

Supplementary Ground Appraisal Report

Portugal Street East, Manchester

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Version History

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Intrusive investigation only allows observation and assessment of ground across a small portion of the total site area. Therefore, it is possible that significant features may not have been encountered during the investigation, despite appropriate design and planning. Apex cannot accept for conditions not revealed by the exploratory holes. Any interpretation of strata between or below exploratory holes is for guidance only and Apex hold no responsibility as to its accuracy.

It should be noted that groundwater levels are susceptible to seasonal and other variations; this should be borne in mind when considering observations/measurements associated with groundwater contained in this Report.

Apex reserve the right to amend this Report in the light of further information that may become available.

Revision	Date	Notes	Prepared by	Checked by	Approved by
001	2021/10/27	First Issue	M Thompson	GECL	M Thompson
002	2021/11/10	Minor amendments	M Thompson	W Ballance	M Thompson

EXECUTIVE SUMMARY

Category	Comments
Site location	East Manchester City Centre, c. 350m from Piccadilly Station. NGR: SJ 851 979 Postcode: M1 2WL
Description	The site is currently occupied by a series of buildings (some derelict) and outdoor areas off Portugal Street East, Heyrod Street, Churchgate Buildings and Betley Street.
Proposed Development	Two residential tower blocks of 30 storeys (west) and 24 storeys (east) with external areas of green space, pedestrian routes and cobbled streets. A basement car park will span beneath both blocks.
History	Terraced housing & social club, industrial buildings, coppersmiths, warehouse and scrap merchants.
Environmental Setting	Not within a Source Protection Zone. No landfills within 250m. Coal Authority Development Low Risk Area.
Ground conditions	Made ground encountered up to 1.9m, varying significantly across different site areas. Cohesive Glacial Deposits below (stiff clay), often interbedded with Granular Glacial Deposits (sand & gravel) from around 5m depth. Sherwood Sandstone bedrock present from c. 9m.
Contamination	Asbestos, PAHs and metal contamination detected in made ground, most notably in the south-east. Beneath the buildings, risks of contamination will be mitigated via removal of the made ground to accommodate the proposed basement. Scrap Metal Deposits (present to 0.15m in the south-east) require removal from site. A 600mm clean soil cover is required in all proposed landscaped areas.
Hazardous gas	No special gas protection measures are required.
Foundations	Piled foundations extending into the Sherwood Sandstone bedrock will be required. Piles for the proposed basement wall may terminate in the shallower Cohesive Glacial Deposits (stiff clay).
Drainage	Soakaways are not considered feasible based on the ground conditions encountered; alternative SUDs should be considered.
UXO	A UXO Safety Awareness Briefing should be given to all relevant personnel involved in earthworks.
Further works	- Post-demolition site investigation. - One borehole: dynamic sampling with rotary core follow-on to c. 30m in the east. - Production of a remediation strategy.

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1. INTRODUCTION

1.1 Background & context

This report has been prepared for Portugal Street East Limited. The agreed scope of works is shown in correspondence in Appendix J.

The purpose of this report is to enable an assessment of ground-related contamination risks associated with the proposed development at Portugal Street East, Manchester.

1.2 Previous reports

Apex have been provided with copies of the following reports relating to this site:

- *Phase 1 Desktop Study, Portugal Street East, Manchester* (ref. MN/AS/p 1 3633 R I) dated April 2017 issued by RoC Consulting
- *Phase 2 Site Investigation Report, Portugal Street East* (ref. LD/AS/p2 3633) dated April 2018 issued by RoC Consulting

The scope of works agreed is intended to supplement existing data. A review of RoC's data is presented in Section 5.

1.3 Scope of works

In summary, the agreed scope of works included:

- Review of 3rd party information (including desk study information) relevant to the wider site area
- Ground investigation (trial pitting and window sampling)
- Laboratory analysis (chemical and geotechnical analysis on soil samples)
- Interpretation of findings and recommendations in relation to remediation requirements

1.4 Development proposals

It is understood that proposals include development of two residential tower blocks of 30 storeys (west) and 24 storeys (east). A basement car park will span beneath both blocks, the base of which will be c. 4m below current ground levels. Externally, areas of green space, pedestrian routes and cobbled streets are proposed. Sections of Betley Street, Churchgate Buildings, Heyrod Street and Portugal Street East are to be stopped up and incorporated into the development.

The proposed layout, is presented as Drawing 002 in Appendix B.

1.5 Planning

The proposed development has planning consent (application no. 121099/FO/2018). With reference to ground, the application includes the following conditions:

- 9) (a) which refers to the need for a Preliminary Risk Assessment (desk study)

- 9) (b) which states that, in the event of potential contamination being identified in the Preliminary Risk Assessment, an intrusive Site Investigation Report is required along with a Remediation Strategy.
- 9) (c) which requires the development to commence in line with the Remediation Strategy, evidenced by a Completion/Verification Report for the specified remediation.
- 9) (d) which refers to the required procedure in the event of any previously unidentified contamination is encountered during construction.

This report, along with RoC's previous work, is intended to satisfy the requirements of Conditions 9a and 9b.

1.6 Sources of information

This report includes findings from a number of external sources including Landmark Information Group, British Geological Survey, Coal Authority, Local and 3rd party reports, as well as our own local knowledge and experience.

Apex do not accept any liability for inaccuracies in third party information.

1.7 Report limitations

The Foreword to this report and the appended guidance notes on Apex's procedures and definitions (Appendix A) should be read in conjunction with the main text.

2. LOCATION AND DESCRIPTION

2.1 Site location

A location plan is included as Drawing 001 in Appendix B. The site is situated in the east of Manchester city centre, next to Piccadilly Railway Station.

2.2 Site description

An engineer from Apex visited site on 29th July 2021 to undertake a walkover survey. Key features identified by RoC during their walkover have also been included in this Section, most notably those identified in RoC's walkover of the internal spaces of Rammon House.

The site comprises 5 main areas/buildings, as summarised below. Each area/building is marked on Drawing 003 in Appendix B.

Rammon House



Figure 1 -Rammon House looking north along Portugal Street East

Rammon House occupies the south-west of the site and is a 3 storey building of brick and concrete construction, occupying c. 2,500m² in plan area. A 'spur' reducing down to 1 storey extends off the north-east corner along Longacre Street.

At the time of the walkover, the building was in a poor state of repair and only limited access to internal areas was available. On the ground floor, the building is mainly occupied by a large, open room with a concrete floor slab and intermittent supporting concrete columns. Rainwater was dripping through onto the ground floor from above and forming large areas of standing water.

Evidence of vandalism was noted throughout and there was a large amount of debris on the floor

including: clothes, furniture, drum kit, tools, gas cylinders, cables and general

rubbish. During RoC's walkover, significant amounts of household waste were noted to have been tipped at the loading bay off Churchgate Buildings in the east.

Key internal features noted by Apex and RoC include:

- Loading bay off Portugal Street East with roller shutter doors in far west, atop a c. 1.2m brick-built platform
- Roller door entrance off Churchgate buildings the east (no access was available via this door at the time of the investigation)
- Goods lift shaft located in the far west corner (next to loading bay)
- Boiler room in the north-eastern 'spur' off Longacre Street. Photos within RoC's report show the boiler to be gas-fired and in a good state of repair at the time (2017)
- Electrical substation in the north-eastern 'spur' off Longacre Street, adjacent to the boiler room.

It should be noted that, whilst the boiler room looked relatively new and in a good state of repair in 2017, the building likely had a boiler fitted prior to this, possibly in the same location, which could have been fuel/oil fired.

Externally, areas of macadam surfacing line the east, south and west walls of Rammon House (i.e. along Portugal Street East, Heyrod Street and Churchgate Buildings) which are used as car parking spaces.

Along the northern wall, a macadam-surfaced pedestrian walkway is present in between Rammon House and the tram lines to the north.



Figure 2 - Rammon House looking south-west along Longacre Street

Transport for Greater Manchester (TfGM) building

The site boundary intersects a two-storey brick-built building which is used by TfGM.

The building occupies 830m² but only the south-west of the building lies within the site boundary (around 300m²).

The TfGM building is accessed via a roller shutter door or a pedestrian door, both on the eastern wall. The far east of the building (beyond the site boundary) is occupied by a series of offices, which are now in poor state of repair. Broken roof tiles and cans of paint were noted in this area. The main section of the building (centre and west) comprises a double-storey warehouse with concrete floor slab

primarily used as a storage unit for various equipment, furniture, bus shelter components (metal seating, glass panels etc), grit boxes and wooden pallets.



Figure 3 - Internal of TfGM building looking at south corner

Externally, to the south-west of the TfGM building is a small, macadam-surfaced car park (c. 220m²), accessed off Churchgate Buildings, with strips of soft landscaping around it, which are now overgrown.

Main scrapyard area

The eastern corner of the site is occupied by a former scrapyard, signposted 'PA Metals' which is segregated on all boundaries with palisade fencing. A dilapidated structure is present in the far east which is of brick and corrugated-sheet metal construction; this looks to be the main office/workshop associated with the scrap metal dealership.

South-west of the building is a yard containing a former weighbridge, a brick out-house with a toilet, and a single storey brick-built storage unit. In this area, various tipped materials could be seen including wooden pallets, garden tools, toolbox, metal storage container, plastic bins, buckets and timber. This area is generally overgrown with shrubs/weeds.



Figure 4 - Main Scrap Yard looking north-east

Beyond the weighbridge, the yard is surfaced in rough broken concrete and macadam hardstand. In some areas where the hardstand was absent/had been broken away, scrap metal deposits could be seen at surface having formed a layer of orange (rust-stained) gravel-sized fragments of metal, mixed with hardcore, fragments of glass and other gravel.

North-west of the building and yard, there is an access road leading through the scrapyard area off Betley Street, accessed via a metal gate. The road is surfaced with concrete and is broken in places, with vegetation growing through. At the entrance off Betley Street, significant amounts of fly-tipped waste and litter were seen.

North-west of the road is a parcel of rough, overgrown grassland including some shrubs. In the south-west of the grassland is a small area (c. 350m²) of broken up macadam/concrete hardstand.

Small scrapyard area

A smaller scrapyard is present on the corner of Betley Street and Heyrod Street, adjoining both the printer's premises and the main scrapyard area, occupying c. 100m². This area is enclosed by Heras fencing with yellow netting around, and no access was available inside. Looking from outside, this area appeared to be surfaced with hardcore gravel. Numerous broken car parts could be seen including chassis, wheels and tyres.



Figure 5 - Small Scrap Yard looking south from Heyrod Street

Printer's premises



Figure 6 - internal of printer's premises looking north-east

The rectangular building in the south-east, off Heyrod Street was in use as a printers at the time of the walkover.

The building is one storey of brick construction, occupying c. 250m² with concrete floor. Internally, the majority of the building is occupied by a single room used to store various printers along with wooden pallets, cardboard boxes and office furniture.

The building is accessed via a roller door of Heyrod Street.

Van hire depot

The southern site boundary intersects a van hire depot (immediately south of the printer's premises), located of Travis Street to the south. The van depot includes an office building and workshop, both of which lie beyond the site boundary. The only part of the

van hire depot which sits within the site boundary is a section of car park, surfaced with granular hardcore.

Site details are summarised in the table below:

CATEGORY	DETAILS
Location	East Manchester City Centre, c. 350m from Piccadilly Station.
NGR	SJ 851 979
Nearest postcode	M1 2WL
Area and shape	Total area c. 9,000m ² , irregular in shape.
Current use	Various current and recent uses including: derelict storage warehouse, derelict scrapyards, van hire depot car park, printer's premises, TfGM storage building (see above).

CATEGORY	DETAILS
Surrounding land	North – Tram lines with apartments and Leeds Liverpool Canal beyond. East – Offices and industrial units off Adair Street South – Offices off Travis Street with railway beyond West – Open air car park and Royal Mail vehicle depot
Known constraints	Ongoing use of the van hire depot, printing shop and TfGM buildings.

3. ENVIRONMENTAL CONTEXT & HISTORY

3.1 General

A more detailed review of the site's environmental setting and history was included in RoC's Phase 1 Desk Study report. Key points are summarised below.

3.2 Environmental context

The site is mapped by BGS as being underlain by Till, Devensian (glacial clay), with Chester Pebble Beds Formation (sandstone bedrock) below.

The Till is classified as a Secondary Aquifer; the underlying Sandstone bedrock is classed as a Principal Aquifer.

No landfills are present within 250m; the closest is 460m east.

Active contemporary trade directory entries within the vicinity include: garage services, knitwear manufacturers & wholesalers, air conditioning & refrigeration contractors, scrap metal merchants and office furniture & equipment. There is also one entry on site, relating to the printers on Heyrod Street.

The site lies in Flood Zone 1. BGS records the site as lying in an area where there is limited potential for groundwater flooding to occur.

3.3 Site history

In summary, the site was occupied by terraced housing from prior to 1851 (with a 'club' building and Sunday school in the east, later labelled 'public buildings').

The terraced housing was demolished by the late 1940s, at which point a coppersmiths is shown in the south-east (current location of the printers' premises), which is later labelled 'works'.

The current 'Rammon House' is first shown in the late 1950s/1960s, albeit named as 'Greenway House' and is marked as a warehouse. A building is also shown in the south-east at this point, in the same location as the current 'PA Metals' scrapyard, along 'Deer Street/Dearden Street'.

By the 1980s the TfGM building is shown as per the current layout, labelled as 'warehouse'.

Rammon House (former Greenway House) underwent a slight change in layout at some point between 2000 and 2006 where part of the north of the warehouse was demolished to make way for the tram lines to the north of Rammon House, creating the north-eastern 'spur' which is seen today. It is likely that this is when the new boiler house was installed (see Section 2 above).

At some stage between 2006 and 2018, the former 'Deer Street/Dearden Street' becomes closed and instead forms the access road into the main scrapyards area (see Section 2). It is likely that this coincided with the use of the south of the site as the van hire depot car park.

In the surrounding area, numerous industrial land uses are shown throughout history including various 'works' buildings, factories and warehouses. The most significant of which are;

- Clothing works & stationary works immediately north, including a chimney, present from early 1900s to 2000s
- 'Works' buildings immediately south, including a 'scrapyard' (location of van hire depot) from 1940s to 2000s
- Sheet metal works (later labelled 'works') immediately east from 1940s to 2000s

4. UXO

4.1 Introduction

The site is shown as being at 'moderate' risk from UXO based on Zetica's online Risk Maps. Therefore, a Preliminary Risk Assessment has been carried out by Brimstone (a UXO specialist). The aim of the Stage 1 assessment is to identify or discount the need for further detailed research - a Stage 2 Detailed UXO Risk Assessment.

A full copy is available in Appendix I.

4.2 Summary of findings

In summary, Manchester was subject to low-to-moderate bombing density during WWII and the nearest Luftwaffe target was located 350m east (Piccadilly Station).

However, any UXB strikes are likely to have been observed and reported at the time, although some may have gone undetected.

The site's substantial redevelopment since the war reduces the chance of UXO being encountered today.

Brimstone conclude that on-site supervision of construction/SI works by UXO specialist is not required. However, a UXO Safety Awareness Briefing should be given to all relevant personnel involved in earthworks.

5. REVIEW OF THIRD-PARTY REPORTS

5.1 Introduction

Apex have been provided with copies of the following third-party reports relating to this site (for ease, each report is given a numerical reference):

- *Phase 1 Desktop Study, Portugal Street East, Manchester* (ref. MN/AS/p 1 3633 R I) dated April 2017 issued by RoC Consulting
- *Phase 2 Site Investigation Report, Portugal Street East* (ref. LD/AS/p2 3633) dated April 2018 issued by RoC Consulting

The above reports were written for Olympian in the context of the current proposed development.

However, the investigations by RoC were restricted to external areas due to access constraints at the time. In addition, since the time of their investigations, the site boundary has increased and now includes additional land to the south and east (proposed external landscaping, access routes etc).

Key points from each of the above, pertinent to the site's current proposed development, are discussed below. RoC's exploratory hole locations are shown on Drawing 006 in Appendix B.

Where appropriate, third-party findings have been included within the following sections of this report

5.2 Scope

RoC's information included a desk study assessment, the findings of which have been incorporated into Sections 2 and 3. The intrusive investigation is summarised below:

Date	Exploratory holes	Depths	Remarks
2017	BH101 to 104m (cable percussion with rotary core follow on).	23.4m to 27.0m	Monitoring wells installed.
	WS101 to WS104 (window sample boreholes)	2.8m and 4.45m	
	FP01 (Hand dug foundation inspection pit)	1.2m	Excavated against south-west corner of Rammon House.

Laboratory testing included:

- Contamination analysis including
 - 12no. samples for pH, metals, PAH, asbestos ID, water-soluble sulphate.
 - 3no. samples for sVOC analysis
 - 1no PCBs

- 2no. samples for waste acceptance criteria (WAC) testing.
- Geotechnical analysis including:
 - 17no. samples of Glacial Clay for plasticity indices
 - 8no. samples for undrained unconsolidated shear strength triaxial tests
 - 3no. samples of granular material for particle size distribution
 - 26no. point load tests and 6 unconfined compressive strength (UCS) tests on samples of rock core

5.3 Ground conditions

To aid with contamination assessment, Apex have categorised the strata encountered by RoC based on ground conditions noted in our recent ground investigation. Strata encountered by RoC is one of 9 broad types:

- Macadam hardstanding (referred to as 'asphalt' in RoC's report)
- Sub-base
- Granular Made Ground
- Cohesive Made Ground
- Relict Topsoil
- Re-worked Natural Soils
- Cohesive Glacial Deposits
- Granular Glacial Deposits
- Sandstone Bedrock

Ground conditions encountered by RoC have been incorporated into Section 8 of this report and are included on the Summary Table in Appendix F.

5.4 Contamination

Chemical testing results obtained by RoC have been included in Section 10 of this report.

In summary, 'marginally elevated' concentrations of metals, PAHs and petroleum hydrocarbons were encountered within the made ground tested by RoC when compared to GAC assuming a residential with no gardens end-use.

No PCBs were detected in the sample tested from within the vicinity of the substation in the north.

5.5 Gas

RoC consider the on-site made ground a potential source of hazardous gas.

Four no. gas monitoring visits were undertaken between 14th February and 19th April 2018; based on the results, the site was classified as CS1 (no protection measures required).

5.6 Foundations, basement & floor slabs

Given the scale of the proposed structure, piled foundations are specified by RoC, terminating within the Sandstone bedrock. RoC state that the “*upper 8-10m of the Sandstone bedrock was broken / heavily weathered and it is considered likely this damage has arisen as a result of the Ardwick Fault (which crosses the site in a south-east to northwest orientation site near its centre with a north easterly down-throw).*”

However, examination of the 1:10,000 BGS plan (ref. SJ89NE) and the BGS online viewer shows this fault to lie c. 150m south of the site. The Sherwood Sandstone (aka. Chester Pebble Beds) is known to be highly weathered in the uppermost c. 10m and is easily disturbed when drilled through at shallow depth (as encountered by RoC). Therefore, Ardwick Fault should not pose significant geotechnical risk to this site.

Foundations for the podium structures are considered by RoC to be suitable for founding within the stiff Glacial Till (present from c. 1m to 2m).

The basement will be founded within Glacial Till and should take into consideration the likelihood of groundwater at the boundary between made ground and the underlying Glacial Till (clay), as well as a resting groundwater level within the natural ground at relatively shallow depth (as shallow as 2.8m in BH102).

A ground-bearing floor slab is specified by RoC, cast within the Glacial Till (clay).

5.7 Further work

Additional assessment of contamination is required; most notably, beneath building footprints and in areas of proposed landscaping (considered the most sensitive areas of the proposed development in terms of human health risk).

Initial discussions with geotechnical designers suggest that an additional deep (rotary cored) borehole would also be prudent in the east in order to confirm ground conditions in the south-east corner of the eastern tower. This is also recommended by RoC in their report.

6. CONCEPTUAL SITE MODEL

6.1 Introduction & planning

With respect to ground conditions and pollution, National Planning Policy Framework (NPPF 2021) Section 183 states that planning policies should ensure that:

- a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and

- any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);
- after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the environmental protection act 1990; and
 - adequate site investigation information, prepared by a competent person, is available to inform these assessments.

6.2 Contamination risks

A conceptual site model has been prepared based on all the information reviewed. A visual version is included in Appendix B as Drawing 005. Key sources, pathways and receptors are summarised below:

	SOURCE	PATHWAY	RECEPTOR
On site	Made ground associated with a miscellany of past uses. A broad range of contaminants might be present including metals, asbestos and organics.	Dermal contact, ingestion, inhalation.	End-users (residents, visitors & staff), site workers.
	Current and previous scrapyards (ferrous staining and metal fragments noted at surface). Metals, asbestos, fuel spillages.	Leaching of mobile contaminants.	Groundwater.
Off site	Industrial land use in vicinity of site throughout history.	Leaching of mobile contaminants onto site.	End-users, site workers.

The proposed change in use to residential dwellings and the potential for ground contamination warrants an intrusive ground contamination assessment, in accordance with the requirements of the NPPF.

6.3 Proposed ground investigation

A ground investigation is required in order to supplement RoC's existing data and to resolve uncertainties highlighted by the conceptual site model . Specifically, the investigation should enable:

- Assessment of the nature, thickness and lateral distribution of made ground, most notably within internal areas and areas of proposed landscaping
- Contamination risk assessment via inspection and sampling of made ground (and natural soils where appropriate)

- Additional investigation of deep ground conditions in the east to aid geotechnical design for the eastern tower.

7. GROUND INVESTIGATION

Following completion of the desk study phase, a ground investigation was undertaken between 31st August and 7th September 2021. All works were supervised by a suitably experienced Geo-Environmental Engineer from Apex.

7.1 Fieldwork

Fieldwork undertaken is summarised in the table below:

Technique	Depths	Remarks/justification
Windowless sample boreholes (WSs 01 to 05, 07 to 09, 11 & 12)	Between 0.75m and 2.80m	Primarily to enable investigation in areas of restricted access (internal) and to enable installation of monitoring wells. WSs 06 and 10 could not be drilled due to access constraints.
Monitoring wells (within WSs 07, 08, 09, 11 & 12)	Between 0.9m and 2.7m	Installed in the event that monitoring is required in future.
Trial pits (TPs 01 to 05)	Between 1.2m and 2.3m	Excavated using mechanical excavator in external areas.
Sample points (SP 01 & 02)	0.1m	Additional shallow pits excavated within the scrap yard to enable further sampling of scrap metal deposits within the vicinity of TP05.

The site investigation was limited to window sampling (as opposed to trial pits) within internal areas. In addition, the following areas could not be investigated:

- Existing roads (due to be stopped up): Betley Street, Heyrod Street, Churchgate Buildings, Portugal Street East.
- Small scrapyards area (no access)
- Inside PA Metals building (within main scrapyard)

Given the constraints, a post-demolition investigation is recommended.

8. GROUND CONDITIONS

For a full record of the ground conditions encountered in each exploratory hole, please refer to the logs in Appendices E & F. A summary table is also presented in Appendix F.

Ground conditions encountered by RoC have been incorporated into this Section.

The typical ground types encountered are described below:

8.1 Made ground

Made ground strata have been categorised (where possible) into 9 main ground 'types' based on their appearance, location on site, and likely origins, as identified during logging and the desk study phase.

It should be noted however that made ground is often heterogeneous by nature and therefore made ground conditions may vary significantly between exploratory hole locations.

The following strata were encountered:

- **Concrete hardstand:** Encountered within internal areas (building floor slabs); 0.15m to 0.20m thick within Rammon House; 0.20m to 0.25m within the TfGM building; 0.05m within the printing shop on Heyrod Street. Reinforcement was only noted in WSs 07 and 08 in the TfGM building.
- **Macadam surfacing:** Encountered in the car park to the west of the TfGM building to c. 0.1m; consists of a red surface course (0.03m) and an underlying black base course (0.07m). Also encountered in external areas around Rammon House to between 0.05m and 0.1m, described as 'asphalt' by RoC.
- **Hardcore surfacing:** Encountered in the van hire depot car park and in the south-west of the scrap yard to 0.2m depth. Typically sandy gravel of limestone, macadam fragments and brick. Occasional fragments of timber, metal and glass.
- **Cobble road:** Encountered buried beneath floor slab of the printing shop and beneath the hardcore in the van hire car park. Represents relict cobble streets from previous use as terraced housing. Present to between c. 0.3m and 0.4m.
- **Sub-base:** Varied between locations:
 - Rammon House (beneath floor slab): Gravelly sand with pockets of clay. Locally with gravel/cobble of brick, cement, garden tiles clinker and sandstone. Present to between 0.75m and 0.8m.

- Rammon House (externally): Encountered by RoC in boreholes located around the perimeter of Rammon House to between 0.1m and 0.3m; no description given by RoC.
- TfGM car park (beneath macadam): sandy gravel of limestone. Present to between 0.35m and 0.6m.
- TfGM building (beneath floor slab): Very clayey gravel including brick, cement and mortar to between 0.6m and 0.7m.
- Printing shop: Gravel of brick, cement, flint and clinker. Cobble of brick also noted here. Present to 0.45m.
- **Scrap metal deposits**: Encountered in the former scrapyard to 0.15m comprising sandy gravel of rusted metal fragments including tools, fixings, washers, sheet metal, poles, nails, keys and sparkplugs. Occasional gravel of mudstone.
- **Granular made ground**: Encountered in the TfGM car park, around the perimeter of Rammon House and scrapyard (WS01, FP01, TP02 and TP05) to between 0.25m and 0.7m comprising black (locally clayey) gravel, predominantly of clinker with some limestone, brick, pottery, metal fragments, glass. Occasional cobble of concrete and brick.
- **Cohesive made ground**: Soft black organic-rich gravelly clay. Gravel includes brick, pottery, sandstone, clayware with rare glass, mudstone and coal. Occasional cobble of brick. Encountered sporadically across the whole site to depths of between 0.7m and 1.9m (average 1.1m).
- **Re-worked natural**: Comprises friable sandy clay with gravel of brick, sandstone, clinker and coal. Encountered in TPs 03 & 04 only, within the grassland adjacent to the scrapyard to 0.8m depth.

8.2 Natural ground

The following strata were encountered:

- **Cohesive glacial deposits**: Encountered in all locations except the window samples in Rammon House (WSs 01 to 05). Typically comprises firm to stiff silty clay, often fissured and occasionally with mudstone gravel.
- **Granular glacial deposits**: Encountered by RoC in BHs 102 to 104 at depths of between 4.7m and 8.7m. Typically clayey, sandy gravel or gravelly sand. Gravel is of mixed lithologies.
- **Sandstone bedrock (Chester Pebble Beds*)**: Encountered by Roc in BHs 101 to 104. Depth to rockhead was reasonably consistent in BHs 102 to 104 (between 8.6m and 8.7m), but slightly deeper in BH101 (10.8m). The bedrock was highly weathered and was often recovered as weakly cemented sand. Typically described by RoC as extremely weak, thinly bedded fine grained sandstone.

* RoC refer to the Chester Pebble Beds by its alternate name, Sherwood Sandstone, in their report.

8.3 Evidence of contamination

Black residue was noted within the sub-base in WSs 02 and 05 (0.15m to 0.4m), both beneath Rammon House. In addition, the black macadam surfacing in TP02 had a slight tar odour from 0.1m to 0.3m.

No other visual/olfactory evidence of organic contamination was noted.

8.4 Stability, groundwater and obstructions

Obstructions

In addition to the concrete hardstand (floor slabs) and macadam surfacing (TfGM car park), below-ground obstructions were encountered in a number of exploratory holes, as summarised in the table below:

EXPLORATORY HOLE	OBSTRUCTION DETAILS
TP05	Broken (weathered) former concrete hardstand; now present as boulders of concrete from 0m to 0.05m
WS01	Borehole terminated on unknown obstruction at 0.75m; likely buried concrete slab.
WS02	Borehole terminated on unknown obstruction at 0.75m; likely buried concrete slab.
WS03	Borehole terminated on unknown obstruction at 0.85m; likely buried concrete slab.
WS04	Borehole terminated on unknown obstruction at 0.80m; likely buried concrete slab.
WS05	Borehole terminated on unknown obstruction at 0.80m; likely buried concrete slab.
WS09	Two courses of brick and mortar from 0.05m to 0.2m. Road cobbles from 0.2m to 0.27m (former cobble streets).
WS11	Two courses of brick and mortar from 0.05m to 0.2m. Road cobbles from 0.2m to 0.3m (former cobble streets).
FP01 (RoC)	RoC excavated a hand-dug trial pit adjacent to the south corner of Rammon House which showed a concrete footing from 0.55m depth, protruding 0.24m outwards and extending to >1.2m.

In addition to the above, significant obstructions associated with the current buildings (foundations, service runs etc) should be anticipated following demolition.

It is understood that as part of the development, sections of Heyrod Street, Portugal Street East and Betley Street will be stopped up. Where sections of these streets require removal, a similar road formation sequence to the conditions encountered in WSs09 and 11 is anticipated (i.e. cobbles beneath the tarmac with sub-base below).

Groundwater

Monitoring of groundwater levels was undertaken by RoC using data loggers, which monitored groundwater in BHs 101, 102 & 104 between 19th April and 21st May 2018, which yielded the following results:

	BH101		BH102		BH104	
	Depth (m)	Level (mAOD)	Depth (m)	Level (mAOD)	Depth (m)	Level (mAOD)
Minimum	6.10	39.31	2.79	42.66	6.94	39.98
Maximum	6.33	39.08	2.98	42.47	7.13	39.79
Average	6.22	31.19	2.88	42.57	7.04	38.88

Monitoring wells installed by RoC have response zones sealed within Glacial Deposits. Those in BHs 102 and 103 intercepted a granular layer within the clay. The results above suggest the presence of perched groundwater within the Granular bed in BH102 (5.1m to 5.6m), which is under sub-artesian pressure.

Perched water is also present in the Cohesive Glacial deposits, as detected in BHs 101 and 104, albeit not encountered during drilling by RoC.

Rising head tests were carried out by RoC in February 2018 involving purging 2x complete well volumes from each well and subsequent monitoring at 5 minute intervals to measure recharge rate. RoC conclude that the water table lies at between 40.50 and 38.9mAOD.

No groundwater strikes were noted by RoC when drilling through the Sandstone bedrock.

No groundwater strikes were noted during Apex's phase of investigation.

Stability

Stability of the made ground and natural strata within trial pit excavations was generally good.

9. GEOTECHNICAL TESTING (LABORATORY TESTS)

9.1 Introduction

Geotechnical assessment and design is beyond the scope of this report. However, it was considered prudent to obtain additional samples for geotechnical testing in order for designers to use in pile/building design in addition to the analysis undertaken by RoC.

Samples taken during the investigation have been delivered to a UKAS accredited laboratory and scheduled for the following geotechnical tests:

Material	No. samples		Analysis scheduled
	Apex	RoC	
Glacial Deposits	6	2	pH & water-soluble sulphate (2:1 extract)
	3	17	Moisture content Atterberg Limits
	3	1	Particle size distribution
Weathered sandstone	Not encountered	2	Particle size distribution
Made Ground	6	9	pH, water-soluble sulphate, chloride, nitrate & magnesium (BRE suite)

A full copy of the results, as received from the laboratory, is included in Appendix H.

Results obtained by RoC have been included within the following sections.

9.2 pH & soluble sulphate

In accordance with BRE SD1¹ and the site's conceptual model, samples were analysed for pH, water-soluble sulphate, chloride, nitrate & magnesium.

Results are summarised below and take into account equivalent chloride, nitrate and magnesium values where appropriate.

Material	pH range	Water soluble sulphate range (mg/l)*
Cohesive Glacial Deposits	7.5 to 8.8	12 to 150
Made Ground	7.3 to 10.4	<10 to 1400

* includes equivalent nitrate, chloride and magnesium where appropriate

Ground beneath this site is not considered likely to contain significant amounts of pyrite. In addition, it is unlikely to be 'disturbed' such that significant oxidation of any sulphide would occur. Therefore, assessment of total potential sulphate has not been carried out.

The site is considered to be brownfield with a mobile groundwater regime.

¹ BRE Special Digest 1 Concrete in aggressive ground 2005

Based on the above, sub-surface concrete in contact with:

- Made ground should be designed assuming a Design Sulphate class of DS-2 and Aggressive Chemical Environment of Concrete of AC-2 and for
- Glacial Deposits, can be reduced to DS-1, AC-1.

It should be noted that no pH & water-soluble sulphate testing has been carried out by RoC on samples of weathered sandstone/sandstone bedrock. This should be carried out as part of any additional deep drilling for pile design.

9.3 Atterberg limits

Results of Atterberg limit testing is summarised by stratum in the table below:

Material	Moisture content	Modified plasticity indices
Cohesive Glacial Deposits	8.3 to 22	13 to 27

Plasticity indices have been modified in accordance with NHBC Chapter 4.2².

Based on the above, the Cohesive Glacial Deposits should be classed as medium shrinkability (aka. volume change potential).

9.4 Particle size distribution (PSD)

PSD tests were carried out on 6 samples to aid engineering observations and help classify materials encountered on site. Results of the testing are summarised in the table below:

Material	Range % passing sieves (average)				Remarks
	37.5mm	20mm	2mm	Fines	
Cohesive Glacial Deposits	100	100	97-98	77-87	Shrinkable
Granular Glacial Deposits	100	72	99-100	13-21	Non-shrinkable
Weathered Sandstone	100	100	39	3	Non-shrinkable

The laboratory results above suggest that the Cohesive Glacial Deposits should be regarded as being shrinkable; whereas, the Granular Glacial Deposits and Weathered Sandstone should be considered non-shrinkable, confirming engineering observations in the field.

² NHBC Standards 2021

10. CHEMICAL TESTING (CONTAMINANTS)

10.1 Conceptual site model & screening values

As discussed in Section 3.3, former site uses include:

- Residential dwellings & ‘club’
- Coppersmiths (south-east)
- Warehouse (Rammon House), including:
 - Substation (north)
 - Boiler house (north)
- Scrapyards (south-east)
- TfGM depot (north-east)
- Printing premises (south)
- Van hire depot (south)

In addition, made ground was encountered across the site, up to 1.9m comprising one of 9 ground types. The made ground varied significantly between different site areas.

Given the above, a total of 23 samples were scheduled for analysis by Apex, along with 12 samples by RoC. Testing scheduled is summarised below:

Material	No. samples	Analysis scheduled
Made Ground	35	Asbestos ID
	34	pH & metals*
	27	Speciated PAH^
	23	Banded TPH
	18	Total Organic Carbon
	12	sVOCs
	5	Speciated TPH & BTEX
	4	Calorific Value
	4	PCBs VOCs
Cohesive Glacial Deposits	3	Speciated PAH pH & metals* Asbestos ID
	1	Speciated TPH & BTEX

* Where metals analysis was carried out by RoC, lead was not included

^ PAH and sVOC analysis (which includes PAHs) was carried out on the same sample by RoC, the worst-case results have been used.

The first phase of contamination risk assessment comprises screening against threshold values. Apex utilise the LQM/CIEJH S4ULs (publication number

S4UL3828) along with C4SLs where relevant (see Appendix A for more details on Apex's approach to contamination risk assessment).

The proposed development comprises high-rise residential structures with external areas of soft and hard landscaping. Therefore, the screening criteria initially utilised assume a without home-grown produce (RwoHP).

For organic compounds, account has been taken of the SOM content of each strata; SOM values used have been determined from laboratory testing and are summarised below:

Stratum	Range of TOC (%)	Average TOC (%)	SOM used	Remarks
Cohesive Made Ground	1.9 to 8.7%	4.9%	6%	
Granular Made Ground	1.8 to 27%	12.3%	6%	
Hardcore Surfacing	12%	12%	6%	Only one sample
Macadam Surfacing	6.7 to 15%	10.9%	N/A	Samples obtained for waste disposal purposes only
Made Ground Topsoil	13%	13%	6%	Only one sample
Re-worked Natural Soils	0.7 to 1.5%	1.1%	1%	
Sub-base	0.2 to 13%	3.5%	2.5%	Conservative (lower than average) value used given variability of results.
Cohesive Glacial Deposits	0.6 to 1.1%	0.9%	1%	
Scrap Metal Deposits	3.8%	3.8%	6%	Only one sample

10.2 Summary of contamination

After screening against the relevant values (see Section 10.1 above), the following exceedances of threshold values have been identified:

TP/BH	Area	Depth	Material	Contaminant(s)	Result*	Screening value*
SP01	Main Scrap Yard	0.05m	Scrap Metal Deposits	Arsenic Lead Mercury Nickel TPH (LRO)	160 2,700 86 470 2,500	40 310 56 180 1,900
TP05	Main Scrap Yard	0.1m	Scrap Metal Deposits	Arsenic Lead Nickel Asbestos Benzo[a]anthracene Benzo[a]pyrene Benzo[b]fluoranthene Dibenz[a,h]anthracene	130 3,700 290 0.085% 17 18 24 4.1	40 31 180 Detected 15 3.2 4.0 0.32
BH103	Rammon House (external)	0.3m	Cohesive Made Ground	Chromium	1,080	910
TP02	TfGM Car Park	0.5m	Granular Made Ground	Lead Calorific value Benzo[a]pyrene Benzo[b]fluoranthene Chrysene Dibenz[a,h]anthracene	320 2.9MJ/kg 5.0 6.4 500 0.88	310 2.0MJ/kg 3.2 4.0 32 0.32
TP05	Main Scrap Yard	0.4m	Granular Made Ground	Lead Calorific value Benzo[a]anthracene Benzo[a]pyrene Benzo[b]fluoranthene Dibenz[a,h]anthracene	1,600 2.2MJ/kg 22 25 31 5.7	310 2.0MJ/kg 15 3.2 4.0 0.32
TP03	Rough Grassland (in scrap yard)	0.2	Made Ground Topsoil	Lead Benzo[a]anthracene Benzo[a]pyrene Benzo[b]fluoranthene Dibenz[a,h]anthracene	780 17 16 20 5.6	310 15 3.2 4.0 0.32
WS02	Rammon House (internal)	0.4m	Sub-base	Asbestos	0.013%	Detected
WS12	Van Hire Depot	0.15m	Hardcore Surfacing	TPH (LRO) Benzo[b]fluoranthene	3,300 4.7	1,900 4.0

* mg/kg unless stated otherwise

Use of screening values which assume a residential with garden end-use provide a useful initial assessment but are potentially over-conservative in relation to this proposed development.

Made ground which sits below the proposed residential blocks will be removed to accommodate the proposed basement car park. Given the relatively flat nature of the site and the surrounding levels of adjacent roads, there is not likely to be any accommodation available on site for this material surplus. Therefore, material excavated beneath the buildings will most likely be exported from site.

Externally the proposed areas of soft and hard landscaping (see Drawing 002) represent a scenario more akin to the POS_{resi} land-use scenario, as defined in

SP1010³. This assumes an area of POS which may be grassed, bare soil or planted in close proximity to a residential development. Exposure pathways in this scenario include:

- Ingestion of soil and dust
- Dermal contact
- Inhalation of dust
- Inhalation of vapours outdoors

When compared to revised screening criteria, which assume a POS_{resi} scenario, the following exceedances of threshold values have been identified:

TP/BH	Area	Depth	Material	Contaminant(s)	Result*	Screening value*
SP01	Main Scrap Yard	0.05m	Scrap Metal Deposits	Arsenic Lead Nickel	160 2,700 470	79 630 230
TP05	Main Scrap Yard	0.1m	Scrap Metal Deposits	Arsenic Lead Nickel Asbestos Benzo[a]pyrene Benzo[b]fluoranthene Dibenz[a,h]anthracene	130 3,700 290 0.085% 18 24 4.1	79 630 230 Detected 5.7 7.2 0.56
TP02	TfGM Car Park	0.5m	Granular Made Ground	Calorific value Chrysene Dibenz[a,h]anthracene	2.9MJ/kg 500 0.88	2.0MJ/kg 75 0.58
TP05	Main Scrap Yard	0.4m	Granular Made Ground	Lead Calorific value Benzo[a]pyrene Dibenz[a,h]anthracene	1,600 2.2MJ/kg 25 5.7	630 2.0MJ/kg 5.7 0.58
TP03	Rough Grassland (in scrap yard)	0.2	Made Ground Topsoil	Lead Benzo[a]pyrene Benzo[b]fluoranthene Dibenz[a,h]anthracene	780 16 20 5.6	630 5.7 7.2 0.58
WS02	Rammon House (internal)	0.4m	Sub-base	Asbestos	0.013%	Detected

In summary, contaminants above their respective screening criteria have been detected in Scrap Metal Deposits, Granular Made Ground, Made Ground Topsoil and Sub-base.

The most common contaminants are metals and speciated PAHs. The majority of the elevated concentrations have been detected in the south-east (Main Scrap Yard Area).

No contamination has been detected within any of the samples of natural ground tested.

³ Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – CL:AIRE (24th September 2014)

10.3 Inorganics

Elevated concentrations of lead, arsenic and nickel have been identified in the Scrap Metal Deposits in the Main Scrapyrd area.

In addition, elevated concentrations of lead were detected in samples of Granular Made Ground and Made Ground Topsoil, within the Main Scrapyrd area and associated rough grassland.

Given the heterogeneity of the made ground, insufficient numbers of samples are available for the made ground types where elevated concentrations of contaminants have been detected, to enable meaningful statistical analysis.

10.4 TPH and PAHs

TPH – fuel source

Speciated TPH analysis was undertaken on samples obtained by RoC taken from within close proximity to the boiler house and electric substation.

None yielded results above their respective screening criteria.

Banded TPH was also scheduled on a number of samples obtained by Apex as an initial ‘screen’ for TPH contamination. No samples yielded results above their respective screening criteria.

PAHs

Testing yielded concentrations of PAHs above screening values in Scrap Metal Deposits, Granular Made Ground and Made Ground Topsoil, located within the Main Scrapyrd Area and the TfGM car park.

10.5 SVOCs & VOCs

Testing for VOCs & sVOCs by RoC and Apex typically yielded results below the limit of detection, with exception of BH104 0.5m (Cohesive Made Ground), which yielded:

- 0.01mg/kg Trichloroethane
- 0.002mg/kg Trichloropropane

Whilst there are no available screening values for the above contaminants, at such low concentrations, they are unlikely to pose a significant risk to human health.

Indeed, BH104 is located in an area which is to be excavated as part of basement construction, so the Cohesive Made Ground here will not remain beneath the proposed building.

10.6 Poly-chlorinated Biphenyls (PCBs)

The four samples analysed for PCBs by Apex and RoC (including within the vicinity of the substation in the north) yielded results which were all below the laboratory’s limit of detection.

10.7 Asbestos

In total, 31 samples of various strata were screened for asbestos. Asbestos was identified in 2 samples; one of Scrap Metal Deposits in the Main Scrapyard and one Sub-base beneath the floor slab of Rammon House.

Quantification was undertaken on the samples where a positive ID, as summarised below:

TP/BH	Depth	Material	Quantification (%)	Remarks
TP05	0.1m	Scrap Metal Deposits	0.085	Amosite & Chrysotile within cement ACM
WS02	0.4m	Sub-base	0.013	Amosite & Chrysotile as fibres/clumps

10.8 Calorific Value (CV)

Calorific value analysis has been undertaken on samples of made ground which contain significant amounts of potential combustible material (ash, clinker, coal etc).

Materials with a CV of >2MJ/kg are considered potentially combustible.

Four samples tested (two Granular Made Ground and two Sub-base).

Granular Made Ground

The two samples of made ground yielded results of 2.9MJ/kg and 2.2MJ/kg. However, this is at the lower end of where the potential for combustion exists. In addition, combustible materials were not detected in laterally extensive/continuous layers, so risks of spontaneous combustion are considered very low.

Sub-base

Both samples of Sub-base yielded results below the screening value of 2MJ/kg.

11. HAZARDOUS GAS

11.1 Background

Gas monitoring and risk assessment was carried out by RoC as part of their 2018 investigation. Further assessment and monitoring is beyond the scope of this report.

11.2 Discussion

RoC consider the presence of on-site made ground a potential source of hazardous gas. Following further intrusive investigation by Apex, the made ground has been found to be of limited thickness and generally comprises material which would not be expected to degrade and produce significant volumes of gas.

In addition, the made ground will be largely (if not fully) removed from beneath the proposed building to accommodate a basement car park, therefore removing the source. The car park itself will also provide some ventilation.

Given the above, and the findings of RoC's report, gas protection measures are not considered necessary and additional monitoring is not required.

11.3 Radon

No radon protection measures are required.

12. REVISED CONCEPTUAL SITE MODEL

12.1 General

The ground investigation and laboratory analysis has enabled revision of the conceptual site model; a revised version is presented as Drawing 007 in Appendix B.

12.2 Geotechnical

The exploratory hole logs and geotechnical testing shows the site to be underlain by made ground of between 0.15m and 1.9m.

Concrete floor slabs have been encountered in all buildings. Within Rammon House, a buried concrete slab is present at around 0.75-0.8m depth which will require grubbing up as part of demolition works. Two courses of brick & mortar and road cobbles are present beneath the Printers premises from 0.05m to 0.3m which likely represent a former cobbled road. A similar sequence is anticipated beneath the macadam surfacing of the surrounding roads.

In addition, foundation and service runs should be anticipated beneath the current buildings which will require removal as part of demolition works.

Natural ground comprises Cohesive Glacial Deposits (firm to stiff, often fissured clay); bands of sand and gravel (Granular Glacial Deposits) were encountered by RoC at around 5.0m depth, interbedded with the clay.

Sub-artesian groundwater has been detected by RoC within Granular Glacial Deposits.

Stability of shallow excavations within natural ground (clay) is expected to be good; shoring may be required for deeper excavations and those within made ground.

12.3 Contamination

Contamination has been detected within various made ground strata which may pose a risk to future end-users within areas of POS.

The most common contaminants are metals, PAHs and asbestos. Whilst contamination was encountered across the site, it was most notable in the south-east (Main Scrap Yard Area; see Drawing 003).

Investigation within internal areas and occupied external areas (Van Hire Depot and outskirts of Rammon House) has been limited to minimally intrusive techniques (window sampling). In addition, no boreholes or trial pits have been advanced in areas still in use as public highways which are due to be stopped up as part of development proposals.

Once demolition is complete and access is available to all site areas, it is recommended that a series of trial pits be excavated to allow inspection of inaccessible areas, most notably:

- Beneath the boiler room of Rammon House
- Through the buried slab beneath Rammon House
- Within footprint of current highways

No gas protection measures are considered necessary.

13. CONTAMINATION ASSESSMENT & REMEDIATION OPTIONS

13.1 Inorganics & PAHs

Elevated concentrations of various PAHs, lead, arsenic and nickel were detected in samples of Scrap Metal Deposits, Made Ground Topsoil, and Granular Made Ground within the Main Scrap Yard Area and associated rough grassland to the north (see Drawing 003).

In addition, elevated concentrations of PAHs were detected in one sample of Granular Made Ground beneath the TfGM car park.

Scrap Metal Deposits

The scrap metal deposits contained significantly elevated concentrations of lead (up to 3,700mg/kg, over 5x the screening value of 630mg/kg), as well as elevated concentrations of arsenic, nickel and PAHs. These deposits are:

- readily identifiable through visual inspection
- at surface (or very near to surface)
- relatively thin (0.15m thick) and are confined to the south-east

Given the above, the Scrap Metal Deposits should be stripped and carefully segregated from other made ground types and placed in a designated stockpile during earthworks. It is recommended that these deposits be removed from site.

Made Ground Topsoil

The Made Ground Topsoil within the Main Scrap Yard is not considered suitable for re-use on site due to the presence of elevated concentrations of lead (and PAHs, see below).

If this material remains on site, it should be provided with at least 600mm clean soil cover in landscaped areas, but be placed at not greater than 1m depth (due to its compressibility and gas-generating potential).

Given its organic and compressible nature, it should not be placed beneath building floor slabs.

Granular Made Ground

The Granular Made Ground contains elevated concentrations of lead and various PAHs. Given the heterogeneity of the Granular Made Ground, similar 'spikes' in inorganic and PAH concentrations could be present elsewhere on site.

The PAHs detected are all considered relatively immobile and therefore, where this material remains beneath areas of proposed hardstanding or the building footprint, no further action is considered necessary of the pathway between the contaminated made ground and site users is essentially broken.

In areas of proposed soft landscaping, at least 600mm clean soil cover should be placed above any made ground in order to protect end-users from any residual risk from contamination exposure.

Asbestos

Asbestos fibres have been identified in 2 out of 31 samples screened. Quantification yielded results of 0.085% (Scrap Metal Deposits in Main Scrap Yard) and 0.013% (Sub-base beneath Rammon House).

Given the history of the site and heterogeneity of the made ground, it is likely that asbestos-containing materials will be found within soils across the site, although testing to date suggests that asbestos contamination is relatively sparse.

It should be borne in mind that to date, limited investigation has been undertaken within the footprint of the buildings on site. Asbestos was often used as shuttering during construction of buildings (i.e. beneath slabs and along foundations) and an asbestos survey carried out has revealed the presence of asbestos throughout the main building on site. Additional sampling of made ground is recommended during the post-demolition trial pitting phase of investigation.

Any suspected ACMs encountered during site works should be hand-picked by a specialist contractor and double-bagged awaiting disposal. Any such material will be classified as hazardous waste.

The demolition/remediation contractors will need to submit a method statement and risk assessment regarding mitigation of asbestos risks. As a minimum, this should ensure that soils are kept damp during site works and that all personnel have appropriate PPE.

Human-health risks to end-users can be mitigated through isolation of the asbestos-containing soils, or removal from site.

Given the quantification results, it is recommended that made ground be placed either beneath hardstanding, or beneath at least 600mm clean cover in landscaped areas. To date, asbestos has only been identified in strata which are due to be removed from site (Scrap Metal Deposits and material from within the

footprint of the basement), therefore no additional measures (such as geotextile membrane or hard-dig layer) should be required unless further evidence of asbestos is identified during earthworks/remediation.

13.2 Summary of remediation options

Human health

After review of all data, appropriate remediation options are summarised in the table below:

Source	Site area	Contaminant	Receptor	Remediation options
Scrap Metal Deposits	Main Scrap Yard, south-east	Inorganics, asbestos, PAHs	Human Health	Careful segregation and removal from site. Not recommended for on-site retention due to very high lead concentrations.
Made Ground Topsoil	Rough grassland in Main Scrap Yard	Lead & PAHs		Isolation beneath 600mm clean cover, but placed at no greater than 1m. Not suitable for placement beneath hardstanding. Alternatively, export from site.
Granular Made Ground	Site wide	PAHs		Isolation beneath 600mm clean cover in landscaped areas, or beneath areas of hardstanding (floor slabs or external areas)
Sub-base	Rammon House	Asbestos		Alternatively, export from site.

When placing contaminated material beneath hardstanding/clean cover, consideration should be given to the likelihood of future disturbance. Therefore, placement above service runs should be avoided; this may necessitate the use of 'clean corridors'.

The proposed 600mm clean soil cover should include at least 150mm topsoil with clean subsoil/capping material below.

Given the lack of significant volumes of suitable material on site for use in landscaped areas, there will be a need for soil import for use as subsoil and topsoil.

A Remediation Strategy will be required and should be sent to the Local Planning Authority for their approval.

Contractors involved in site works whose staff are likely to come into contact with contaminants identified will need to detail appropriate mitigation measures in their risk assessments and method statements.

Groundwater

Contamination has been detected within shallow made ground soils. However, following remediation, risks of downward migration of contaminants will be significantly reduced due to:

- Isolation of contaminated materials beneath hardstanding/floor slabs

- Removal of the Scrap Metal Deposits (the most heavily contaminated)
- Excavation and removal of material to c. 4m depth below current ground levels to accommodate the proposed basement

In addition, there is a significant thickness of low permeability clay beneath the site which should afford sufficient protection for the underlying aquifers against any residual risk of leaching.

13.3 Contingency

It should be noted that the nature of ground investigation is such that, even after a thorough investigation, only a limited amount of the ground is actually uncovered. Therefore, areas of as yet unidentified contamination may be present.

During site preparatory works, if evidence of any unrecorded contamination is encountered (for example, odours, staining, oily sheens, ACMs etc), works should cease, and additional advice should be sought from Apex.

Particular attention should be paid to the presence of any suspected asbestos-containing materials, especially beneath floor slabs and along the side of foundations/service runs as such materials were often used as shuttering.

To mitigate risks further, post-demolition trial pitting is recommended.

14. WASTE AND MATERIALS MANAGEMENT

14.1 Materials Management Plan

The required remediation (placement of clean soil cover and isolation of made ground) will likely involve re-use of made ground on site along with soil import. Therefore, a Materials Management Plan (MMP) should be prepared by the remediation contractor.

This report has identified sub-populations of made ground which have different chemical characteristics (see Sections 8 and 10) which may be classed as differing waste types.

Consequently, it is essential that groundworkers involved in the excavation and handling of materials beneath the site are adequately briefed on the importance of good materials management (i.e. not mixing soils from different waste types).

In particular, the Scrap Metal Deposits, Made Ground Topsoil and any hydrocarbon impacted soils should be kept separate from other materials.

Any natural soils excavated as part of site preparatory works (i.e. below the basement, for drainage etc) should also be kept separate from all other made ground strata.

14.2 Waste classification

Assessment of any material proposed for off-site disposal should be undertaken in accordance with WM3⁴. At the heart of this guidance is the need to accurately characterise sub-populations of waste via appropriate sampling (ideally when stockpiled). Waste classification should never be determined on the basis of individual sample test results.

Waste Acceptance Criteria (WAC) testing should only be required where material is likely to be disposed of as 'hazardous' based on the WM3 assessment.

Asbestos

In accordance with WM3, soils which contain >0.1% asbestos will be regarded as hazardous waste.

In addition, any soils which contain visible fragments of potentially asbestos-containing materials will be regarded as hazardous waste (if the fragments contain >0.1% asbestos), unless all such fragments can be removed by hand-picking prior to disposal. Such material (asbestos-containing cement) was encountered within the Scrap Metal Deposits in the south-east.

Macadam surfacing

As part of the ground investigation, two samples of macadam surfacing from within the TfGM car park were scheduled for PAH analysis in order to assist waste assessment for this material.

Based on the results obtained, which include benzo(a)pyrene of <10mg/kg, the macadam surfacing will likely be classed as non-hazardous. However, this should be confirmed by those who carry out the waste assessment prior to off-site disposal.

Additional testing of the macadam surfacing in the roads to be stopped up is recommended to confirm disposal costs.

Conclusion

Contractors involved in the removal of waste from site should assess the data within this report (and RoC's) in order to make their own assessment with respect to appropriate waste codes and disposal routes.

⁴ Technical Guidance WM3 – Guidance on the classification and assessment of waste – Environment Agency (2015)

15. PREPARATORY WORKS & CONSTRUCTION ISSUES

15.1 Excavations

As discussed in Section 8.4, significant obstructions are present beneath the site, which may require breaking out where they conflict with the line of excavations for service runs, foundations, basement etc.

Stability of excavations in made ground should be expected to be poor and may necessitate shoring. Stability of excavations within natural soils (clay) is expected to be good.

Some perched water may be present in the made ground from around 1m to 2m depth, most notably at the boundary of the natural and made ground soils.

Depending on the final dig depth of the basement, Granular Glacial Deposits (sand & gravel) may be encountered, interbedded with the Cohesive Glacial Deposits (clay). RoC's data suggests the possible presence of groundwater within this material under sub-artesian pressure. Groundworkers should bear this in mind when carrying out excavations for the basement and have appropriate contingencies in place.

This will also need to be factored in to floor slab design by geotechnical designers.

15.2 Drainage and new water supplies

Based on the ground conditions encountered, soakaways will not provide a suitable means of water disposal at this site. Alternative SUDs should be considered.

Where new water mains are to be laid, UKWIR testing will be required in order to confirm pipe construction materials, as detailed in UKWIR report 10/WM/03/21⁵. This should ideally be carried post-earthworks and after any remediation.

15.3 Existing services

Underground electricity, BT, drainage, fibre, water and gas services run along Churchgate Buildings, Heyrod Street, Portugal Street East and Betley Street which feed the existing buildings.

Consultation is required with service providers in order to ascertain any restrictions or easements required, along with feasibility of diversion (where required).

⁵ Guidance for the selection of water supply pipes to be used in brownfield sites – UK Water Industry Research (2011)

16. CONCLUSIONS AND RECOMMENDATIONS

16.1 Background & proposed development

The site is currently occupied by a series of buildings and outdoor areas off Portugal Street East, Heyrod Street, Churchgate Buildings and Betley Street.

It is understood that proposals include development of two residential tower blocks of 30 storeys (west) and 24 storeys (east). A basement car park will span beneath both blocks. Externally, areas of green space, pedestrian routes and cobbled streets are proposed. Sections of Betley Street, Churchgate Buildings, Heyrod Street and Portugal Street East are to be stopped up and incorporated into the development.

16.2 Ground conditions

The site is underlain by made ground of between 0.15m and 1.9m.

Concrete floor slabs have been encountered in all buildings. Within Rammon House, a buried concrete slab is present at around 0.75-0.8m depth which will require grubbing up as part of demolition works. Two courses of brick & mortar and road cobbles are present beneath the Printers premises from 0.05m to 0.3m which likely represent a former cobbled road. A similar sequence is anticipated beneath the macadam surfacing of the surrounding roads.

In addition, foundation and service runs should be anticipated beneath the current buildings which will require removal as part of demolition works.

Natural ground comprises Cohesive Glacial Deposits (firm to stiff, often fissured clay); bands of sand and gravel (Granular Glacial Deposits) were encountered by RoC at around 5.0m depth, interbedded with the clay.

Sub-artesian groundwater is present within Granular Glacial deposits, encountered from c. 5m depth interbedded with Cohesive Glacial Deposits.

16.3 Contamination and remediation

Contamination has been detected within various made ground strata which may pose a risk to future end-users within areas of POS.

The most common contaminants are metals, PAHs and asbestos. Whilst contamination was encountered across the site, it was most notable in the south-east (Main Scrap Yard Area).

Scrap Metal Deposits, encountered to 0.15m in the south-east, should be removed from site as part of preparatory works.

A 600mm clean soil cover system should be placed in areas of proposed soft landscaping. Beneath the proposed buildings, the excavation for the basement will result in the majority of made ground (and therefore contamination) being removed.

Once demolition is complete and access is available to all site areas, it is recommended that a series of trial pits be excavated to allow inspection of inaccessible areas, most notably:

- Beneath the boiler room of Rammon House
- Through the buried slab beneath Rammon House
- Within footprint of current highways

16.4 Hazardous gas

Based on the ground conditions encountered and the work previously undertaken by RoC, no gas protection measures are required.

No radon protection measures are required.

16.5 Foundations

Given the scale of the proposed buildings, piled foundations extending into the Sherwood Sandstone bedrock will be required. Piles for the proposed basement wall may terminate in the shallower Cohesive Glacial Deposits (stiff clay).

Geotechnical assessment is beyond the scope of this report; Olympian should make use of the recommendations contained within RoC's 2018 Report.

16.6 Drainage

Given the presence of substantial thicknesses of clay beneath the site, use of soakaways is not considered feasible; alternative SUDs options should be considered.

16.7 Flooding

The site lies in Flood Zone 1.

BGS records the site as lying in an area where there is limited potential for groundwater flooding to occur.

16.8 UXO

A Preliminary Risk Assessment has been carried out by Brimstone (a UXO specialist).

Brimstone conclude that on-site supervision of construction/SI works by UXO specialist is not required. However, a UXO Safety Awareness Briefing should be given to all relevant personnel involved in earthworks.

16.9 Further works

The following additional works are recommended in light of this investigation:

- Post-demolition site investigation
- Dynamic sampling with rotary core follow-on to c. 30m in the east to supplement RoC's existing data for pile design.

- Updating this report when the supplementary investigations are complete.
- Production of a Remediation Strategy once remediation options are finalised and after the post-demolition site investigation.



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Appendix A – Guidance Notes

Guidance Note B – Fieldwork

1. UK GUIDANCE

Ground investigation fieldwork undertaken by Apex Consult (SY) Ltd is done so in general accordance with UK guidance. Most notably, in planning and carrying out ground investigation fieldwork, the following documents are referred to: BS5930:2015¹; BS10175²; LCRM³, BS8004⁴, BS1377-9⁵.

2. GROUND INVESTIGATION DESIGN

Locations

Locations of exploratory holes are selected after formulation of the site's conceptual site model, which looks at geotechnical and contamination risks. Positions of exploratory holes are selected in order to resolve uncertainties highlighted by the conceptual model (for example, checking for obstructions associated with a former builder or to enable sampling close to a former fuel tank, etc). In addition, hole locations are selected to gain a general view of the strata across the site to enable refinement of the conceptual site model.

On site, positions may be altered due to access constraints or risks posed by service runs. Further exploratory holes might be advanced to enable delineation of features such as grossly contaminated soils, poor ground, etc.

Techniques

The following techniques are typically utilised depending on ground conditions and site constraints:

- Trial pitting – used wherever possible as this allows better quality representative sampling and a more thorough inspection of the ground (stability, ease of excavations, etc) than techniques such as windowless sampling. Limited to around 3-4m depth or presence of bedrock. Hand shear vane tests are carried out in cohesive soils throughout trial pitting to enable assessment of undrained shear strength.
- Windowless sampling – typically used where access constraints prevent trial pitting and/or to enable installation of monitoring wells to up to c. 5m depth. Limited to around 3-4m depth or presence of bedrock. Where appropriate, standard penetration tests (SPTs) might be carried out in granular soils. Whilst hand-vane tests can be carried out, they are considered less reliable than those within trial pits due to the disturbance caused during drilling.
- Cable percussion boreholes – Used where geotechnical parameters and detailed inspection of ground conditions are required from depths greater than can be reached with trial pitting/window sampling techniques. SPTs

¹ Code of practice for ground investigations (2015+A1:2020)

² Investigation of potentially contaminated sites – code of practice (2011 + A2:2017)

³ Land Contamination Risk Management (8th October 2020)

⁴ Code of practice for foundations (2015+A1:2020)

⁵ Methods of test for soils for civil engineering purposes. In-situ tests (1990)

are typically undertaken at c. 1m intervals to allow assessment of the density of granular soils and/or estimation of undrained shear strength of cohesive soils. Within cohesive soils, SPTs are usually alternated with collection of UT100 samples (undisturbed samples). Depending on ground conditions, use of dynamic sampling or rotary drilling with a casing system (for example, Odex/Duplex drilling) gives similar results, but might be considered more appropriate. This is discussed with the drilling contractor prior to fieldwork.

- Rotary open-hole drilling – typically used in coal mining investigations to look at the depth and thickness of underlying coal seams (and/or evidence of mineworking's). Generally, at least 3 holes are taken to c. 30m depth below rockhead in all coal mining investigations, with additional boreholes drilled to the depths of the targeted coal seams.
- Rotary core drilling – this is utilised where detailed information (fracture spacing, RQD TCR values) is needed from bedrock, usually for pile design. Rotary coring also enables recovery of rock samples for strength tests such as point load index and unconfined compressive strength (UCS).

During drilling, installations to monitor for hazardous gas and/or groundwater might be installed as per the Engineer's instructions.

Other ground investigation techniques (such as hand-excavated inspection pits, CPTs, etc) might be utilised on certain sites depending on ground conditions and redevelopment proposals.

3. SAMPLING

Usually, at least one sample is taken from each stratum encountered in each exploratory hole, with particular attention paid to made ground deposits within the uppermost 1m. Unless stated otherwise, samples taken are representative of the stratum encountered at a given depth. In trial pitting, this involves taking samples from around the side walls of the entire trial pit (where possible) and not from a specific point. Where a 'spot' sample is required (for example, a sample of lens of ash & clinker or oily fill), this is clearly denoted on the sample by an "★" and in the Engineer's notebook.

Samples are collected in containers appropriate for their proposed analysis, as dictated by laboratory requirements. Typically, this means that the following containers are needed for soils:

- For chemical analysis: 50ml glass jar, 500ml glass jar, and 500ml plastic tub
- For geotechnical analysis on disturbed samples: 500ml plastic tub, and bulk bags

Once collected, all samples scheduled for chemical analysis are stored in cool boxes at c. 4°C. Samples scheduled for asbestos ID are 'double bagged' (i.e., plastic tubs stored within a plastic bulk bag).

If groundwater sampling is required, typically 2 x 1 litre glass bottled, and 2 x 50ml glass vials will be collected from each sample point. However, specific instructions regarding containers will be discussed with the laboratory.

4. ENGINEERING SUPERVISION & LOGGING

During fieldwork, full time engineering supervision is required. The Engineer logs the ground conditions in general accordance with BS 5930 including observations on groundwater, stability, ease of excavation, and any visual/olfactory evidence of organic contamination.

Guidance Note C – Contamination Testing & Assessment

1. CONCEPTUAL SITE MODEL

The conceptual site model, combined with fieldwork findings, is used to determine the locations and depths of samples scheduled for chemical analysis. Samples taken from points of interest (i.e., potential sources of contamination, as determined during the desk study phase and/or by visual and olfactory evidence on site) are scheduled for analysis as well as samples from across the site to enable characterisation of ground types encountered.

The analysis suite is determined by a review of the history of both the site and surrounding area as well as current features. Reference is also made to relevant DETR Industry Profiles.

Typically, all soil samples are scheduled for the following analysis as a broad screen, with additional site-specific contaminants tested for as and when required based on the conceptual model:

- pH & metals
- Asbestos ID (with quantification if evidence of asbestos is detected)
- Water soluble sulphate
- Total organic carbon
- Speciated polycyclic aromatic hydrocarbons
- Petroleum hydrocarbons (brownfield only, unless a clear source is shown on greenfield sites) with speciation where appropriate

Where significant risks to controlled waters are identified, leachability analysis may also be scheduled as well as analysis of water samples (ground/surface). Additional assessment may be required.

Details of laboratory analysis techniques and limits of detection are included within the laboratory results.

2. ASSESSMENT CRITERIA

To assess whether a plausible pollutant linkage exists between a contaminant source and a site receptor, Apex initially screen results against generic assessment criteria as part of a generic quantitative risk assessment. The criteria used are the LQM/CIEH “Suitable 4 Use Levels” (S4UL)¹, publication number S4UL3828 and Category 4 Screening Values (C4SLs). This approach is in line with LCRM². Screening values used for a variety of end-uses are shown at the end of this guidance note.

Where criteria other than S4ULs or C4SLs have been used, this is stated in the report’s main text.

¹ The LQM/CIEH S4ULs for Human Health Risk Assessment (2015)

² Land Contamination Risk Management (8th October 2020)

2.1 LQM/CIEH Suitable 4 Use Levels (S4UL)

The S4ULs are “intended for use in assessing the potential risks posed to human health by contaminants in soil and as transparently-derived and cautious ‘trigger values’ above which further assessment of the risks or remedial actions may be needed.”

The S4ULs are based on a principal of minimal or tolerable risk in line with SR2³ and are therefore considered suitable as assessment criteria under the planning regime.

The S4ULs are derived using CLEA software; the S4UL for each contaminant is the concentration of the contaminant in soil at which the predicted average daily exposure equals the Health Criteria Value¹.

The S4ULs assume a sandy loam as per Environment Agency guidance³. For organic contaminants, soil organic matter (derived from TOC testing) is also considered in order to apply the correct screening value for each contaminant.

In assessing contamination risks by comparing site-derived values with the S4ULs, it should be noted that:

- Non-exceedance of a relevant S4UL indicates that soil contaminant levels are such as not to compromise human health¹
- Exceedance of a S4UL does not necessarily mean there is a significant possibility of significant harm, nor that remediation is needed under the planning regime¹
- Exceedance should however warrant further discussion, assessment, and possibly additional investigation, following this, the need for remediation should then be considered

2.2 Category 4 Screening Values (C4SL)

Category 4 Screening Values were published by Defra in 2014 as part of SP1010⁴. C4SLs are available for six contaminants (arsenic, benzene, benzo[a]pyrene, cadmium, chromium VI, and lead). These values were based on a ‘low level of toxicological concern’ (LLTC) rather than minimal or tolerable level of risk as advocated by the Environment Agency in SR2³.

In the absence of S4ULs, namely for lead, C4SLs have been adopted by Apex as initial screening criteria. This approach is generally accepted by regulators.

2.3 TPH assessment

When assessing TPH results, a 3-step approach is adopted by Apex, in accordance with Environment Agency guidance⁵. This involves:

³ Human health toxicological assessment of contaminants in soil (1st January 2009)

⁴ Development of Category 4 Screening Values (C4SLs) for Assessment of Land Affected by Contamination

⁵ Environment Agency document P5-080/TR3 - The UK approach for evaluating human health risks from petroleum hydrocarbons in soils (June 2003)

Step 1 – assessment of indicator compounds. Results of laboratory testing for the indicator compounds given in Table 4.1 of P5-080/TR3⁵ are compared to the appropriate screening values (see above).

Step 2 – assessment of individual fractions. Where indicator compounds are present, results for the individual TPH fractions are assessed against their respective screening values.

Step 3 – assessment of cumulative effects

This is done using the following equation:

$$HI = \sum_{F_i=1}^{16} HQ F_i = \frac{\text{Measured concentration } F_i \text{ (mg kg}^{-1}\text{)}}{SGV F_i \text{ (mg kg}^{-1}\text{)}}$$

where HI = Hazard Index
 HQ = Hazard Quotient
 F_i = Fraction i
 SGV = Soil Guideline Value

In the event of exceedances of screening value at Stages 1 or 2, no further assessment is needed.

In stead of speciated TPH, banded TPH may be scheduled as an initial ‘screen’ for potential TPH contamination. This splits the results into 3 bandings: gasoline-range, diesel range, and lubricating range organics (GRO, DRO and LRO). When assessing results of banded TPH analysis, the most stringent S4UL screening value for individual TPH bandings is used from within the GRO, DRO and LRO ranges. This is considered to be a conservative approach, and where exceedances are recorded, additional analysis (speciated TPH) may be scheduled to enable further risk assessment.

2.4 Asbestos

There is no published screening value below which asbestos within soil is deemed as ‘safe’. This is because, even at trace amounts (<0.001%) potentially respirable fibres may be present within soils which could cause harm to human health. However, CL:AIRE guidance⁶ suggests that release of asbestos fibres from the ground is unlikely to result in airborne concentrations equivalent to those which could be released when working with asbestos-containing building materials (insulation, AIB, coatings etc). This assumes that the asbestos-containing soils are not being subjected to highly energetic processes (e.g. crushing & screening).

When assessing site investigation data, any sample where asbestos fibres are detected requires further assessment to fully understand risks.

Quantification is scheduled on samples where asbestos is identified. This looks at the amount of asbestos with a sample as a percentage of the soil mass, also gives details on the type of asbestos and its nature within the sample (e.g. a fragment of ACM, loose fibres, debris etc).

After quantification, a risk assessment is carried out based on the number of samples yielding a positive ID, the strata where asbestos was identified, the

⁶ Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials – Control of Asbestos Regulations, CL:AIRE (2012).

nature of the asbestos, any proposed earthworks and the final development layout.

3. ADDITIONAL ASSESSMENT

In the event of exceedances during the initial screen, a number of options might be used to further assess the hazard posed by contaminants in soils:

3.1 Statistical assessment

Additional assessment using various statistical techniques where appropriate. It should be borne in mind that statistical methods should only be used where a sufficient number of samples are available from each ground type (typically six as a minimum). In addition, statistics should only be used in conjunction with appropriate averaging areas. These may be certain material types, site sub-areas based on past use, spillage of contaminants etc. Where averaging areas and statistics are used, further detail is given in the report text.

3.2 Detailed quantitative risk assessment (dQRA)

Additional assessment might be undertaken to determine whether a risk actually exists. For example, this may involve re-visiting input parameters in the CLEA model and deriving site-specific screening values or use of bio-accessibility testing.

3.3 Additional investigation

Where areas of contamination are encountered, particularly those thought to be attributed to a 'hotspot' (i.e., a spillage or leakage of contamination) additional sampling and analysis might be recommended to delineate areas of soil affected.

3.4 Remediation

Where the above procedures highlight an unacceptable risk, remediation options will be advocated. This might involve removal of the source, or breakage of the pathway(s).

Guidance Note D – Geotechnical Testing & Assessment

The following geotechnical analysis is commonly undertaken by Apex. All testing is done in accordance with the specified methods outlined in BS1377:1990.

Any additional testing not listed below and/or deviations from set procedures will be stated in the report's main text.

1. UNDRAINED, UNCONSOLIDATED TRIAXIAL TESTING

The above is frequently scheduled on undisturbed samples (ideally UT100s) as a method of assessing undrained shear strength of cohesive soils in the worst-case scenario (i.e. during loading, where excess pore pressure has not dissipated, meaning effective strength is at its lowest).

Where possible, tests are scheduled on a single 100mm diameter specimen as opposed to 3no. 38mm diameter sub-specimens to minimise the risk of sample disturbance.

Samples are typically scheduled for analysis at a confining pressure roughly equal to overburden pressure.

2. OEDOMETER (CONSOLIDATION) TESTS

This testing is undertaken to enable assessment of consolidation settlement in clays for a given load. This is usually done for cohesive soils other than those which are over-consolidated and/or where significant ground surcharge is anticipated.

Samples are scheduled to include 4 loading pressures and one unloading pressure. In accordance with BS1377, the initial pressure is determined by the soil's origin and strength and where possible, the scale of pressures should include at least one which is equal to (or greater than) the likely maximum pressure to be imposed on the soil.

The results are used to give typical coefficient of volume compressibility (m_v) values for ground types across a range of depths. This is used in settlement calculations and might be used by others in pile design for example.

3. ATTERBERG LIMITS

Atterberg Limits testing is carried out on samples of cohesive soils to help determine minimum foundation depths including the impact of any tree influence, requirements for heave precaution etc.

The test involves determination of the Liquid and Plastic Limits of cohesive soils using the rolling thread test cone penetrometer method.

Results received are modified by Apex in line with BRE Special Digest 240¹ and NHBC Chapter 4.2² in order to determine a soil's volume change potential (aka. shrinkability). Data is typically grouped into ground types and average shrinkability values are used for each type. However, where a significant number of samples of yield results in a higher shrinkability category to that of the average, the ground type is conservatively assigned the higher shrinkability category.

This may also be used in conjunction with Particle Size Distribution tests (PSDs) to determine whether a particular soil/sample should be classed as potentially shrinkable or not. This is done by looking at the 'fines' content (%< 63µm) from the PSD test along with the modified plasticity indices. Where the soil contains <35% fines and/or has a modified PI value of <10%, it can be regarded as non-shrinkable (in accordance with NHBC Chapter 4.2).

4. Sulphate and pH

Samples are scheduled for pH and water-soluble sulphate analysis in order to determine the Aggressive Chemical Environment for Concrete (ACEC) classification along with the Design Sulphate (DS) class in accordance with the requirements of BRE SD1³.

Where groundwater samples are available, sulphate results from groundwater may be used in addition to soil results.

On all sites, pH and water-soluble sulphate analysis is scheduled on each ground type. On brownfield sites, testing for nitrate and chloride is also undertaken. These are converted to equivalent sulphate values ($\text{NO}_3 \times 0.77$ and $\text{Cl} \times 1.35$) and are added to the water-soluble sulphate results for each sample.

Where sulphate readings are >3,000mg/l, magnesium concentrations are also considered.

Where there is a risk of pyrite (iron sulphide) within the ground (as identified by the desk study), total sulphur and total sulphate may also be scheduled in order to determine the "total potential sulphate (TPS)". However, the risks to concrete associated with pyrite need only be considered where ground is 'disturbed'. Examples include colliery spoil or cut slopes. For a typical shallow foundation within in-situ natural soils, pyrite should not present a significant risk.

Results are used to determine the highest water-soluble sulphate (or TPS where risks of pyrite need to be considered) and lowest pH for each soil type. Where >10 samples for each soil type are available, the mean of the highest/lowest 20% of values for water-soluble sulphate/pH are used respectively.

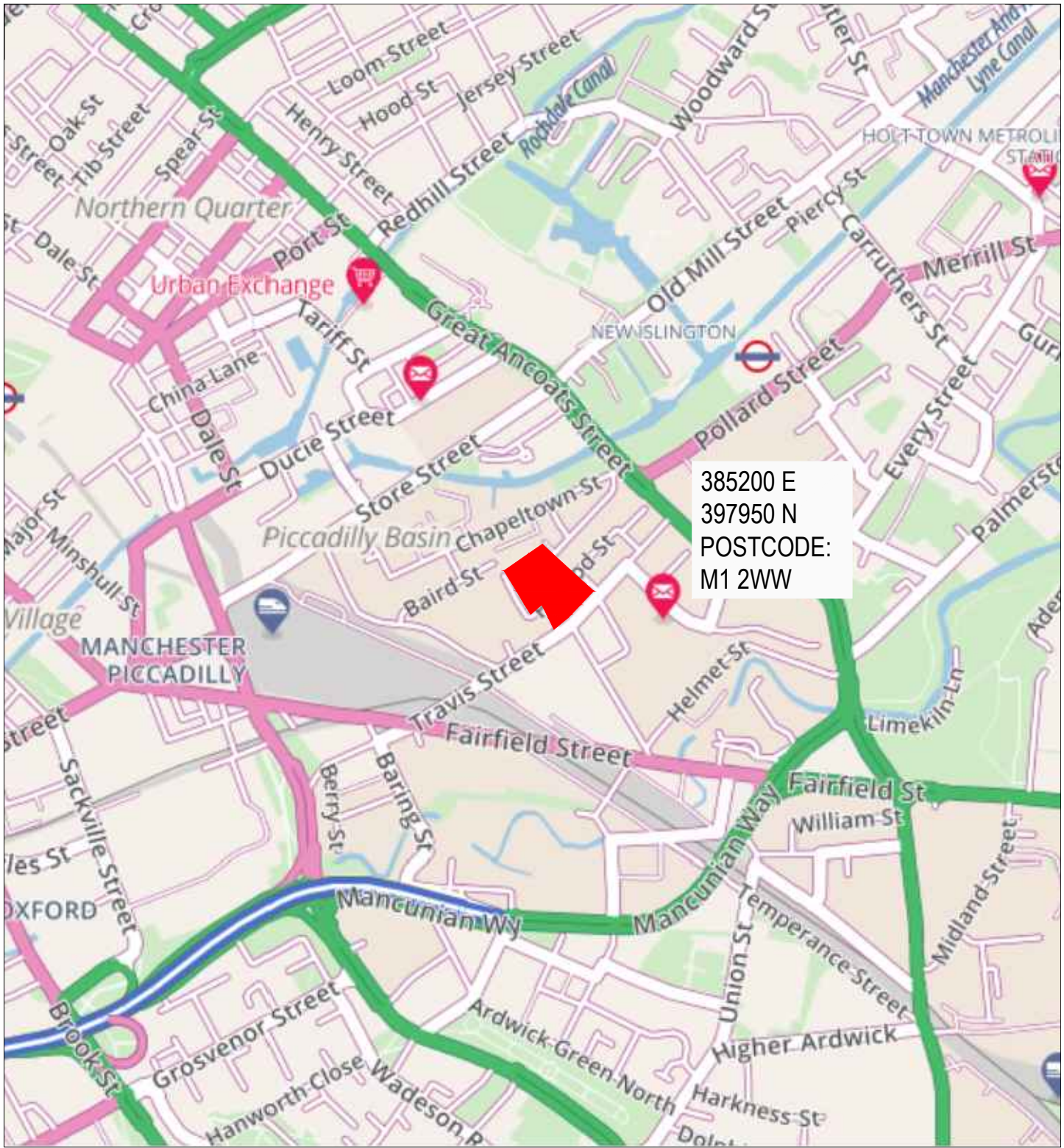
The results from the above are used to determine the ACEC and DS classes for static and mobile groundwater using Tables C1 (for greenfield sites) and C2 (for brownfield sites) of BRE SD1. Where flowing groundwater is identified (eg springs), additional consideration of carbon dioxide may be required.

¹ Low-rise buildings on shrinkable soils (1993)

² Building Near trees - NHBC Standards (2021)

³ Concrete in aggressive ground - third edition (2005)

Appendix B – Drawings

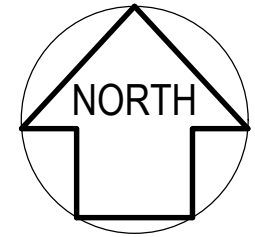
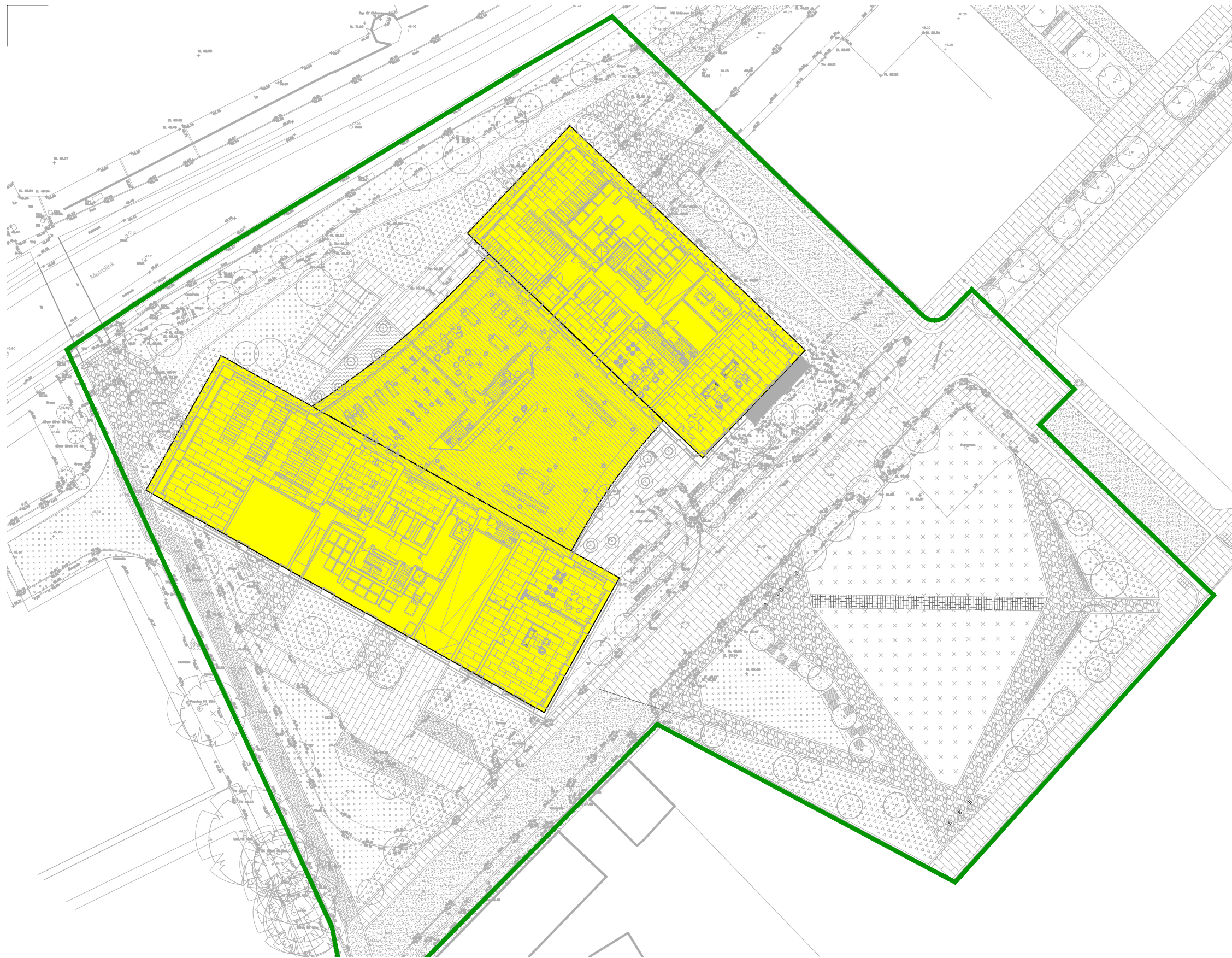


Client	_____
PORTUGAL STREET EAST LIMITED	
Project	_____
PORTUGAL STREET EAST	
Title	_____
001 - SITE LOCATION PLAN	
Job No.	_____
1007	
A4	



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— SITE BOUNDARY

KEY TO SHADING

 PROPOSED BUILDINGS

Client	Project	Scale
PORTUGAL STREET EAST LIMITED	PORTUGAL STREET EAST, MANCHESTER	1:500 @ A3
		Date
		OCTOBER 2021
	Title	
	002 - PROPOSED LAYOUT	
		1007

A3



APEX CONSULTING ENGINEERS

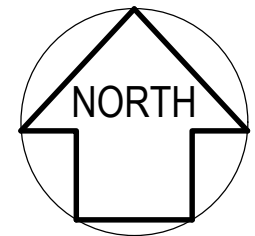
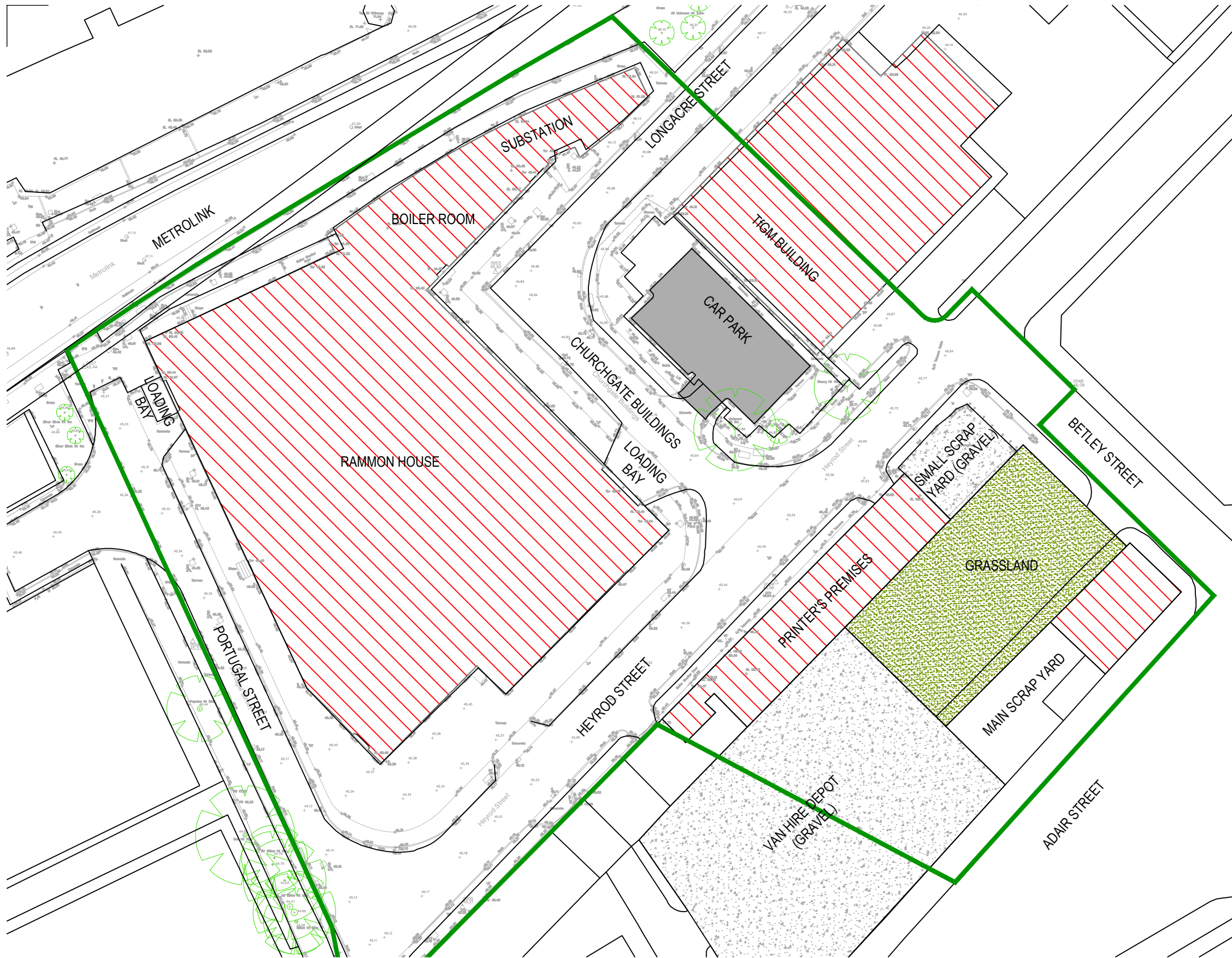
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QMS

ISO 9001 : 2015
REGISTERED



— SITE BOUNDARY

KEY TO SHADING

	EXISTING BUILDINGS
	GRAVEL CAR PARK
	HARDSTANDING
	GRASSLAND

Client	Project	Scale
PORTUGAL STREET EAST LIMITED	PORTUGAL STREET EAST, MANCHESTER	1:500 @ A3
		Date
		OCTOBER 2021
	Title	
	003 - SITE FEATURES PLAN	
A3		1007

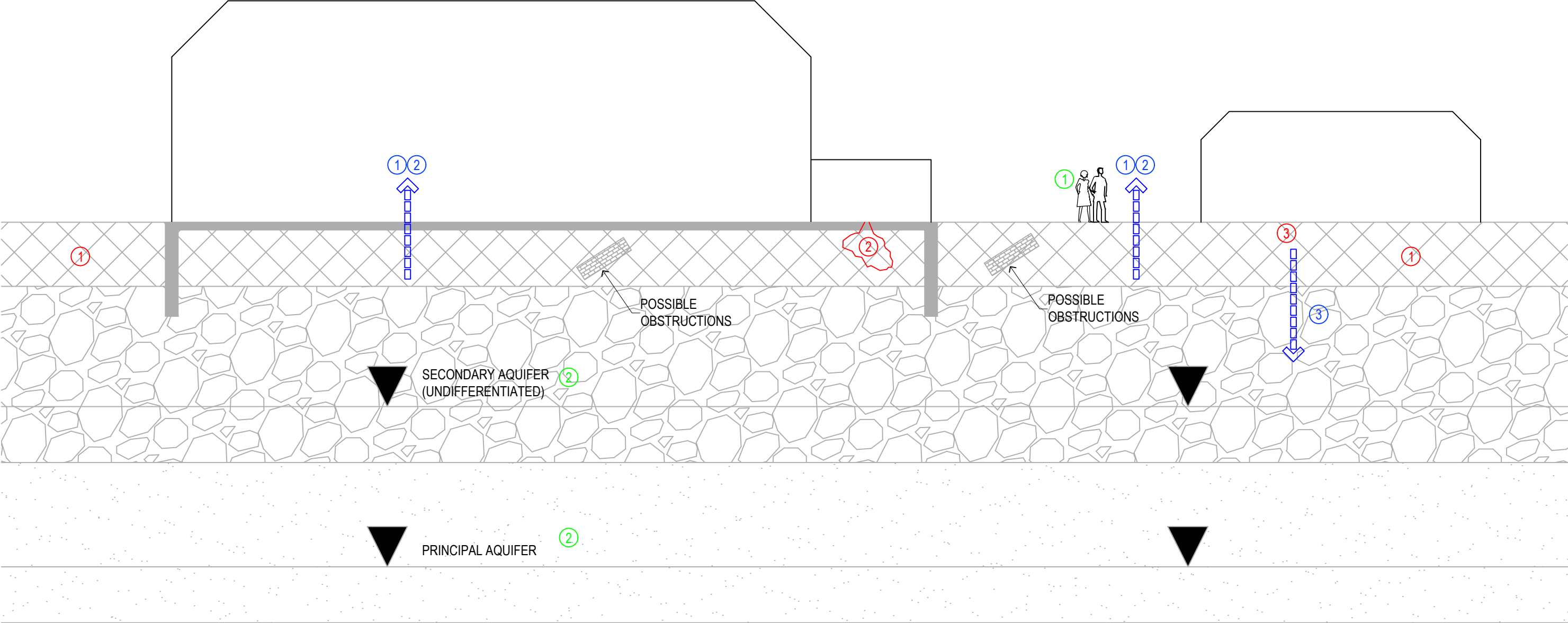
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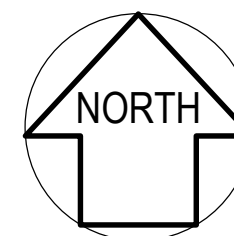
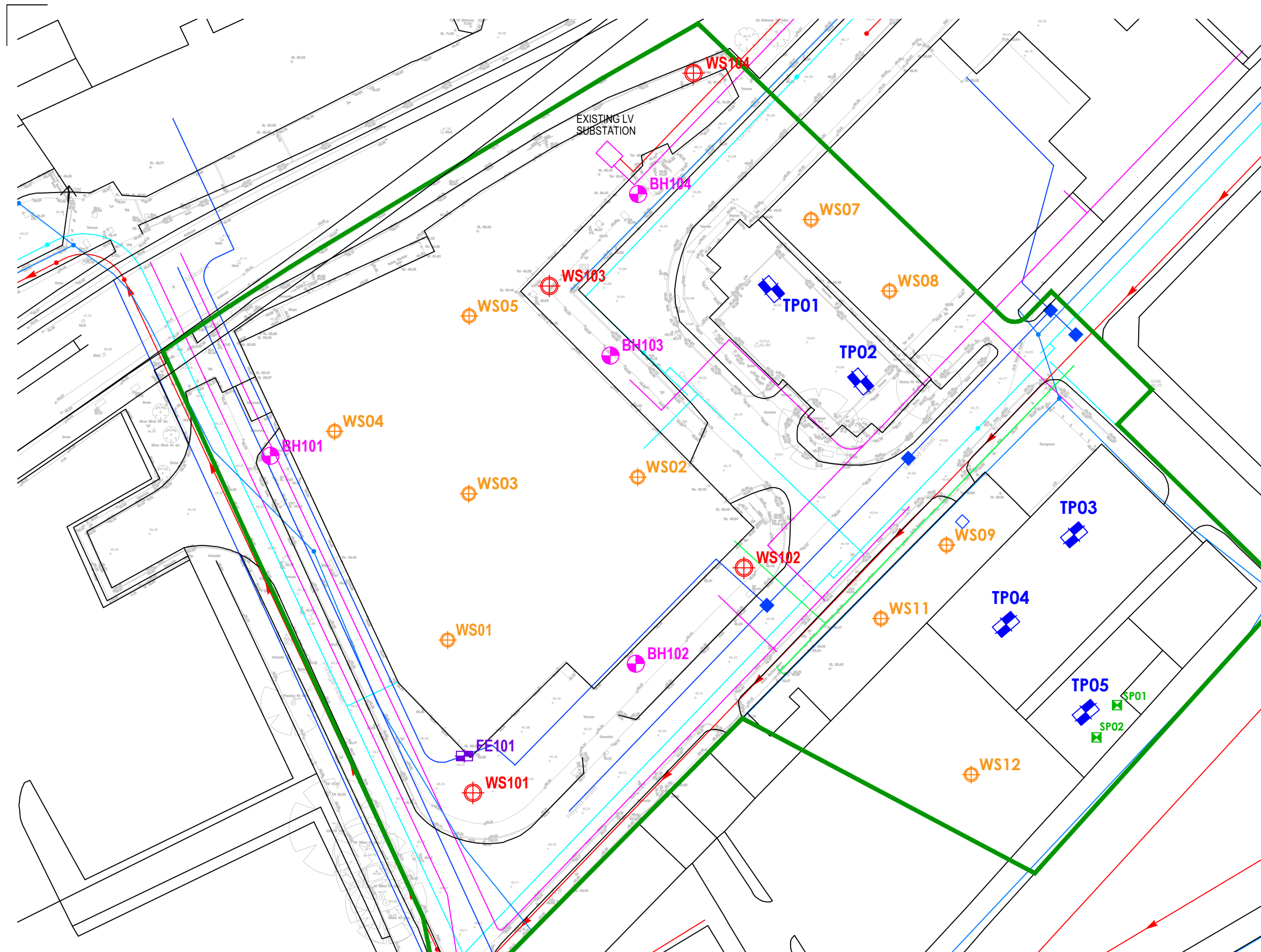
QMS

ISO 9001 : 2015 REGISTERED



GROUND TYPES	SOURCES	PATHWAYS	RECEPTORS
MADE GROUND GLACIAL TILL CHESTER PEBBLE BEDS FORMATION	① MADE GROUND ② SPILLAGE / LEAKAGE (BOILER ROOM) ③ SCRAP YARD	① DERMAL CONTACT, INGESTION, INHALATION OF DUST ② VOLATILISATION ③ LEACHING	① HUMAN HEALTH ② GROUND WATER

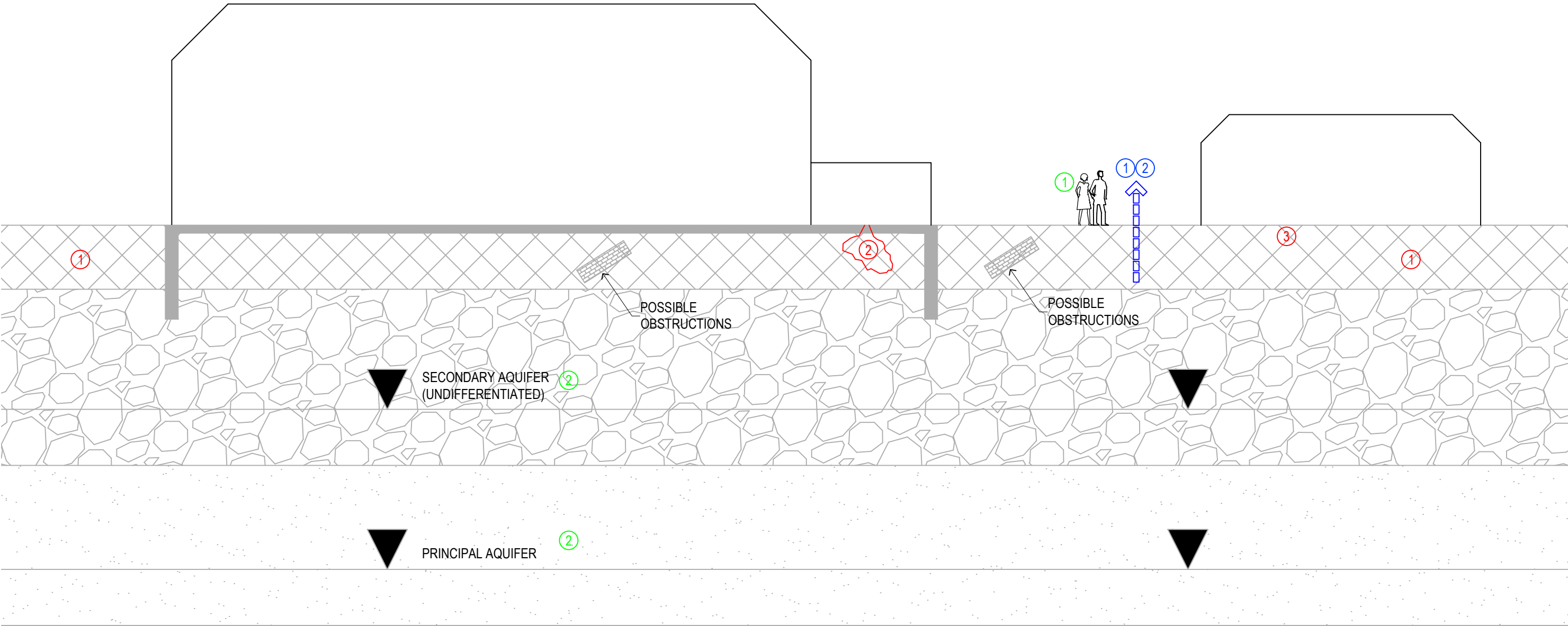
Client	Project	Scale
PORTUGAL STREET EAST LIMITED	PORTUGAL STREET EAST, MANCHESTER	NOT TO SCALE
	Title	Date
	005 - PRELIMINARY CONCEPTUAL SITE MODEL	OCTOBER 2021
A3		1007



HOLE LOCATION KEY	
	TRIAL PIT
	WINDOW SAMPLE BOREHOLE
	SAMPLE POINT
	ROC FOUNDATION EXPOSURE LOCATION
	ROC WINDOW SAMPLE BOREHOLE
	ROC ROTARY BOREHOLE LOCATION

	- WATER SERVICES
	- GAS SERVICES
	- DRAINAGE SERVICES
	- LV - LOW VOLTAGE SERVICES
	- HV - HIGH VOLTAGE SERVICES
	- BT - TELECOMMUNICATION SERVICES
	- VM - VIRGIN MEDIA SERVICES
	- VODA - VODAFONE SERVICES
	- DRAINAGE FLOW ARROW
	- SERVICE TO BE REMOVED

Client	Project	Scale
PORTUGAL STREET EAST LIMITED	PORTUGAL STREET EAST	1:500 @ A3
		Date
		SEPTEMBER 2021
	Title	
	006 - EXPLORATORY HOLE LOCATION PLAN	
A3		1007



GROUND TYPES	SOURCES	PATHWAYS	RECEPTORS
MADE GROUND GLACIAL TILL CHESTER PEBBLE BEDS FORMATION	① MADE GROUND (METALS, ASBESTOS, PAHs) ② SPILLAGE / LEAKAGE (BOILER ROOM) ③ SCRAP METAL DEPOSITS (METALS, ASBESTOS, PAHs)	① DERMAL CONTACT, INGESTION, INHALATION OF DUST ② VOLATILISATION	① HUMAN HEALTH ② GROUND WATER

Client	Project	Scale
PORTUGAL STREET EAST LIMITED	PORTUGAL STREET EAST, MANCHESTER	NOT TO SCALE
	Title	Date
	007 - REVISED CONCEPTUAL SITE MODEL	OCTOBER 2021
A3		1007

Appendix C – Search Extracts (from RoC report)

Envirocheck[®] Report:

Datasheet

Order Details:

Order Number:

168765715_1_1

Customer Reference:

3633 Rev.2

National Grid Reference:

385190, 397940

Slice:

A

Site Area (Ha):

0.84

Search Buffer (m):

1000

Site Details:

1, Portugal Street East
MANCHESTER
M1 2WX

Client Details:

Mr L Daley
Roc Consulting
Commercial Wharf
6 Commercial Street
Manchester
M15 4PZ

Report Section	Page Number
Summary	-
Agency & Hydrological	1
Waste	48
Hazardous Substances	-
Geological	55
Industrial Land Use	64
Sensitive Land Use	145
Data Currency	146
Data Suppliers	153
Useful Contacts	154

Introduction

The Environment Act 1995 has made site sensitivity a key issue, as the legislation pays as much attention to the pathways by which contamination could spread, and to the vulnerable targets of contamination, as it does the potential sources of contamination. For this reason, Landmark's Site Sensitivity maps and Datasheet(s) place great emphasis on statutory data provided by the Environment Agency/Natural Resources Wales and the Scottish Environment Protection Agency; it also incorporates data from Natural England (and the Scottish and Welsh equivalents) and Local Authorities; and highlights hydrogeological features required by environmental and geotechnical consultants. It does not include any information concerning past uses of land. The datasheet is produced by querying the Landmark database to a distance defined by the client from a site boundary provided by the client. In the attached datasheet the National Grid References (NGRs) are rounded to the nearest 10m in accordance with Landmark's agreements with a number of Data Suppliers.

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Report Version v53.0

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Agency & Hydrological					
BGS Groundwater Flooding Susceptibility	pg 1	Yes	Yes	Yes	n/a
Contaminated Land Register Entries and Notices					
Discharge Consents	pg 2		2	17	50
Prosecutions Relating to Controlled Waters			n/a	n/a	n/a
Enforcement and Prohibition Notices					
Integrated Pollution Controls					
Integrated Pollution Prevention And Control					
Local Authority Integrated Pollution Prevention And Control					
Local Authority Pollution Prevention and Controls	pg 19		4	3	16
Local Authority Pollution Prevention and Control Enforcements	pg 22			1	1
Nearest Surface Water Feature	pg 22		Yes		
Pollution Incidents to Controlled Waters	pg 22		2	9	19
Prosecutions Relating to Authorised Processes					
Registered Radioactive Substances	pg 27				9
River Quality	pg 29		1	3	1
River Quality Biology Sampling Points					
River Quality Chemistry Sampling Points	pg 30			1	
Substantiated Pollution Incident Register	pg 30			1	
Water Abstractions	pg 31			1	2 (*38)
Water Industry Act Referrals					
Groundwater Vulnerability	pg 41	Yes	n/a	n/a	n/a
Drift Deposits	pg 41	1	n/a	n/a	n/a
Bedrock Aquifer Designations	pg 41	Yes	n/a	n/a	n/a
Superficial Aquifer Designations	pg 41	Yes	n/a	n/a	n/a
Source Protection Zones					
Extreme Flooding from Rivers or Sea without Defences	pg 41		Yes	n/a	n/a
Flooding from Rivers or Sea without Defences	pg 41		Yes	n/a	n/a
Areas Benefiting from Flood Defences				n/a	n/a
Flood Water Storage Areas				n/a	n/a
Flood Defences				n/a	n/a
OS Water Network Lines	pg 41		10	25	18

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Waste					
BGS Recorded Landfill Sites					
Historical Landfill Sites	pg 48			1	
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)					
Licensed Waste Management Facilities (Locations)	pg 48			4	4
Local Authority Landfill Coverage	pg 50	1	n/a	n/a	n/a
Local Authority Recorded Landfill Sites					
Potentially Infilled Land (Non-Water)	pg 50				7
Potentially Infilled Land (Water)	pg 50		3	13	24
Registered Landfill Sites	pg 52			1	
Registered Waste Transfer Sites	pg 53			1	
Registered Waste Treatment or Disposal Sites	pg 53			2	
Hazardous Substances					
Control of Major Accident Hazards Sites (COMAH)					
Explosive Sites					
Notification of Installations Handling Hazardous Substances (NIHHS)					
Planning Hazardous Substance Consents					
Planning Hazardous Substance Enforcements					

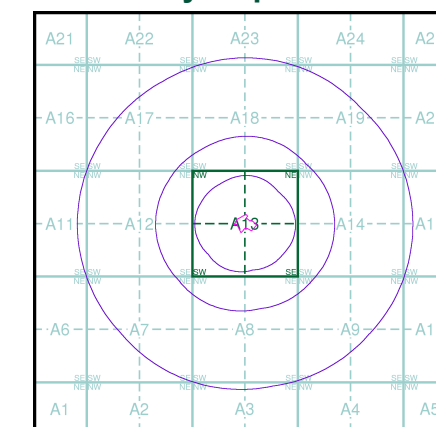
Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Geological					
BGS 1:625,000 Solid Geology	pg 55	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry	pg 55	Yes	Yes	Yes	Yes
BGS Recorded Mineral Sites	pg 57				6
BGS Urban Soil Chemistry	pg 58		Yes	Yes	Yes
BGS Urban Soil Chemistry Averages	pg 62	Yes			
CBSCB Compensation District			n/a	n/a	n/a
Coal Mining Affected Areas	pg 62	Yes	n/a	n/a	n/a
Mining Instability	pg 62	Yes	n/a	n/a	n/a
Man-Made Mining Cavities	pg 62				1
Natural Cavities					
Non Coal Mining Areas of Great Britain				n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 62	Yes	Yes	n/a	n/a
Potential for Compressible Ground Stability Hazards	pg 62		Yes	n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 63	Yes	Yes	n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 63	Yes	Yes	n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 63	Yes	Yes	n/a	n/a
Radon Potential - Radon Affected Areas			n/a	n/a	n/a
Radon Potential - Radon Protection Measures			n/a	n/a	n/a
Industrial Land Use					
Contemporary Trade Directory Entries	pg 64	3	48	125	459
Fuel Station Entries	pg 118			1	4
Points of Interest - Commercial Services	pg 118		13	31	79
Points of Interest - Education and Health	pg 128			1	
Points of Interest - Manufacturing and Production	pg 129	2	19	42	87
Points of Interest - Public Infrastructure	pg 141		1	8	23
Points of Interest - Recreational and Environmental	pg 144				9
Gas Pipelines					
Underground Electrical Cables					

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Sensitive Land Use					
Ancient Woodland					
Areas of Adopted Green Belt					
Areas of Unadopted Green Belt					
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves					
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones	pg 145				1
Ramsar Sites					
Sites of Special Scientific Interest					
Special Areas of Conservation					
Special Protection Areas					
World Heritage Sites					



- General**
- Specified Site
 - Specified Buffer(s)
 - Bearing Reference Point
 - Map ID
- Agency and Hydrological**
- Contaminated Land Register Entry or Notice (Location)
 - Contaminated Land Register Entry or Notice
 - Discharge Consent
 - Enforcement or Prohibition Notice
 - Integrated Pollution Control
 - Integrated Pollution Prevention Control
 - Local Authority Integrated Pollution Prevention and Control
 - Local Authority Pollution Prevention and Control
 - Local Authority Pollution Prevention and Control Enforcement
 - Pollution Incident to Controlled Waters
 - Prosecution Relating to Authorised Processes
 - Prosecution Relating to Controlled Waters
 - Registered Radioactive Substance
 - River Network or Water Feature
 - River Quality Sampling Point
 - Substantiated Pollution Incident Register
 - Water Abstraction
 - Water Industry Act Referral
- Hazardous Substances**
- COMAH Site
 - Explosive Site
 - NIHHS Site
 - Planning Hazardous Substance Consent
 - Planning Hazardous Substance Enforcement
 - BGS Recorded Mineral Site
- Waste**
- BGS Recorded Landfill Site (Location)
 - BGS Recorded Landfill Site
 - EA Historic Landfill (Buffered Point)
 - EA Historic Landfill (Polygon)
 - Integrated Pollution Control Registered Waste Site
 - Licensed Waste Management Facility (Landfill Boundary)
 - Licensed Waste Management Facility (Location)
 - Local Authority Recorded Landfill Site (Location)
 - Local Authority Recorded Landfill Site
 - Potentially Infilled Land (Non-water)
 - Potentially Infilled Land (Non-water)
 - Potentially Infilled Land (Non-water)
 - Potentially Infilled Land (Water)
 - Potentially Infilled Land (Water)
 - Potentially Infilled Land (Water)
 - Registered Landfill Site (Location)
 - Registered Landfill Site (Point Buffered to 100m)
 - Registered Landfill Site (Point Buffered to 250m)
 - Registered Waste Transfer Site (Location)
 - Registered Waste Transfer Site
 - Registered Waste Treatment or Disposal Site (Location)
 - Registered Waste Treatment or Disposal Site

Site Sensitivity Map - Slice A



Order Details

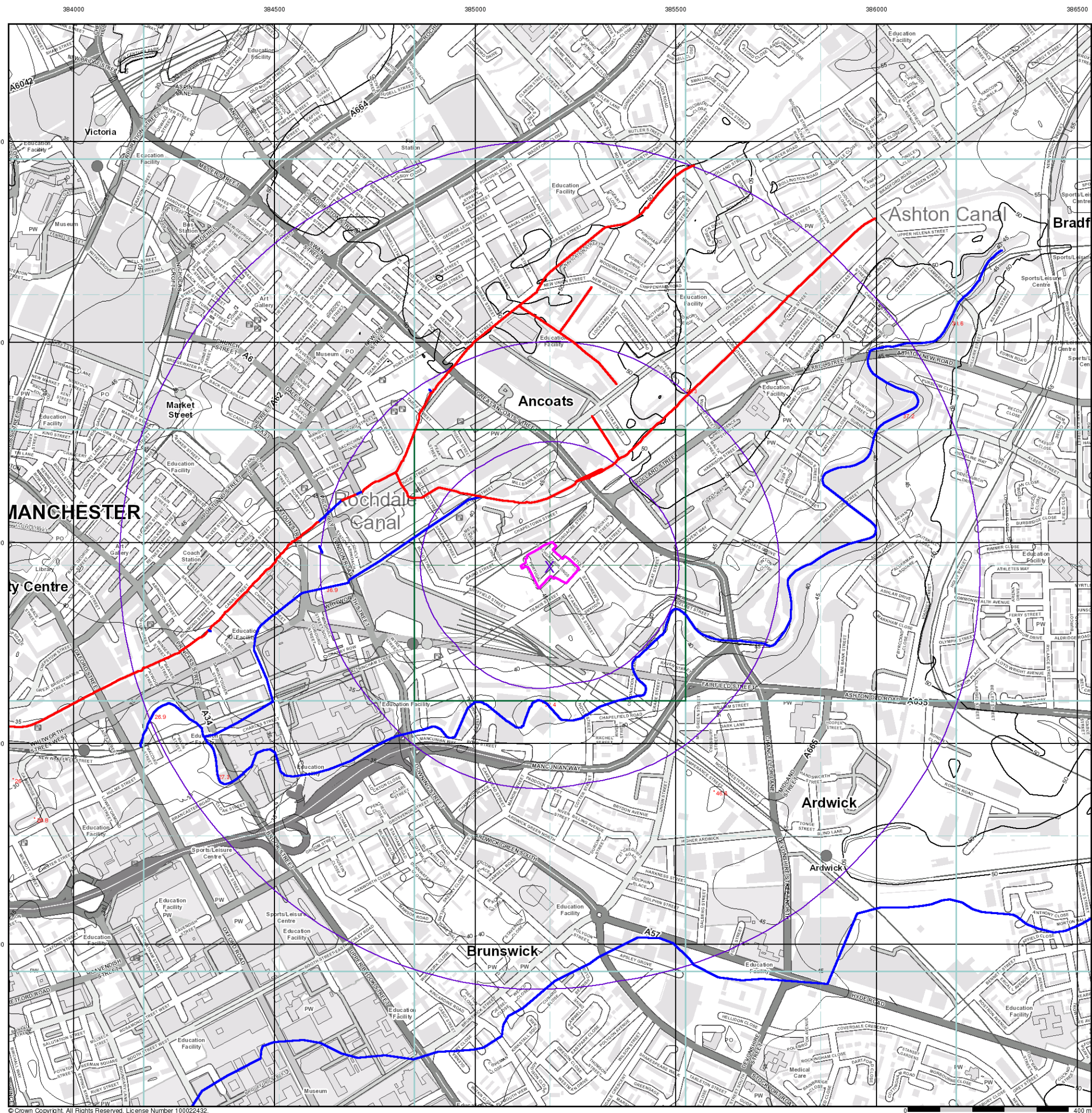
Order Number: 168765715_1_1
Customer Ref: 3633 Rev.2
National Grid Reference: 385190, 397940
Slice: A
Site Area (Ha): 0.84
Search Buffer (m): 1000

Site Details

1, Portugal Street East, MANCHESTER, M1 2WX

Landmark
INFORMATION GROUP

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



General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

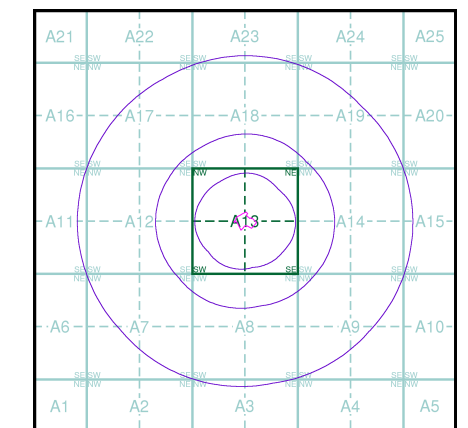
OS Water Network Data

- | | |
|--------------|-------------------------|
| Canal | Drain |
| Reservoir | Other |
| Foreshore | Lake |
| Marsh | Transfer |
| Tidal River | Lock Or Flight Of Locks |
| Inland River | Sea |

Contours (height in meters)

- Standard Contour 105 100 95
- Master Contour
- Spot Height 167.3
- MLW Mean Low Water
- MHW Mean High Water

OS Water Network Map - Slice A



Order Details

Order Number: 168765715_1_1
Customer Ref: 3633 Rev.2
National Grid Reference: 385190, 397940
Slice: A
Site Area (Ha): 0.84
Search Buffer (m): 1000

Site Details

1, Portugal Street East, MANCHESTER, M1 2WX



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



General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Risk of Flooding from Surface Water

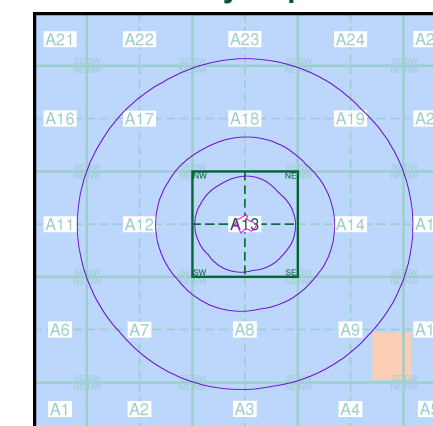
- High - 30 Year Return
- Medium - 100 Year Return
- Low - 1000 Year Return

Suitability

See the suitability map below

- National to county
- County to town
- Town to street
- Street to parcels of land
- Property

E/NRW Suitability Map - Slice A



Order Details

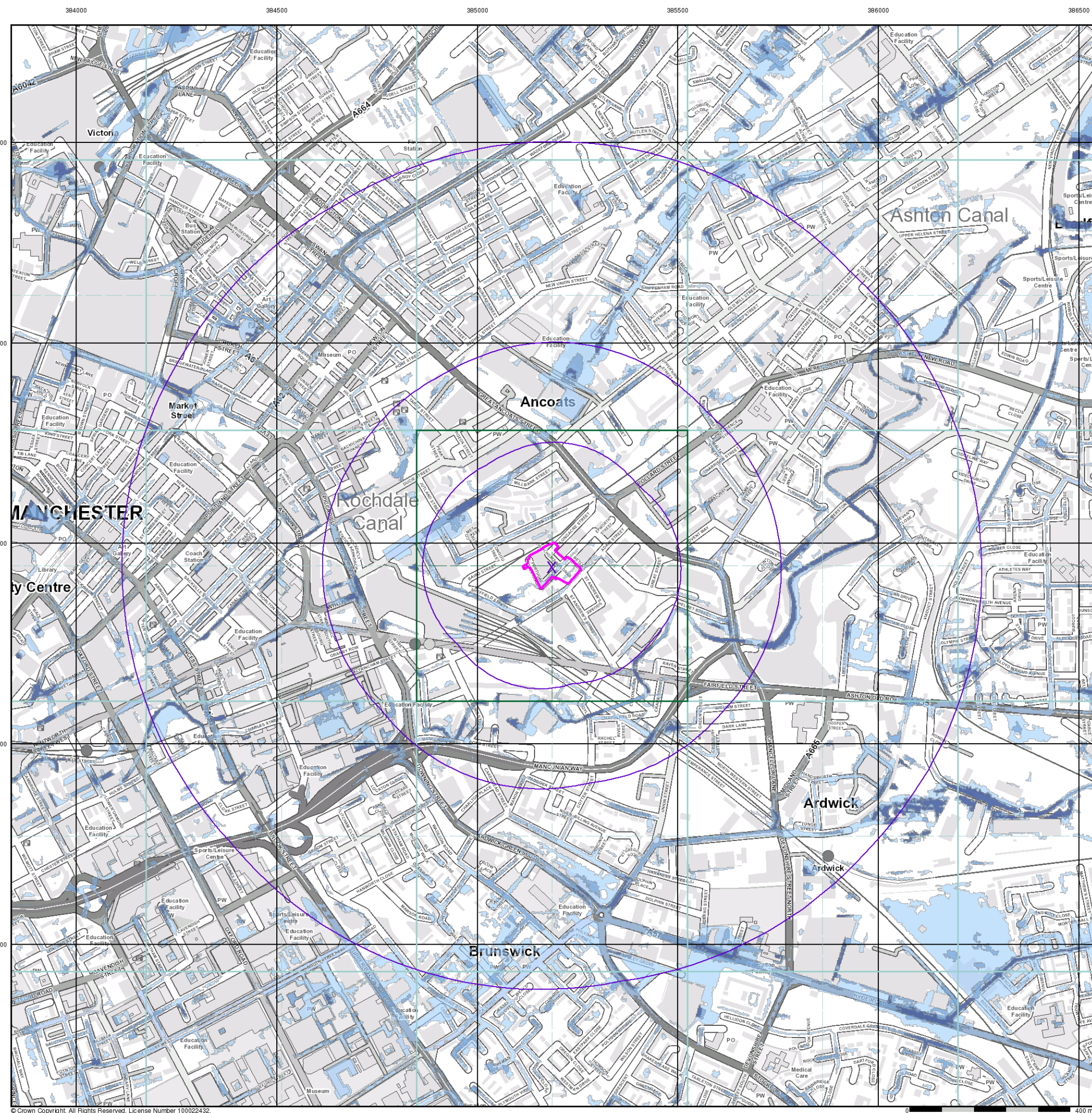
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Customer Ref: 3633 Rev.2
National Grid Reference: 385190, 397940
Slice: A
Site Area (Ha): 0.84
Search Buffer (m): 1000

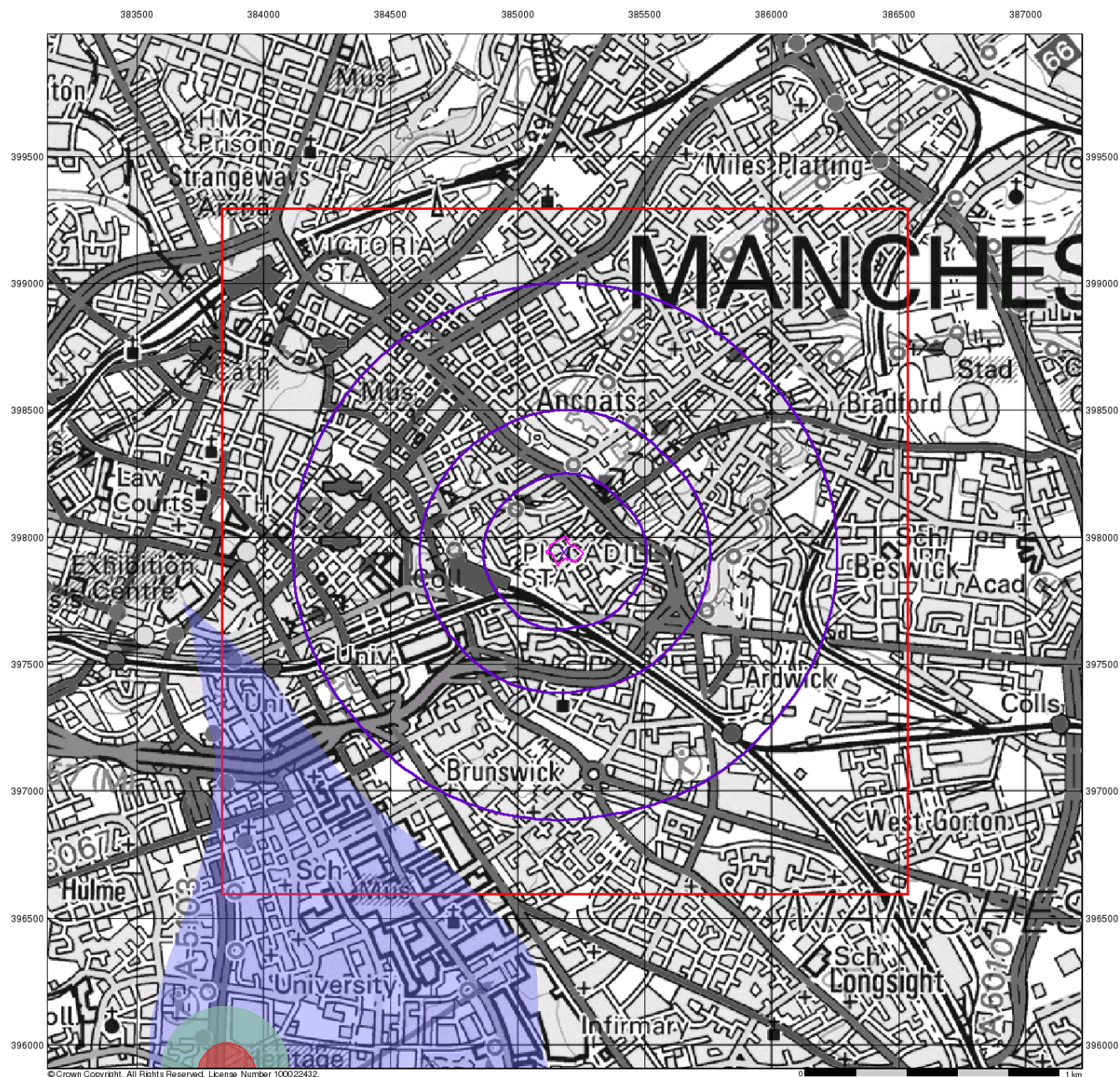
Site Details

1, Portugal Street East, MANCHESTER, M1 2WX

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INFORMATION GROUP

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





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Source Protection Zones

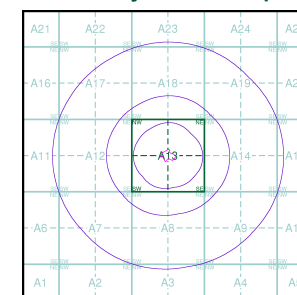
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice
- Map ID

Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)

Site Sensitivity Context Map - Slice A



Order Details

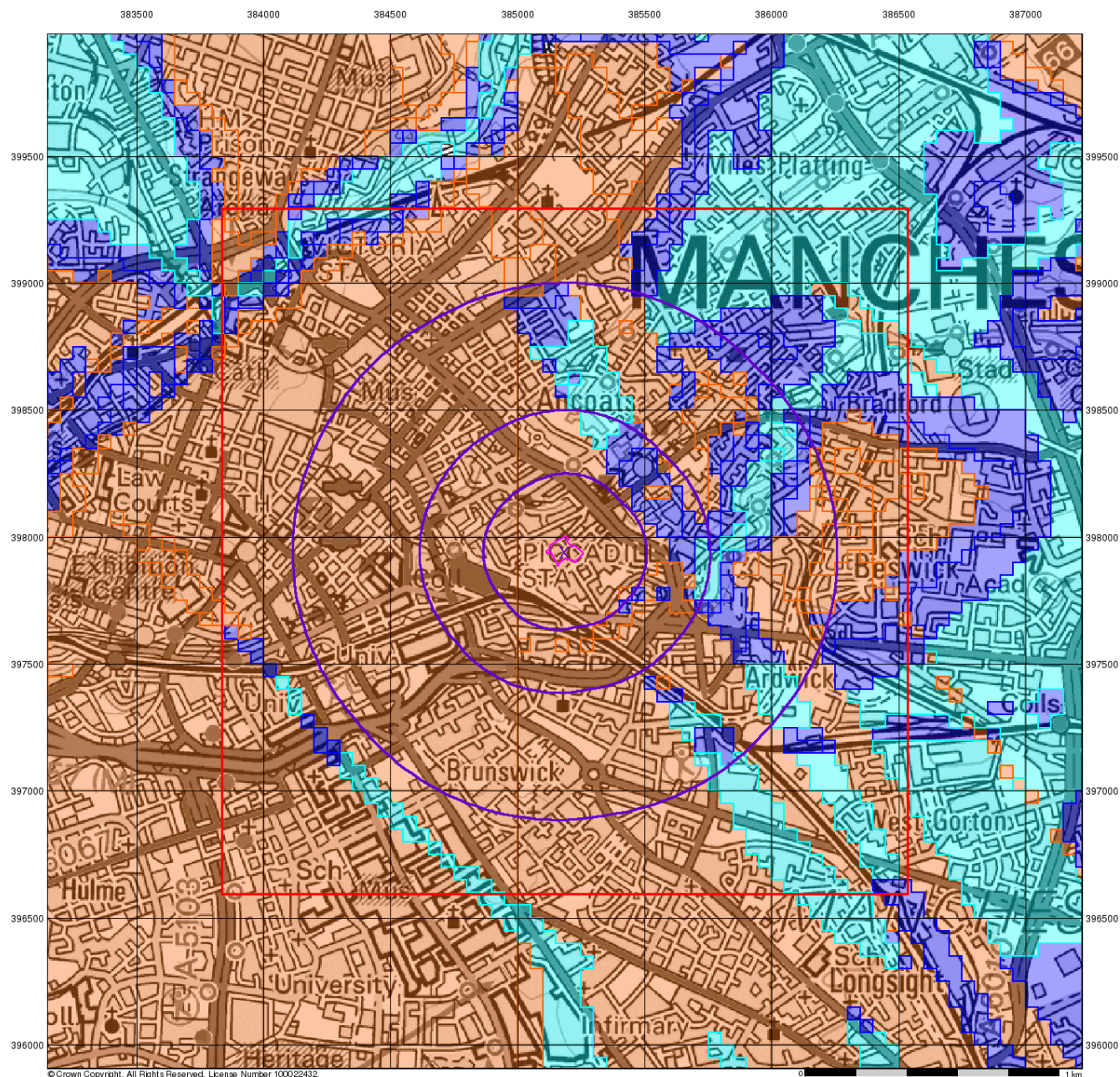
Order Number: 168765715_1_1
 Customer Ref: 3633 Rev.2
 National Grid Reference: 385190, 397940
 Slice: A
 Site Area (Ha): 0.84
 Search Buffer (m): 1000

Site Details

1, Portugal Street East, MANCHESTER, M1 2WX

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BGS Flood GFS Data

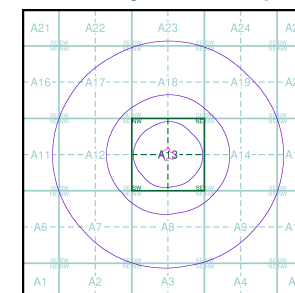
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice

Agency and Hydrological (Flood)

- Limited Potential for Groundwater Flooding to Occur
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Potential for Groundwater Flooding to Occur at Surface

Site Sensitivity Context Map - Slice A



Order Details

Order Number: 168765715_1_1
 Customer Ref: 3633 Rev.2
 National Grid Reference: 385190, 397940
 Slice: A
 Site Area (Ha): 0.84
 Search Buffer (m): 1000

Site Details

1, Portugal Street East, MANCHESTER, M1 2WX

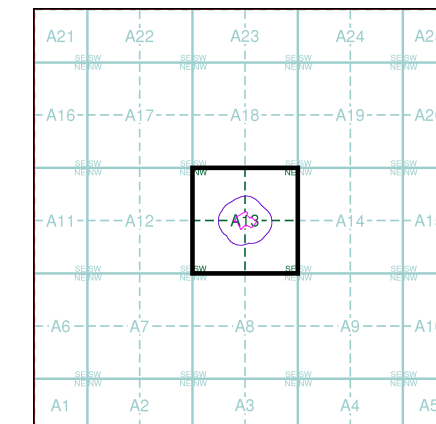
Landmark
 INFORMATION GROUP

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

General

- | | | | | | | | |
|---|--|---|--|---|---|---|--------|
|  | Specified Site |  | Specified Buffer(s) |  | Bearing Reference Point |  | Map ID |
|  | Several of Type at Location |  | Pylon |  | Overhead Transmission Line | | |
| Agency and Hydrological | | | | Waste | | | |
|  | Contaminated Land Register Entry or Notice (Location) |  | BGS Recorded Landfill Site (Location) |  | BGS Recorded Landfill Site | | |
|  | Contaminated Land Register Entry or Notice (Location) |  | EA Historic Landfill (Buffered Point) |  | EA Historic Landfill (Polygon) | | |
|  | Discharge Consent |  | Integrated Pollution Control Registered Waste Site |  | Integrated Pollution Control Registered Waste Site | | |
|  | Enforcement or Prohibition Notice |  | Licensed Waste Management Facility (Landfill Boundary) |  | Licensed Waste Management Facility (Location) | | |
|  | Integrated Pollution Control |  | Local Authority Integrated Pollution Prevention and Control |  | Local Authority Integrated Pollution Prevention and Control | | |
|  | Integrated Pollution Prevention Control |  | Local Authority Pollution Prevention and Control Enforcement |  | Local Authority Recorded Landfill Site (Location) | | |
|  | Local Authority Integrated Pollution Prevention and Control |  | Potentially Infilled Land (Non-water) |  | Potentially Infilled Land (Non-water) | | |
|  | Local Authority Pollution Prevention and Control |  | Potentially Infilled Land (Non-water) |  | Potentially Infilled Land (Non-water) | | |
|  | Local Authority Pollution Prevention and Control Enforcement |  | Potentially Infilled Land (Water) |  | Potentially Infilled Land (Water) | | |
|  | Pollution Incident to Controlled Waters |  | Potentially Infilled Land (Water) |  | Potentially Infilled Land (Water) | | |
|  | Prosecution Relating to Authorised Processes |  | Potentially Infilled Land (Water) |  | Potentially Infilled Land (Water) | | |
|  | Prosecution Relating to Controlled Waters |  | Potentially Infilled Land (Water) |  | Potentially Infilled Land (Water) | | |
|  | Registered Radioactive Substance |  | Potentially Infilled Land (Water) |  | Potentially Infilled Land (Water) | | |
|  | River Network or Water Feature |  | Potentially Infilled Land (Water) |  | Potentially Infilled Land (Water) | | |
|  | River Quality Sampling Point |  | Potentially Infilled Land (Water) |  | Potentially Infilled Land (Water) | | |
|  | Substantiated Pollution Incident Register |  | Potentially Infilled Land (Water) |  | Potentially Infilled Land (Water) | | |
|  | Water Abstraction |  | Potentially Infilled Land (Water) |  | Potentially Infilled Land (Water) | | |
|  | Water Industry Act Referral |  | Potentially Infilled Land (Water) |  | Potentially Infilled Land (Water) | | |
| Hazardous Substances | | | | Waste | | | |
|  | COMAH Site |  | Explosive Site |  | Registered Landfill Site | | |
|  | NIHHS Site |  | Explosive Site |  | Registered Landfill Site (Point Buffered to 100m) | | |
|  | Planning Hazardous Substance Consent |  | Explosive Site |  | Registered Landfill Site (Point Buffered to 250m) | | |
|  | Planning Hazardous Substance Enforcement |  | Explosive Site |  | Registered Waste Transfer Site (Location) | | |
|  | Planning Hazardous Substance Enforcement |  | Explosive Site |  | Registered Waste Treatment or Disposal Site (Location) | | |
|  | Planning Hazardous Substance Enforcement |  | Explosive Site |  | | | |

Site Sensitivity Map - Segment A13



Order Details

Order Number: 168765715_1_1
Customer Ref: 3633 Rev.2
National Grid Reference: 385190, 397940
Slice: A
Site Area (Ha): 0.84
Plot Buffer (m): 100

Site Details

1, Portugal Street East, MANCHESTER, M1 2WX

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