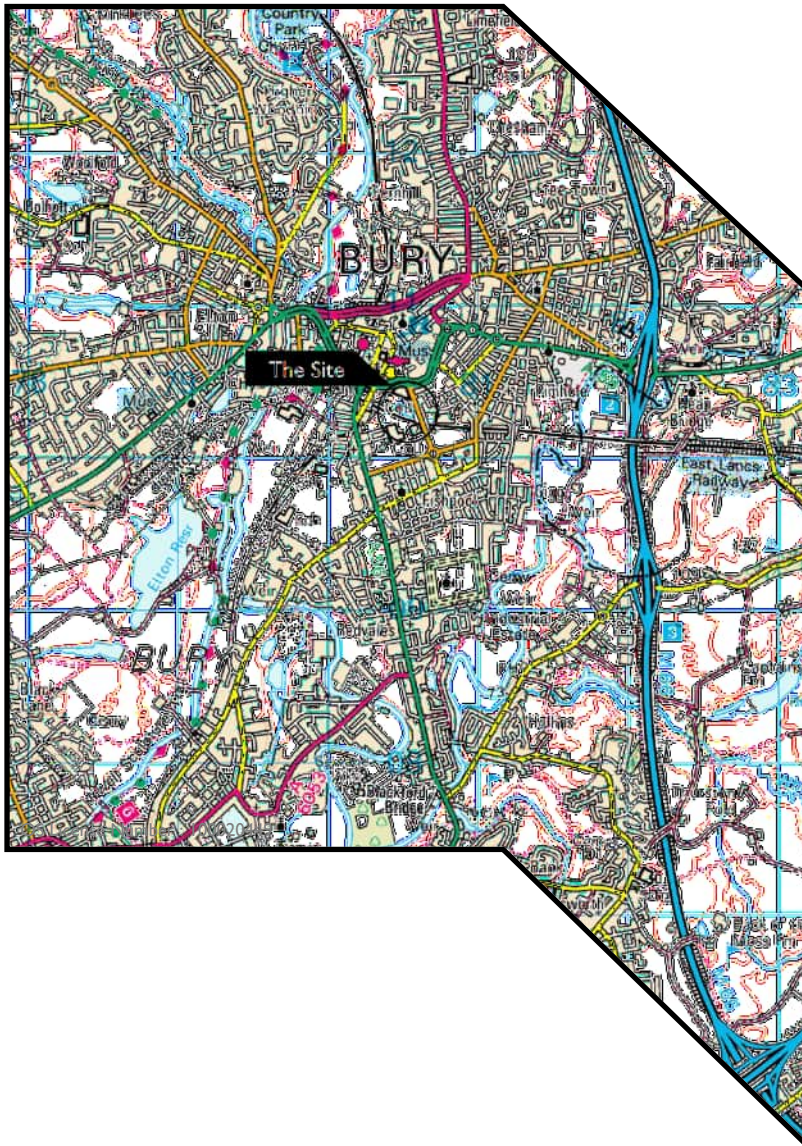
Appendix 3

Site Investigation Information

Ground Investigation



www.geotechnics.co.uk



PYRAMID PARK, BURY

Factual Report

for
Campbell Reith Hill LLP

Engineer : Campbell Reith Hill LLP

Project Number PN234595

March 2024

Issuing Office North West Office
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mail@exeter.geotechnics.co.uk

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Factual Report

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Project No:
PN234595
March 2024

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