



COMPLEX CHALLENGES ...
MADE SIMPLE

Phase 2 Site Investigation

The Hut Group, H!VE
for
Airport City Partnership

January 2019

Phase 2 Site Investigation

on

The Hut Group, H!VE

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I.0 INTRODUCTION

I.1 Background

- I.1.1 R^oC Consulting has been appointed by Airport City Partnerships to conduct a Phase 2 Site Investigation across Plots C, D and O for the 2018 Revised Airport City North masterplan (the site). It is understood that the site is to be redeveloped by The Hut Group for use as a commercial office space with associated public realm landscaping, recreational space and a 1500 space multi-storey car park in accordance with Exterior Architecture drawings (ref: 1827-EXA-00-XX-SK-L-100 F) provided within Appendix A.
- I.1.2 The following assessment has been completed to support design and planning requirements for the site's redevelopment and follows on from a number of site investigations relating to the development site, specifically:
 - I) Phase I Desktop Study completed by RoC Consulting dated August 2018 (ref: ES/ROC/p1 3647)
- I.1.3 It is recommended reference be made to the abovementioned report when reviewing the current assessment.
- I.1.4 The scope of the report and its assessment has been based around the site's redevelopment proposals as outlined in the aforementioned Exterior Architecture plans. It should be noted that any subsequent revision of the proposed redevelopment or site boundary away from the above-mentioned drawing may result in the full or partial re-interpretation of this report and assessment.

I.2 Terms of Reference

- I.2.1 The Phase 2 Site Investigation was carried out following receipt of an instruction from Stuart Rogers of Faithful & Gould on behalf of Airport City Limited Partnership.

1.3 Objectives

1.3.1 The scope of works has been tailored to meet both planning and design requirements to assist with the site's redevelopment. These considerations include:

- 1) Design a programme of site investigation works to establish ground conditions beneath the site and target known or suspected sources of contamination (as revealed by the Phase I desktop study).
- 2) Completion of site investigation fieldworks including the formation of 6 cable percussive boreholes with rotary follow-on to establish the sites geology, as well as 10 window sampler boreholes to investigate sources of contamination across the site.
- 3) Completion of geo-environmental and geotechnical laboratory analysis of soil / rock samples to determine physical and chemical characteristics.
- 4) Completion of a detailed geotechnical assessment of site conditions to inform new building foundation design and associated earthworks. The scope of this assessment will also include reference to the findings and result of previous site investigation works.
- 5) Completion of a geo-environmental assessment utilising information provided by both the current and previous phases of site investigation works sufficient in its scope to assist with the discharge of contaminated land related planning conditions.



2.0 LIMITATIONS OF STUDY ASSESSMENT

- 2.0.1 The report has been produced by R²C Consulting for the client solely for the purposes of a review of information for the above-mentioned site. It may not be used by any person for any other purpose other than that specified without the express written permission of R²C Consulting. Any liability arising out of its use by a third party for purposes not wholly connected with the above shall be the responsibility of that party who shall indemnify R²C Consulting against all claims, costs, damages and losses arising out of such use.
- 2.0.2 This report is written in the context of an agreed scope of work and should not be used in a different context. The report should be read in its entirety. Furthermore, new information, improved practices and changes in legislation may require re-interpretation of this report in whole or in part after its original issue. R²C Consulting reserve the right to alter their conclusions and recommendations in the light of further information that may become available.
- 2.0.3 Ground conditions can change rapidly, especially in areas of made ground, however, it is assumed that the ground conditions observed are typical and representative of the site as a whole. The ground conditions have been determined from a limited number of exploratory holes formed across the property, therefore, only a small percentage of the total area of the property has been investigated. Interpolation between exploratory holes has enabled a general picture of the subsurface conditions to be produced.
- 2.0.4 Conclusions drawn from the ground investigation should be read in this context. R²C Consulting cannot accept responsibility for any situations resulting from locally unforeseen ground conditions occurring between exploratory holes.



3.0 BACKGROUND INFORMATION

- 3.0.1 The overview below outlines the most salient points / considerations and it is recommended reference be made to the complete findings of previous site investigation reports for additional information / clarification.

3.1 Site Description

- 3.1.1 The site covers approximately 7.7ha and is located approximately 200m north of Manchester Airport. The site is bound by the recently constructed Enterprise Way to the north and north east of the site. The Airport Spur Ringway Road forms the southern boundary of the site. A long-stay car park extends beyond the western boundary of the site.
- 3.1.2 The currently active long stay carpark covers the western and central portion of the site while the remainder of the site comprises disused vegetated land. A brook runs across the centre of the site from the south east to the north west. The site is generally flat with the exception of localised sloping towards the brook.

3.2 Geological Characteristics

- 3.2.1 Review of publically available BGS geological map records indicate the site is underlain by the following:

Drift Geology: Till, Devensian - Diamicton

Solid Geology: Bollin Mudstone Member - Mudstone

- 3.2.2 The Envirocheck report (Appendix C) indicates that the site is not located in an area which may be affected by historic Coal Mining and a Coal Authority report is not required.

3.3 Site History and Environmental Characteristics

- 3.3.1 Historical records indicate the site comprises undeveloped greenfield until 1960 where a number of structures and greenhouses are indicated at the site associated with a nursery. The long-stay car park was constructed in 1996 and the buildings associated with the nursery were demolished in 2000.
- 3.3.2 The Envirocheck Groundwater Vulnerability Map indicates the drift geology is classified as a Secondary Aquifer – Undifferentiated with the underlying Mudstone bedrock classed as a Secondary Aquifer - B. The site is not said to be located within any Environment Agency Source Protection Zones or in close proximity to any sensitive water abstraction points (e.g. potable water supply well).
- 3.3.3 The nearest surface water feature is indicated on site in the form of the Baguley Brook. Water quality of this receptor has not been provided.
- 3.3.4 The nearest discharge consent is indicated 118m to the south west held by Ladbroke Hotels for the release of Other Matter-Surface Water into the Painswick Pool pond/lake.
- 3.3.5 There is a single historic landfill site located 612m south east of the site at Airport Woodhouse Park. The specified waste type, licence holder and input dates have not been provided for this landfill.





- 3.3.6 Potentially infilled land, both water and non-water, has been identified within a 500m radius of the site. The closest areas of potentially infilled land are 39m south (non-water) and 68m south (water) of the site.
- 3.3.7 The site is not located in an area at risk of flooding and is classified as a Flood Zone I (low probability of flooding) by the Environment Agency.



4.0 SITE INVESTIGATION DESIGN

General

- 4.0.1 The R²C intrusive investigation was designed and completed to further investigate geo-environmental issues identified during previous site investigations as well as provide geotechnical information to facilitate new building design.
- 4.0.2 The site investigation works comprised the formation of 6 cable percussion with rotary follow-on boreholes and a total of 10 window sampler boreholes.
- 4.0.3 Exploratory hole placement was dictated by the findings of the Phase I Desktop Study to zone in on areas where current / previous activity may have impacted soil quality. In addition, boreholes were located within the footprint of the proposed new development to establish ground conditions and support foundation design.
- 4.0.4 Samples of soil collected during the investigation works are to be analysed for a variety of determinants associated with the pattern of current / historic activity across the site as outlined within the preliminary conceptual site model.
- 4.0.5 Table 4.0 below provides location justification for each exploratory hole formed during the site investigation fieldworks. The purpose of this table is to illustrate the targeting of potential sources of contamination during the Phase 2 site investigation works.

Table 4.0: Borehole Locations & Justification

BH/WS ID.	Reason for selection
BH101-BH106	Located within the proposed development footprint to investigate ground conditions to aid development design.
WS101-WS105	Located across the site to investigate ground conditions and any sources of contaminants across the site originating from on-site historic use.
WS106	Located within the long-stay car park to investigate ground conditions and any sources of contaminants across the site originating from on-site use as a car park.
WS201-WS204	Located to delineate identified area of hydrocarbon contamination encountered within BH104.

- 4.0.6 Exploratory hole locations are shown on R²C Consulting drawing ES101 (Current Site) and ES102 (Prop Development) provided within Appendix A.

5.0 SITE INVESTIGATION FIELDWORKS

- 5.0.1 Site investigation fieldworks were completed between the 29 October and 21 November 2018 by drilling contractors Taylor Drilling Services Ltd. Boreholes were formed using a Dando 150 rig (Cable Tool Boreholes) and a Beretta T41 (Rotary Boreholes) or a Competitor 150 (Window Sampler Boreholes).
- 5.0.2 Information with respect to buried services was obtained from relevant providers prior to commencement of the investigation works. However, as a precautionary measure all exploratory hole locations were scanned with a Cable Avoidance Tool prior to the commencement of works. In addition, hand dug service pits were completed to a depth of 1.2mbgl at all borehole locations deemed to fall in close proximity to the suspected location of possible buried service runs / infrastructure.
- 5.0.3 To ensure no new sources of contamination were introduced to underlying soils / bedrock during the formation of each borehole, steel casing was used throughout as well as vegetable oil as a lubrication medium for all drilling apparatus. Sampling equipment was also cleaned between sampling to reduce cross-contamination risks.
- 5.0.4 Soil and rock core samples were collected for subsequent chemical and geotechnical laboratory analysis. Soil samples used for geotechnical analysis were collected in 500g plastic sample tubs and U100 wax sealed sample tubes. Samples collected for chemical testing were collected in 300g glass jars and 500g plastic sample tubs. Samples were obtained from both made ground and natural strata to assess the overall quality of underlying soils. In situ soil strength was investigated using Standard Penetration Tests (SPT) within superficial deposits as well as to confirm rock head had been reached.
- 5.0.5 The shallow soils encountered during construction of the boreholes were described and logged by a suitably qualified engineer in accordance with BS 5930: Code of Practice for Site Investigations (the log sheets for which have been provided within Appendix B).
- 5.0.6 A total of 5 ground gas and ground water monitoring wells were installed within rotary follow-on boreholes. Installation details are provided within Table 5.1 below, copies of ground water and gas monitoring records are provided within Appendix E.

Table 5.1: Monitoring Well Installations.

BH ID	Monitoring well depth (mbgl)	Response zone (mbgl)	Response zone strata
BH101A, BH102, BH103, BH106	4.00	0.5 to 4.00	Made Ground and natural strata
BH104	2.80	0.5 to 2.80	Made Ground

6.0 ENCOUNTERED GROUND CONDITIONS

- 6.0.1 The following ground conditions are summarised from the exploratory holes formed during the RQC Consulting site investigation. The following represents an overview of encountered ground conditions and it is recommended reference be made to the borehole log sheets provided within Appendix B for a detailed strata description; all depths shown are given in metres below ground level (mbgl) unless otherwise stated.



6.1 Ground Conditions Overview

Phase I Office

- 6.1.1 A total of 4 exploratory hole locations are located within the footprint of the Phase I Office building (BH101, BH102, WSI05 and WSI06). BH101A is located approximately 10m outside of the development footprint and as such has been included as part of the ground conditions assessment.

Made Ground

- 6.1.2 Made ground deposits were encountered at four of five exploratory hole locations to a depth between 0.50 and 3.00mbgl. At BH101 and BH101A made ground comprised a slightly sandy gravelly reworked clay. Gravels were described as fine to coarse subangular of limestone, sandstone, concrete and tarmac. At BH102, made ground comprised greyish cream very sandy gravel over a fine to coarse sand. At WSI06 a grey gravel overlay a gravelly sand. At both locations within the long stay carpark (BH102 and WSI06), a geotextile membrane was noted at 0.40 and 0.50mbgl.
- 6.1.3 BH101 and BH101A are located within a built-up area of made ground over the previous road alignment. Levels in this area are approximately 2-3m greater than the remainder of the site.

Topsoil

- 6.1.4 Topsoil was encountered at WSI05 to a depth of 0.30mbgl. Topsoil comprised brown slightly clayey slightly gravel sand with frequent roots and rootlets.

Natural Strata

- 6.1.5 Natural strata at all exploratory hole locations generally comprised a reddish brown slightly silty clay, becoming friable with depth. Clay was encountered between 69.85 and 65.75mAOD. KPa values for the clay are in the range 32 – 60kPa (soft to firm) with an average of 44kPa (firm).

Bedrock

- 6.1.6 The weathered mudstone was encountered between 68.85 and 65.75mAOD with an average depth of 67.42mAOD. The strata was generally described as very weak to weak reddish brown mottled grey silty de-structured to distinctly weathered Bolin Mudstone. Fracture spacing was extremely close to very close becoming widely spaced with depth.
- 6.1.7 Non-weathered bedrock was encountered between 61.77 and 60.7mAOD and generally described as weak to very weak reddish brown Bolin Mudstone. Fracture spacing in the non-weathered bedrock was medium to widely spaced. Frequent zones of de-structured / completely weathered mudstone was recorded throughout the rock core.

Phase I Car Park

- 6.1.8 A total of 2 exploratory holes are located within the building footprint with a further two exploratory holes located 8 and 11m outside of the building footprint (BH105, BH106, WSI01 and WSI02).

Topsoil

- 6.1.9 At WSI01 a 0.15m layer of topsoil was reported at ground level comprising a dark brown clayey sand with frequent roots and rootlets.

Made Ground

- 6.1.10 Made ground was encountered at a total of 3 out of 4 exploratory hole locations. Made ground deposits were reported as multicoloured reworked clay with pockets of yellowish brown sand in



BH105, dark brown slightly sandy slightly gravelly clay in BH106 and gravelly clay with rootlets in the upper 0.20m in WS102.

Natural Strata

- 6.1.11 Natural strata encountered at all exploratory hole locations comprised a reddish brown mottled grey silty clay. Strength of the clay is in the range of 32 – 92kPa (soft to stiff) with an average of 45kPa (firm). At WS101, two bands of brown slightly clayey sand 0.20 and 0.35m thick were reported interbedded with clay.

Bedrock

- 6.1.12 Weathered bedrock was encountered at all exploratory hole locations between depths of 66.74 and 62.43mAOD with an average depth of 65.10mAOD. The weathered bedrock was generally described as de-structured to distinctly weathered extremely weak to weak reddish brown Bolin Mudstone. Joints were generally very closely to closely spaced becoming widely spaced with depth.
- 6.1.13 Non-weathered bedrock was reported between 55.68 and 56.27mAOD and reported as weak to very weak reddish brown banded cream, dark reddish brown and light grey Bolin Mudstone with fractures closely to widely spaced. Completely weathered / de-structured zones were reported throughout the rock core.

Phase 2/3 Office

- 6.1.14 A total of 8 boreholes are located within the Phase 2/3 Office footprint are BH103, BH104, WS104 and WS201, WS202A, WS203, WS204 and WS204A. WS102 and WS202 are located approximately 7m and 5m respectively outside of the building footprint and as such have been included as part of the assessment. It is noted that WS201-204/A are located within an approximate 5-10m radius of BH104 and placed to delineate an area of contamination identified at BH104 (further details of which provided overleaf and in Section 6.2).

Topsoil

- 6.1.15 Topsoil was noted at a total of three locations (BH103, BH104 and WS104). The topsoil was generally described as a brown slightly gravelly clay to a depth between 0.03 and 0.10mbgl. Gravels comprised limestone, sandstone and siltstone. At WS104 topsoil was noted to be dark brown slightly gravelly and extended to a greater depth of 0.40mbgl.

Made Ground

- 6.1.16 Made ground deposits were encountered at all exploratory hole locations with the exception of WS104. Generally, made ground comprised a dark brown to slightly sandy slightly gravelly clay. Gravels comprised limestone and sandstone with rare pieces of ceramic tile, glass and occasional brick fragments. Made ground was encountered either from surface level or underlying topsoil to a depth of 1.00 - 1.50mbgl and to a maximum depth of 2.80mbgl at a single exploratory hole location (BH104).
- 6.1.17 At BH104 and WS204, made ground extended to greater depths and strata encountered comprised a light brown mottled grey sandy reworked clay overlying a greyish black sandy silty ashy clay becoming dark greyish brown and very sandy with depth. A slight to strong hydrocarbon odour was noted between 1.70m and 2.40mbgl.
- 6.1.18 No hydrocarbon odours were noted in WS201 – WS204 (placed to delineate sources of contamination in BH104). Made ground in these boreholes generally comprised a blackish brown sandy lightly gravelly clay. At WS202A, a 0.05m layer of black broken asphalt was noted at 1.35m overlying a brownish black sandy clay.

Natural Strata

- 6.1.19 Natural strata encountered at all exploratory hole locations comprised reddish brown mottled grey silty clay. Strength values ranged from 20kPa – 64kPa (soft to firm). At BH103 a reddish brown fine silty sand was reported between depths of 4.60 – 5.20mbgl overlying the weathered mudstone fraction.

Bedrock

- 6.1.20 Weathered bedrock was encountered at 3 exploratory hole locations between depths of 66.48 and 64.09mbgl. Weathered bedrock was generally described as extremely weak to weak de-structured to distinctly weathered reddish brown Bolin Mudstone. Fracture spacing was generally reported as very close to close.
- 6.1.21 Non-weathered bedrock was reported between 62.36 and 51.15mAOD and reported as extremely weak to weak reddish brown thinly bedded Bolin Mudstone with close to medium spaced fractures. Multiple completely weathered zones were reported throughout the rock core recovered as clay and gravel.
- 6.1.22 A programme of geotechnical testing was completed on rock samples obtained from site investigation works copies of which are provided within Appendix D.

6.2 Groundwater & Contamination Observations

- 6.2.1 Olfactory evidence of hydrocarbon was reported at BH104 between 1.70 and 2.80mbgl. No further evidence of hydrocarbon contamination was noted in window sampler boreholes located within 5 – 10m radius of BH104 to delineate the spatial extent of any contamination in this area.
- 6.2.2 Asbestos cement was identified within WS204 at 0.80m. Analysis of the sample indicated asbestos type to be crocidolite and chrysotile. Asbestos was also reported in the form of loose chrysotile fibres in a nearby borehole (WS201).
- 6.2.3 No groundwater strikes or minor ingresses were noted during site investigations. Resting groundwater monitoring results (as revealed from borehole standpipes) indicate a groundwater table within the made ground, clay and weathered mudstone strata at depths between 68.70 and 66.71mAOD. Groundwater levels are highest at the northern area of the site and dip towards the north of the site.
- 6.2.4 Full details of monitoring results have been provided within Appendix E.

6.3 Below Ground Obstructions

- 6.3.1 Boulders were encountered in WS103 at 2.62mbgl and WS202 at 1.00mbgl. BH101 was relocated due to the possibility of active services.

7.0 LABORATORY TESTING

7.0.1 To establish the physical and chemical properties of underlying soils, a programme of laboratory analysis was completed utilising samples obtained during site investigation works. This analysis comprised the testing of soil samples to assist with the estimation of risks posed by contaminated land related concerns.

Chemical Testing

7.0.2 R^{OC} Consulting submitted a total of 18 soil and 3 water samples to a UKAS accredited testing facility for analysis against a range of determinands.

Determinands	No. of Tests
Toxic and phytotoxic metals and metalloids	17
Total & Speciated Polycyclic Aromatic Hydrocarbons (PAH),	17
Other inorganic substances (e.g. Sulphate, Cyanide etc)	17
Asbestos ID	18
Leachate Analysis (Heavy Metals etc) / WAC	3
Water Soluble Sulfate & pH	17
TPH CWG	6
Heavy metals in water	3
Total & Speciated PAH in water	3
TPHCWG in water	3
Other inorganic substances (e.g. Sulphate, Cyanide etc) in water	3

7.0.3 Copies of chemical testing results have been provided within Appendix C.

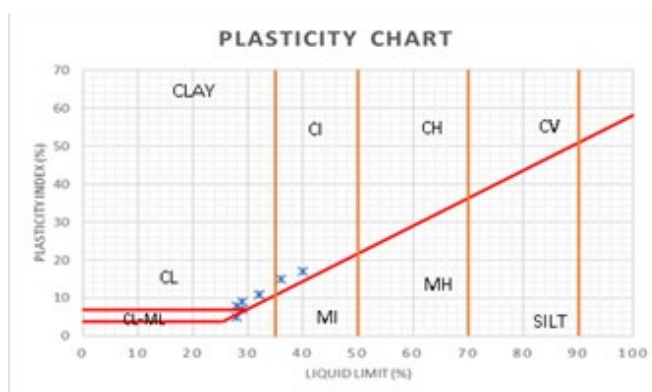
Geotechnical Testing

7.0.4 A programme of geotechnical laboratory analysis was also completed on tub and undisturbed soil samples obtained during site investigation works.

Plasticity Index

7.0.5 A total of 8 soil samples were tested for the determination of the glacial clays plasticity index. The depth range of samples tested varied from 2 to 7.5m with a mean depth of 3.77mbgl. The plasticity index range varied between 5 and 17% with a mean value of 10%. These results indicate 7 of the samples are clays of a low to intermediate plastic nature. One sample (BH105 4.00 – 4.45m) was reported as silt of low plasticity.

Figure 7.1: Plasticity of site soils



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Undrained Shear Strength

- 7.0.6 A total of 3 glacial clay samples were tested for the determination of undrained shear strength from depths ranging between 1.20 and 3.45mbgl. Shear strength results vary between 64 and 100kPa with a mean value of 81.33kPa. These results indicate shallow clay strengths vary between firm and stiff.

One Dimensional Consolidation

- 7.0.7 A total of 5 glacial clay samples were tested for the determination of One Dimensional Consolidation. Tests were completed on undisturbed "U100" samples obtained from cable tool boreholes using a range of applied pressures (0 to 300kPa). Resulting M_v values were found to range between 0.046 and 0.94m²/MN.

Rock Strength Testing

Point Load Testing

- 7.0.8 A total of 40 axial (load applied along the core axis, normal to the observed bedding) point load tests were completed on rock core samples obtained from rotary boreholes from depths ranging between 6.15 and 20.79mbgl.
- 7.0.9 Measured Is_{50} values from Point Load index tests have been converted using a factor of 24 (Hoek and Bray 1981) for mudstone to obtain estimated UCS values. These results are presented in Table 7.1 below.

Table 7.1: Overview to Point Load Testing Results

Borehole ID	Orientation	Is_{50}		Estimated UCS		
		Min (MPa)	Max (MPa)	Min (MPa)	Max (MPa)	Average (MPa)
BH101A	Axial	0.02	0.43	0.48	10.32	5.73
BH102		0.07	0.32	1.68	7.68	4.22
BH103		0.07	0.35	1.68	8.4	3.43
BH104		0.01	0.36	0.24	8.64	3.60
BH105		0.02	0.19	0.48	4.56	2.98
BH106		0.03	0.16	0.72	3.84	2.08

UCS Testing

- 7.0.10 A total of 20 Unconfined Compressive Strength Tests were completed on rock core samples obtained from rotary boreholes at depths ranging between 7.17m and 21.71mbgl. The results are presented in Table 7.2 below.

Table 7.2: Overview to UCS Strength Testing Results

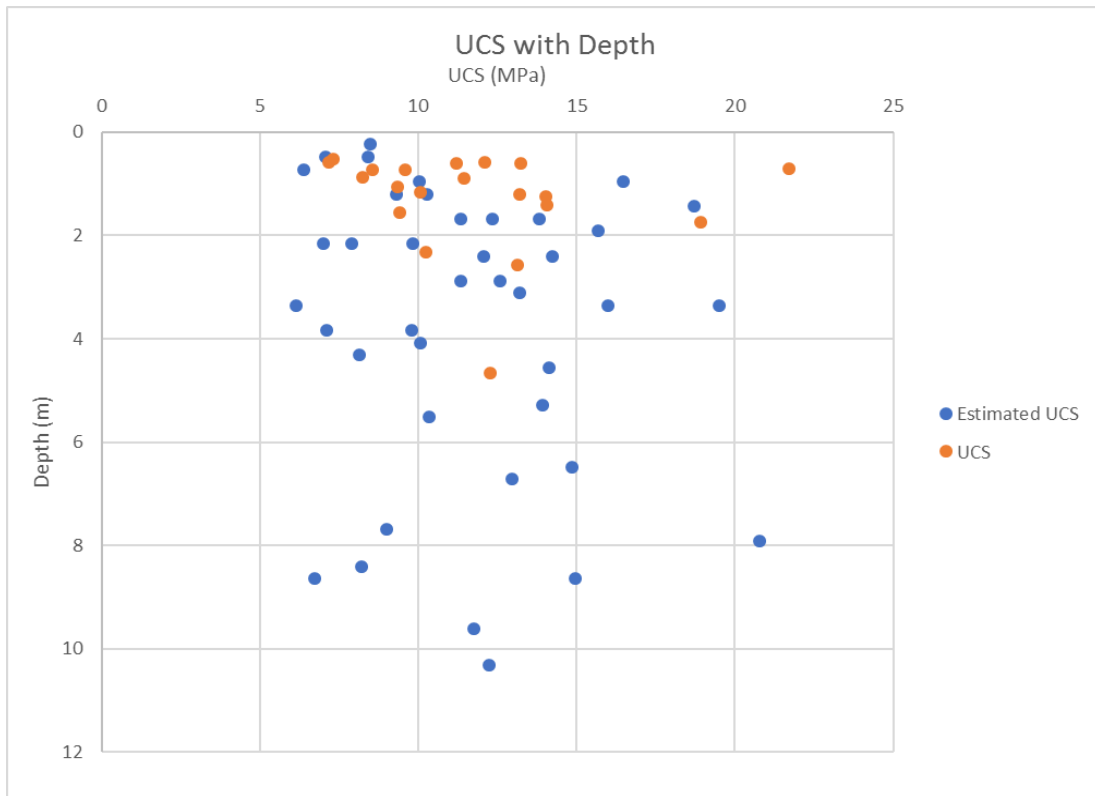
Borehole ID	Min (MPa)	Max (MPa)	Average (MPa)
BH101A	1.16	1.55	1.36
BH102	0.87	4.67	2.32
BH103	0.58	1.06	0.79
BH104	0.70	1.74	1.23
BH105	0.52	1.21	0.76
BH106	0.59	2.58	1.30

- 7.0.11 Figure 7.1 (provided overleaf) indicates the Unconfined Compressive Strength and Point Load Axial Index (Is_{50}) derived estimated Uniaxial Compressive Strength values plotted versus depth. The results indicate that the compressive strength of the mudstone ranges between 0.24 and 10.32MPa (extremely weak to weak) with no correlation between rock strength and depth.

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Figure 7.2: Converted and measured UCS results with depth from core samples taken at BH101A – BH106.



7.0.12 It is noted that strength assessments do not take into account the highly fractured nature of the mudstone and any weathered zones within rock cores. Tests are only able to be carried out on unfractured lengths of rock core samples and as a result may overestimate the total rock strength. Detailed consideration of the rock will be required when estimating total level of settlement that may occur within any foundations formed on bedrock.

7.0.13 Results from geotechnical laboratory testing have been provided within Appendix D.

8.0 GEO-ENVIRONMENTAL ASSESSMENT

- 8.0.1 The information obtained during the desk-based study has been reviewed to establish the Preliminary Conceptual Model for the site. This model is based around the Source / Pathway / Receptor methodology as outlined in Figure 8.0.

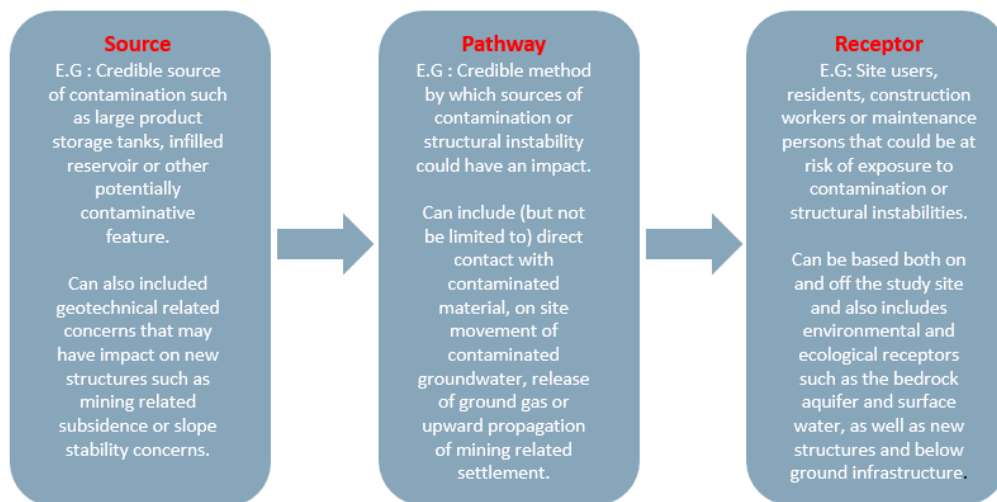


Figure 8.0 Source Pathway Receptor Diagram

- 8.0.2 Risk assessment is the process of collating known information on a hazard or set hazards in order to establish actual or potential risks to receptors. The receptor may be human health, controlled waters, a sensitive local ecosystem or even construction materials. Receptors can be connected with the hazard under consideration via one or several exposure pathways (e.g. the pathway of direct skin contact and oral exposure).
- 8.0.3 Risks are generally managed by isolating or removing the hazard, isolating the receptor, or by intercepting the exposure pathway. Without the three essential components of a source (hazard), pathway and receptor, there is deemed to be no risk. In other words, the mere presence of a hazard at a site does not mean that there will necessarily be risks.
- 8.0.4 A CLEA CLR 8 provides a selection of contaminants that may be relevant for the assessment of contaminated land, based on site usage, because they are likely to be found on a large number of industrial sites in the UK and have the potential to affect human health and the environment. The CLEA CLR 8 documentation, along with other relevant guidance, forms the basis against which the site has been assessed.
- 8.0.5 A Preliminary desk-based risk assessment has been completed for the site utilising the current and historical environmental information available (refer to RoC Consulting report ref: ES/ROC/p1 3647). This report formed the basis from which the current program of ground investigations was designed and undertaken.
- 8.0.6 With reference to the development proposals it is noted a cut / fill earth works exercise will be required to create a level development platform. In addition, the existing water course is likely to be put partially into culvert with the associated removal of organic rich soils. It is likely any cut / fill earth works will seek to re-use site won material (likely to comprise reworked clays) although unsuitable material (such as organic rich or contaminated soils) that are encountered during the earthworks process are unlikely to be reused as part

of earth reprofiling operations. These bulk earthworks are likely to have an impact on contaminated land assessments and have been taken into account during the below review.

- 8.0.7 The results from these intrusive site investigations have allowed a geo-environmental risk assessment to be completed in accordance with the guidelines and principals of the Environment Agency CLEA Methodology and with reference to the guidance outlined within CIRIA 552 “Contaminated land risk assessment. A good practise guide”. This risk assessment methodology considers the potential consequence / severity of risks that may be present within soils in comparison with the likelihood of exposure to or / and occurrence of said risk. A range of risk classifications are provided within CIRIA 552 further details of which are provided in Table 8.0 below.

Table 8.0: Definition of Risk Class and Consequence

Risk Class	Definition	Example
Minor	Potential for harm, although not significant, which may result in financial loss to resolve. Ground conditions where the use of PPE would readily mitigate risks posed to human health.	Low level contamination hotspots within made ground / demolition fill materials. Stunted or impeded plant growth due to poor soil quality.
Mild	Pollution of non-sensitive water resources or damage to crops, plant growth, below ground utilities or structures.	Perched groundwater contamination overlying low permeability aquifer or aggressive sulphate concentrations in soils.
Medium	Sources of contamination identified on site have the potential to cause both long and short term health effects on site residents / users. Alternatively (or in conjunction with) sources of contamination may have the potential to impact surface or groundwater quality or impede vegetation growth.	Elevated concentrations of hydrocarbon contamination reported within topsoil tested within residential gardens as a result of inadequate or incomplete previous remediation works. Movement of contaminated groundwater from leaking below ground storage tank into adjacent surface water course.
Severe	Sources of contamination pose a credible and acute risk to human health with potential for “Significant Harm” occurring as defined by the Part IIA of the Environmental Protection Act (1990). Alternatively (or in conjunction with risks posed to human health) sources of contamination may pose an immediate risk to controlled water resources or ecosystems.	Grossly contaminated soils are encountered or disturbed during excavation works, causing an immediate release of toxic soil vapour and leachate / contaminated groundwater flow across adjacent land.

- 8.0.8 As previously discussed the contaminated land risk assessment model evaluates both the severity of risks that may be present within soils / groundwaters in the context of threats posed to identified receptors before deriving the actual risk rating based on the probability of occurrence. Table 8.1 (provided below) outlines the range likelihood of risk.

Table 8.1: Probability Assessment

Classification	Definition
High likelihood	A credible pollutant linkage has been identified and it is very likely contaminants will impact identified receptors in both the short or long term (or is already actively doing so). The potential for harm to be caused is thus highly likely.
Likely	Pollutant linkages between the sources of contamination and identified receptors are present and it is considered likely they will become active given the right set of circumstances (e.g. contaminants currently buried below ground that are likely to be exposed or disturbed during construction / excavation works. The circumstances are such that an event is not inevitable but is possible in the short term and likely over the longer term.
Low likelihood	A theoretical pollutant linkage has been identified that has the potential to exposure receptors to contaminants under the correct circumstances. However, the likelihood of such an event occurring is not a certainty, even in the long term
Unlikely	There is no / minimal likelihood a pollutant linkage would occur, even over the long term.

8.0.9 The risk assessment process is a combination of probability and consequence, recognising that it may be possible to have a significant source of contamination beneath a site (such as a large below ground chemical storage tank) that may only present a relatively moderate to low risk (owing to the fact it may be contained within a secure concrete bund). Table 8.2 indicates how the actual nature of risk is established with Table 8.3 illustrating how the risk is interpreted in the context of contaminated land risk assessment.

Table 8.2 : Risk Definition

		Consequence			
		Severe	Medium	Mild	Minor
Probability	High Likelihood	Very High Risk	High Risk	Moderate Risk	Moderate / Low Risk
	Likely	High Risk	Moderate Risk	Moderate / Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate / Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate / Low Risk	Low Risk	Very Low Risk	

Table 8.3 : Description of risks posed

Risk Definition	Description
Very High	Active pollutant linkages between a significant source of contamination and identified receptors have been established and there is a high likelihood of severe harm occurring to said receptors unless immediate investigation and remediation action is taken.
High Risk	Harm is likely to arise to receptors from an identified hazard in the short and long term. Urgent investigation of the contaminant issue will be required, and remedial treatment is likely.
Moderate Risk	The possibility of harm has been identified toward receptors under the right circumstances, although the severity of harm would be relatively mild. Further investigation of identified issues would be prudent and possible need for remedial measures in the long term.
Low Risk	It is possible harm could arise to a designated receptor from identified hazard, but it is likely (if realised) any harm would be (at worst) mild.
Very Low Risk	No significant pollutant linkages have been identified and the possibility of harm occurring to receptors is low.





- 8.0.10 A geo-environmental risk assessment has been completed to quantify the risks posed to identified receptors (as outlined in the preliminary site conceptual model) using the information obtained during site investigation fieldworks. Broadly speaking, this risk assessment process can be divided based on the receptor group in question between:
1. Risks posed to human health by soil contamination (both construction persons and future site users).
 2. Risks posed to human health by hazardous ground gas ingress (both construction persons and future site users).
 3. Risks posed to controlled waters by soil or groundwater contamination (both surface water features and bedrock aquifers).
 4. Risks posed to new building construction by aggressive ground conditions (namely elevated sulphate concentrations).
- 8.0.11 It is noted the site is being developed for commercial office space with associated public realm landscaping, recreational space and a 1500 space multi-storey car park.
- 8.0.12 Appropriate assessment have been completed for each of the above utilising the latest statutory and non-statutory guidance documents; for details of risks posed to human health refer to Section 8.1 (soils) and Section 8.2 (ground gas), for details of risks posed to controlled waters refer to Section 8.3 and risks posed to new structures refer to Section 8.4.

8.1 Assessment of Soil Contamination

- 8.1.1 In order to estimate the risks posed to human health from soil contamination, a quantitative risk assessment has been completed utilising the latest Environment Agency CLEA methodology. The assessment utilises the chemical testing results obtained during the site investigation fieldworks to characterise site conditions and facilitate the completion of the risk assessment process.
- 8.1.2 The assessment is based on the comparison of soil chemical testing results with published Environment Agency Category Four Screening Levels (C4SL's) under the proposed end use scenario to determine the sites suitability for use. C4SL values represent the highest acceptable values for contaminants within site soils under the proposed end use and are derived using the Environment Agency CLEA risk assessment methodology. A result in exceedance of a C4SL level may indicate the presence of contaminants within site soils and require further assessment.
- 8.1.3 It is noted only a limited number of C4SL values have been derived by the Environment Agency for use and reference has been made to LQM/CIEH Suitable For Use Levels (S4UL's) for a wider range of other contaminants (Heavy Metals, Poly Aromatic Hydrocarbons, TPH, SVOC and VOC's) to increase the depth and robustness of our assessment.





- 8.1.4 Chemical testing results are compared against C4SL and S4UL values for each determinant with any results reported in exceedance of screening criteria identified and their significance reviewed. When determining the significance of any exceedances within the dataset the magnitude and frequency of the exceedance need to be taken into account, for example, a single exceedance of a screening value may be considered a localised hotspot whereas consistently elevated levels of a substance at multiple locations across the site may indicate a more prevalent contamination issue.
- 8.1.5 In addition to this assessment, an Asbestos Identification test (via the visual inspection method) has been completed on all samples of made ground obtained during the investigation to determine risks posed. Any positive occurrences of Asbestos will be subject to quantification analysis to further assess the extent and significance of risks posed.
- 8.1.6 As required, for each exceedance reference will be made to the Conceptual Site Model to establish the most likely source of contaminants and initial commentary given as to the likely scope of remedial measures. In addition, reference will also be made to the assumptions used to derive generic assessment criteria (C4SL and S4UL values) to determine their comparability with the proposed end use.





- 8.1.7 For the purposes of this assessment we have assumed a “commercial” end use scenario when reviewing chemical testing data against C4SL / S4UL values; a “worst case” Soil Organic Matter content value of 1% has been assumed for the initial assessment. In addition, and as discussed in paragraph 8.0.6, it is noted the site will require a cut / fill exercise to facilitate development which will, in turn have an impact on the assessment and refined conceptual site model provided.

Summary and Assessment of Risks Posed by Soil Contamination

- 8.1.8 Results from chemical testing analysis indicate the following:
- 1) No exceedances of CLEA SGV or CIEH LQM generic assessment criteria when reviewed under a “commercial” end use scenario.
 - 2) Slightly elevated levels of heavy metals, PAHs and aliphatic and aromatic hydrocarbons.
 - 3) Asbestos was identified in made ground deposits at two locations (details of which are provided below).
- 8.1.9 Asbestos has been identified at WS204 in the form of crocidolite and chrysotile in buried cement and at WS201 as loose chrysotile fibres. It is considered that asbestos cement was likely disposed of on-site and buried. Asbestos quantification revealed <0.001% of fibres were present in made ground sample from WS201.
- 8.1.10 The findings of the above have been used to update the Refined Conceptual Site Model (provided within Section 9.0) as well as inform the scope of any further investigation or remedial works deemed necessary to support the sites development.

8.2 Ground Gas Risk Assessment

- 8.2.1 The Preliminary Conceptual Site model identified the decay of organic material within made or reworked soils across the site, as well as organic rich alluvial deposits associated with the water course that crosses the site. The site is not said to be located in an area at risk from Radon gas ingress. It is considered construction persons and future site users are at risk of exposure to ground gases when working within buildings confined / enclosed spaces.
- 8.2.2 To estimate the risks posed by ground gas generation a total of 5 exploratory holes were installed with gas monitoring wells (BH101A – BH104, BH106). The purpose of these standpipes is to investigate ground gas generation potential of shallow and at depth soils and the associated implications this may have for new building design.
- 8.2.3 At the time of writing, a total of five ground gas monitoring visits have been completed on site during varying weather conditions and atmospheric pressure (refer to Appendix E for further information). The results from these monitoring works revealed a maximum Carbon Dioxide concentration of 6.10% with maximum gas flow rates of 86.90l/hr, although steady flow rates are markedly less than this initial peak.
- 8.2.4 The results also indicated depleted oxygen levels within monitoring wells, elevated levels of methane with peak readings of 3.30% and an absence of hydrogen sulphide gases. Gas readings at BH102 indicated the presence of carbon monoxide at this location with a peak gas reading of 12ppm.
- 8.2.5 With reference to guidance provided in CIRIA C665 “Assessing risks posed by hazardous ground gases to buildings” and assuming the development comprises a commercial end use; the above-mentioned worst-case gas levels and borehole flow rates equate to a gas screening value of 5.30 l/hr. This value equates to a characteristic 4 situation (moderate to high risk).



- 8.2.6 However, the worst-case gas screening value is derived from a peak flow rate of 86.90 l/hr noted in BH103, and it is noted that the majority of monitoring visits reported flow rates at or around 0.00 l/hr. As such the worst-case scenario as detailed above is not considered representative of the gas regime at the site. It is instead recommended a steady average flow rate of 0.01 l/hr is used to calculate the gas screening value the results of which equates to a Characteristic I Situation (very low risk) scenario with no requirement to install gas protection measures in new structures.
- 8.2.7 Whilst levels of Methane and Carbon Dioxide reported in BH101A and BH104 are in exceedance of the stipulated 1% and 5% threshold for a Characteristic I Situation respectively, due to the absence of sustained gas flow during gas monitoring a Characteristic I Situation is considered suitable for the gas regime at the site. In addition to the absence of flow, it has been noted that a cut and fill exercise will be carried out across the site and will likely result in a removal of organic material from the site and therefore further reduce the gas risk.

8.3 Controlled Waters

- 8.3.1 A programme of groundwater sampling was undertaken by engineers from RoC Consulting on 11/12/18. Groundwater samples were collected from a total of 3 boreholes located across the site (BH103, BH106 and BH102). Samples were taken from monitoring wells where resting water levels were sufficient for samples to be taken.
- 8.3.2 Prior to the collection of water samples, the resting water level in each of the standpipes was measured and x2 volumes of the total water volume was purged to obtain a representative sample of groundwater. Water samples were subject to chemical analysis to identify any contamination arising from site activities.
- 8.3.3 Water samples were collected in 1l glass jars and 100ml plastic vials and obtained using plastic disposable bailers. Samples were delivered to the chemical testing facility for analysis on the same day. No evidence of contamination was noted during the water sampling visit. Chemical testing results have been provided within Appendix C.
- 8.3.4 It is understood the site is underlain by a Secondary Aquifer and is not said to be located within any Environment Agency Zone source protection zones or in close proximity to sensitive groundwater abstraction boreholes. The nearest surface water feature is located on-site and is considered to be at risk of contaminant migration from the study site.
- 8.3.5 Results obtained from chemical testing have been compared against Environmental Quality Standards, UK Drinking Water Standards (UKDWS) and Potable Groundwater SPZ screening values. It is noted that only a limited number of EQS values have been derived and therefore reference has been made to UKDWS and Potable Groundwater SPZ guidelines for a wider range of contaminants and to increase the robustness of our assessment. Any exceedance of screening criteria has been reported and the significance reviewed.

Summary and Assessment of Risks Posed by Water Contamination

- 8.3.6 Chemical analysis of ground water samples indicated an exceedance of selenium (UK Drinking Water Standards) at BH106 and of sulphate at BH103, BH106 and BH102 (Potable Groundwater SPZ screen). Levels of total PAH were marginally elevated above detection levels at BH102, BH103 and BH106. At BH102 and BH106 levels of TPH were marginally elevated above detection levels.
- 8.3.7 It is noted that the only exceedances made are UKDWS and Potable Groundwater SPZ Screening values. Given the low sensitivity of the aquifer beneath the site it is considered that elevated levels of contaminants identified do not pose a risk to controlled waters at the site.





8.4 Below Ground Concrete Construction

- 8.4.1 Peak potential sulphate concentrations range between <10 and 417mg/l, however the majority of samples were in the range of <10 to 73mg/l with 2 samples of peak potential sulphate concentrations of 411 and 417mg/l. Soil pH values range between 5.84 and 8.36 however 16 of 17 samples tested were in the range of 7.32 and 8.36. Based on these results, it is considered that well compacted buried concrete should be designed in accordance with Class DS-I AC-I's requirements as specified in BRE Digest Special Digest 1:2005 *Concrete in aggressive ground: Version 3*.



9.0 REFINED CONCEPTUAL SITE MODEL

9.0.1 The Environmental Protection Act Part IIA: 1990, defines contamination as land containing levels of contamination which form a risk to human health, controlled waters or other ecosystems. Therefore, contamination in exceedance of the relevant screening values is considered a source. Table 9.0 assesses and summarises the sources, pathways and receptors that may exist at the site.

TABLE 9.0: REFINED CONCEPTUAL SITE MODEL		
Potential Sources		
Contamination Source	Risks Posed	Comment
Historical land use and recent operations as long stay car park	Low - Medium	Site investigation works have identified marginally elevated levels of heavy metals, poly aromatic hydrocarbons and total petroleum hydrocarbons at locations across the site within both Made Ground and natural deposits, although no exceedances of screening criteria have been noted. A hot spot of contamination has been noted in the area adjacent Enterprise Way comprising Asbestos cement and loose fibres. This hotspot will require excavation and removal from site (with suitable mitigations in place to afford protection to construction persons and the wider public).
Proposed land use	Low	The site is to be developed for commercial office and retail space with areas of landscaping and is considered to pose a low risk in terms of contaminative potential.
Hazardous ground gas generation	Low - Medium	Gas monitoring results indicate marginal elevations of ground gas levels beneath the site however due to the sustained absence of gas flow the gas regime at the site is a Characteristic I Situation.
Off-site sources	Low	No significant sources of off-site contamination have been identified.
Potential Receptors		
Human Health – Construction Process		Construction workers and members of the public could be at risk of exposure to contaminants during the redevelopment and subsequent operation. In addition, this group could be at risk of exposure to potentially hazardous ground gas during the sites development and subsequent operation.
Human Health – Operational Phase		The site is to be developed to comprise commercial office and retail space with areas of landscaping and it considered future site users and maintenance persons may be at risk of exposure to sources of contamination as outlined above.
Off-site properties		Land use within the immediate vicinity of the site comprises car parking and commercial office spaces. Members of the public and off-site users may be at risk of exposure to contamination through wind-blown dust during the construction phase.

Controlled waters - Surface waters & Secondary Aquifer		The underlying aquifers and the surface water feature present on-site may be at risk of contamination. However, the bedrock and drift aquifers are classified as secondary aquifers and do not represent a sensitive receptor to contaminants.
Below ground infrastructure & construction		Below ground water supply pipe work and concrete structures are considered at risk of damage or could have their integrity compromised by aggressive chemical conditions.
Ecological Receptors		No sensitive ecological receptors have been identified.
Potential Pathways		
Pathway route	Likelihood of linkage	Reason
Direct dermal contact, ingestion and inhalation of contaminated soil / dust Off-site inhalation of ground gas/vapour	Low to Medium	Construction Workers: It is considered the risks posed to construction personnel by identified hotspots of contamination, can be adequately mitigated against via the use of full PPE and the adoption of good hygiene and site practises. Any sources of contamination uncovered during site development works should be brought to the immediate attention of RoC Consulting for consideration and comment. Appropriate personal ground gas detection equipment should be deployed by all site operatives when working in below ground or confined spaces. Special mitigation measures may be required when working in areas where asbestos has been identified.
	Low	Future site employees / users: In areas of hardstanding it is not considered likely that future site users are at risk of direct contact with any contaminated soils. The ground gas regime at the site has been Characterised as a Situation 1 with no remedial measures required to control gas ingress.
Leaching of contaminated soil and impact to Aquifer beneath site	Low	Chemical analysis of ground water samples indicated an exceedance of UKDWS and Potable Groundwater SPZ screening values of sulphate and selenium. This is not considered to pose a risk to the aquifer beneath the site or surface water features given the site is not located within a Source Protection Zone or sensitive abstraction points.
Migration of contaminated groundwater into surface water features	Low	Additionally, the widespread presence of clay deposits across the site limits the potential for any contaminant migration to ground water. A risk of contaminated run-off to surface water features during the construction phase has been identified. Mitigation measures will be required to prevent the accidental spillage or release of sediment rich surface water run off or fuel spillages into surface water features on and adjacent the site.
Below ground service runs	Low	All below ground concrete structures to be designed in accordance with a Class DS-I AC-Is requirements as specified in BRE Digest Special Digest 1:2005 <i>Concrete in aggressive ground: Version 3</i> .

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- 9.0.2 Re-appraisal and reassessment of the conceptual site model (following completion of investigation works) has identified no exceedances of contaminants when screened against a commercial end use. However, an area of asbestos containing material has been identified on site that will require excavation and disposal as part of redevelopment proposals.
- 9.0.3 With reference to development proposals it is noted a cut / fill bulk earth works exercise will be required in order to facilitate a level construction platform. As previously discussed, it is likely these bulk earthworks will remove and dispose of any unsuitable organic rich or contaminated material encountered. A known hotspot of contamination is present on site to the eastern extent and will require excavation and disposal from site by contractors with due consideration of associated H&S provision for site operators (particularly in view of the presence of Asbestos containing material).
- 9.0.4 In addition to the above it is recommended all construction contractors take reasonable precautions to control environmental impacts that may occur as a result of redevelopment works with respect of soil and groundwater quality. These measures should include (and not be limited to):
- 1) Any sources of contamination uncovered during site development works should be brought to the immediate attention of RoC Consulting for consideration and comment. As required, the findings and recommendations of the current assessment may require amendment to reflect changes in site condition.
 - 2) The operation of plant, refuelling facilities and general earth works should include appropriate provision to reduce the risk of leakage / spillage, particularly into the site's groundwater table or exposed natural soils.
 - 3) Appropriate dust mitigation measures should be deployed during excavation works, particularly when handling and excavating made ground deposits.
 - 4) All excavated materials stockpiled should be periodically dampened down to control dust release. Similarly, the disposal of any material from site should be completed using covered wagons.





10.0 GEOTECHNICAL & FOUNDATION DESIGN ASSESSMENT

Background Information

- 10.0.1 It is understood the site is to be developed for commercial office end uses across a number of phases with the initial Phase I scheme comprising a commercial office structure to the site's southern extent with associated car parking. Later phases of commercial office space are proposed to the north and east of the site with the central portion comprising an amphitheatre and areas of landscaping as indicated on Exterior Architecture drawings (ref: 1827-EXA-00-XX-SK-L-100 F) provided within Appendix A.
- 10.0.2 At the time of writing proposed finished floor levels for all structures are set at 70.00mAOD, with an assumed sub-formation level of 68.60mAOD in areas of the Phase I and Phase 2/3 Office building, rising to 69.75mAOD within the Phase I Car Park. RoC Consulting have completed an earth works assessment of the site and drawing CF03 has been provided in Appendix A detailing areas of cut and fill across the site required to facilitate the above development levels. We have adopted a finished floor level (70.0mAoD) to determine areas of cut and fill during the following assessment.
- 10.0.3 Site investigations identified made ground deposits across the majority of the site to maximum depth of 3.00mbgl with an average depth of 1.34mbgl. Made Ground generally comprised gravelly reworked clay. Natural strata beneath made ground deposits comprised a reddish brown silty clay becoming friable with depth. The weathered bedrock fraction was encountered at an average depth of 67.18mAOD with non-weathered bedrock at an average depth of 58.52mAOD and described as extremely weak to weak reddish brown banded grey thinly bedded mudstone.

10.1 New Building Foundation Design

Phase I Office Building

- 10.1.1 A reduced level dig will be required to achieve sub-formation levels across the area of the Phase I Office building with an alteration of existing site levels by between 0.81 and 4.25m. Founding strata for this phase of development comprises weathered mudstone at the south western area of the structure and clay across the remainder. Material to be removed primarily comprises reworked clay / made ground and some natural strata (clay and weathered mudstone) at depth. Initial structural design works indicate the maximum loadings associated with this development are said to be of the order of 8000 - 10000kN./per sq m.
- 10.1.2 Strength of the natural clays range in strength from 32 – 60kPa (soft to firm). The strength of the clays / weathered mudstone significantly increases (SPT N values 47 – 50) at a depth between 68.85 and 65.75mAOD.
- 10.1.3 Given the relatively high column loadings associated with this development it is recommended a piled foundation solution be adopted for primary structural columns and supports. Initial discussions have been held with Rock & Alluvium piling contractors to determine an initial pile design based on the above. Discussions indicate the above mentioned loadings would require five 600mm diameter piles to a depth of 12.5mbgl for column loads of 8,000kN, with six 600mm diameter piles groups taken to a depth of 13mbgl for column loads of 10,000kN.
- 10.1.4 The ground bearing floor slab is likely to be founded across the weathered mudstone and clays varying in strength from soft to firm. Given the relatively low strength of the clays across the north and north eastern area of the site compared to that of the weathered mudstone at the south west of the site, it is recommended a programme of vibro works are employed to achieve suitable bearing capacity to allow for a ground bearing floor slab (and reduce the associated risk of differential settlement therein). It is

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recommended vibro ground improvement works are carried out across the entire Phase I Office site to create an even platform and avoid uneven settlement during the site's development.

Phase I Car Park

- 10.1.5 Development sub-formation level of 69.75mAOD will require levels to be built up across the area of the Phase I carpark by between a minimum of 1.32 and 1.01m, depending on requirement for removal of topsoil and other unsuitable material. Higher levels at the north east of the site, comprising reworked clay/ made ground, will require removal to achieve levels of 69.750mAOD.
- 10.1.6 Column and floor slab loadings for the Phase I Car Park are anticipated to be relatively low although the structure will be constructed across an area of fill. The associated depths to reach competent strata post bulk earth works operation are likely to be significant (>2m) and it is recommended consideration is given to the use of vibro stabilisation works (in conjunction with the cut / fill earthworks) to stabilise soils in area of upfill and allow construction of conventional pad / strip foundations for the proposed car park.
- 10.1.7 Discussions should be held with suitably qualified vibro ground improvement contractors and copies of this site investigation report provided for review (as well as detailed information on development proposals, loadings and earthworks strategies). Ground improvement works should treat soils to a bearing capacity of 150kN/m² in areas of proposed structural foundation and 50kN/m² in areas of ground bearing floor slab.

Phase 2/3 Office

- 10.1.8 To achieve sub-formation levels for the Phase 2/3 Office will require a reduction in levels between a minimum 0.01 and 0.68m with material to be removed primarily comprising topsoil and made ground deposits. The founding strata at 38.600mAOD comprises topsoil and / or reworked clay and it is not recommended new building foundations be constructed within these deposits. The variable composition and in situ strength of these materials is such that unacceptable levels of total and differential settlement will occur as a result.
- 10.1.9 At the time of writing specific detail of the building design and loadings are still to be confirmed, although it is likely they will be comparable with those discussed for the Phase I development. The adoption of a CFA Piled foundation (similar to that discussed for the Phase I development) is likely to provide the most suitable founding solution for the structure with the use of ground improvement techniques to treat soils in area of lightly loaded structures or floor slabs.
- 10.1.10 It is recommended detailed discussions be held with piling and ground improvement contractors at such a time when the design of the Phase 2 / 3 developments has sufficiently progressed to determine the most effective foundation solution.

10.2 General Comments

- 10.2.1 Removal of overburden pressure during cut exercise to achieve development levels may result in heave and associated reduction in bearing capacity in the clay. Use of vibro ground improvement techniques may provide mitigation against the effect of heave within the clays however the use of clay boards may be prudent to further mitigate this risk.
- 10.2.2 It is noted that the development is to be constructed over a surface water course present across the centre of the site and as such it is recommended this watercourse is culverted. Any culvert constructed beneath the proposed building footprint must be structurally isolated from the proposed foundation solution to prevent damage to the culvert.
- 10.2.3 Peak potential sulphate concentrations range between <10 and 417mg/l, however the majority of samples

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were in the range of <10 to 73mg/l with 2 samples of peak potential sulphate concentrations of 411 and 417mg/l. Soil pH values range between 5.84 and 8.36 however 16 of 17 samples tested were in the range of 7.32 and 8.36. Based on these results, it is considered that well compacted buried concrete should be designed in accordance with Class DS-I ACIs requirements as specified in BRE Digest Special Digest 1:2005 *Concrete in aggressive ground: Version 3*.

- 10.2.4 No entry should be permitted into excavations exceeding 1.2m depth without appropriate risk assessments, shoring and support. Whilst groundwater was not encountered in significant volumes during site investigation works the presence of a perched water table cannot be precluded. Appropriate provisions should be made to dewater excavations as and when required.
- 10.2.5 Similarly it is not recommended foundation excavations to underlying clay be left open and exposed to the elements as rainwater ingress will damage and reduce its strength (and subsequent bearing capacity). Similarly, no vehicular movements should be permitted within exposed foundation locations.





11.0 CONCLUSIONS AND RECOMMENDATIONS

- 11.0.1 RoC Consulting was engaged by Airport City Partnerships Ltd to complete a programme of ground investigations across Plots C, D and O of the 2018 Revised Airport City North masterplan (the site). It is understood that the site is to be redeveloped by The Hut Group for use as a commercial office space with associated public realm landscaping, recreational space and a 1500 space multi-storey car park in accordance with Exterior Architecture drawings (ref: 1827-EXA-00-XX-SK-L-100 F) provided within Appendix A.
- 11.0.2 Site investigations identified made ground deposits across the majority of the site to a maximum depth of 3.00mbgl with an average depth of 1.34mbgl. Made Ground generally comprised gravelly clay. Natural strata beneath made ground deposits generally comprised a reddish brown silty clay becoming friable with depth. The weathered bedrock fraction was encountered at an average depth of 67.18mAOD with non-weathered bedrock at an average depth of 58.52mAOD and described as reddish brown banded grey thinly bedded mudstone.
- 11.0.3 Chemical assessment of site soils has failed to reveal any sources of soil contamination when compared against a “commercial” end use scenario. Buried asbestos cement and loose fibres were encountered within an area adjacent the recently constructed Enterprise Way. Due care and attention should be taken at all times when excavating site soils and any suspected sources of contamination identified brought to the immediate attention of RoC Consulting. No significant groundwater contamination was identified. No remedial measures are required to control gas ingress.
- 11.0.5 The adoption of a piled foundation solution is recommended for all significantly loaded structures with vibro ground improvement recommended to treat floor slabs and external areas in conjunction with wider cut / fill earth works operations. It is recommended discussions be held with suitably qualified ground improvement contractors to determine the most cost effective treatment solutions. Copies of the current ground investigation report and proposed development / earthworks information should also be provided to assist with their review.
- 11.0.6 As required, any suspected sources of contamination discovered during the site development (outside those discussed in this report) should be brought to the attention of RoC Consulting and their implications assessed. Depending on the extent and severity, the findings and assessment of the current study may require re-interpretation and a remediation strategy proposed to support the sites development.
- 11.0.7 Copies of the current report, along with the Phase I Desktop Study, should be submitted to the local planning authority for consideration and comment. As required, any feedback received from the local authority should be passed back to RoC Consulting for review.





APPENDIX A - SITE DRAWINGS



P:\2018\1827 THE HUT GROUP\01 CAD\02 SHEET LAYOUT\1827-EXA-00-XX-SK-L-100.DWG



KEY

Proposed hard landscape

- Phase 1 redline boundary
- Primary insitu concrete surface
Natural creamstone: washed finish with coloured glass and 'glow stone' aggregate.
- Metal edge to insitu concrete surface
Rusted finish, height varies.
- Seating features
Outdoor flexible furniture
- Corten retaining structure
Approximately 1m high
- Anti ram bollards
- Sun-lounger & steps
Lounger with steps (gravel tread with rusted metal riser)
- PROW
Re-aligned public right of way within landscape setting.
Width: 1.5m
Material: compacted gravel
- Compacted gravel path
colour: gold
65mm depth/ compacted to 50mm depth.
- Rooftop terrace
Surface matial TBC
- Intercom system
Specification TBC

Proposed soft landscape

- Boundary hedge
70% Fagus sylvatica / 30% Fagus sylvatica
'Aspenifolia' in bare root stock, 175-200cm 3no.
per linear meter in 9 staggered row equating to 27
plants per linear meter. 2m H x 2.5m W including
1.8m security fence.
- Evergreen hedge
1.8m high Choisya ternata or similar approved. 3no.
plants per linear meter, 15L containerised stock.
- 'Low hedge'
Metal fence at 1.8m height in line with architectural
detailing with 3no. climbers per linear meter either
side at 1.8m height frame.
- Ornamental planting
Refer to Phase 2 report for further details.
- Sculptural wildflower meadow
Mix tbc
- Lawn
Pre-grown hard wearing, shade tolerant turf.
- Orchard tree
Parrotia persica multi-stem minimum 3 stems, height
500-600cm, clear stem minimum 180cm, umbrella
shape, clipped top. Refer to Phase 2 report for
further details.

No dimensions are to be scaled from this drawing.
All dimensions are to be checked on site.
Area measurements for indicative purposes only.

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Client

MANCHESTER AIRPORT GROUP

F	Minor Amendments	02.08.2018
E	Updated inline with comments	01.08.2018
D	Revised concept design	31.07.2018
C	Co-ordination	19.07.2018
B	Co-ordination	03.07.2018
A	Stage 2 Issue	26.06.2018
Rev	Description	Date

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Project title

THE HIVE
MANCHESTER AIRPORT
PHASE 1

Drawing title

GENERAL ARRANGEMENT

Issued By Manchester
Scale 1:500 @ A1
Status DRAFT
Date 25.06.18

Drawing number
1827-EXA-00-XX-SK-L-100

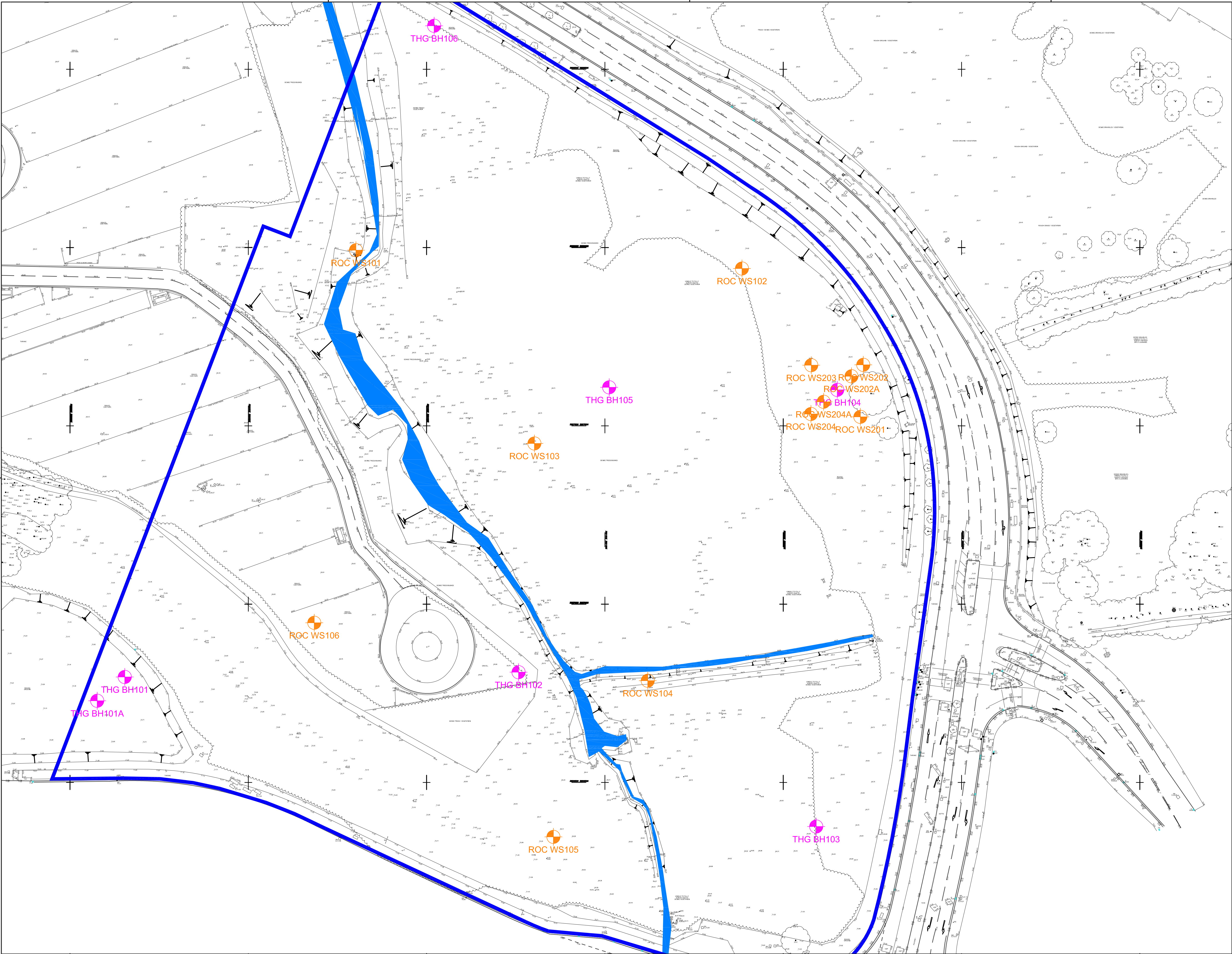
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Revision

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NOTES

KEY TO SYMBOLS

- APPROXIMATE SITE BOUNDARY
- SURFACE WATER FEATURE
- 2018 ROC ROTARY BOREHOLE
- 2018 ROC WINDOW SAMPLE BOREHOLE

DRAWING NOTES

- EXPLORATORY HOLE LOCATIONS SHOWN AT APPROXIMATE EXTENTS.
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- TOPO AND LEVELS FROM SURVEY OPERATIONS (DRAWING REF: 18F106_A)

REV.	DATE	DETAILS	DRN.	CHK.
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INFORMATION				
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AIRPORT CITY NORTH: THE HUT GROUP				
DRAWING TITLE				
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PROJECT No.	DRAWING No.	REV.		
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