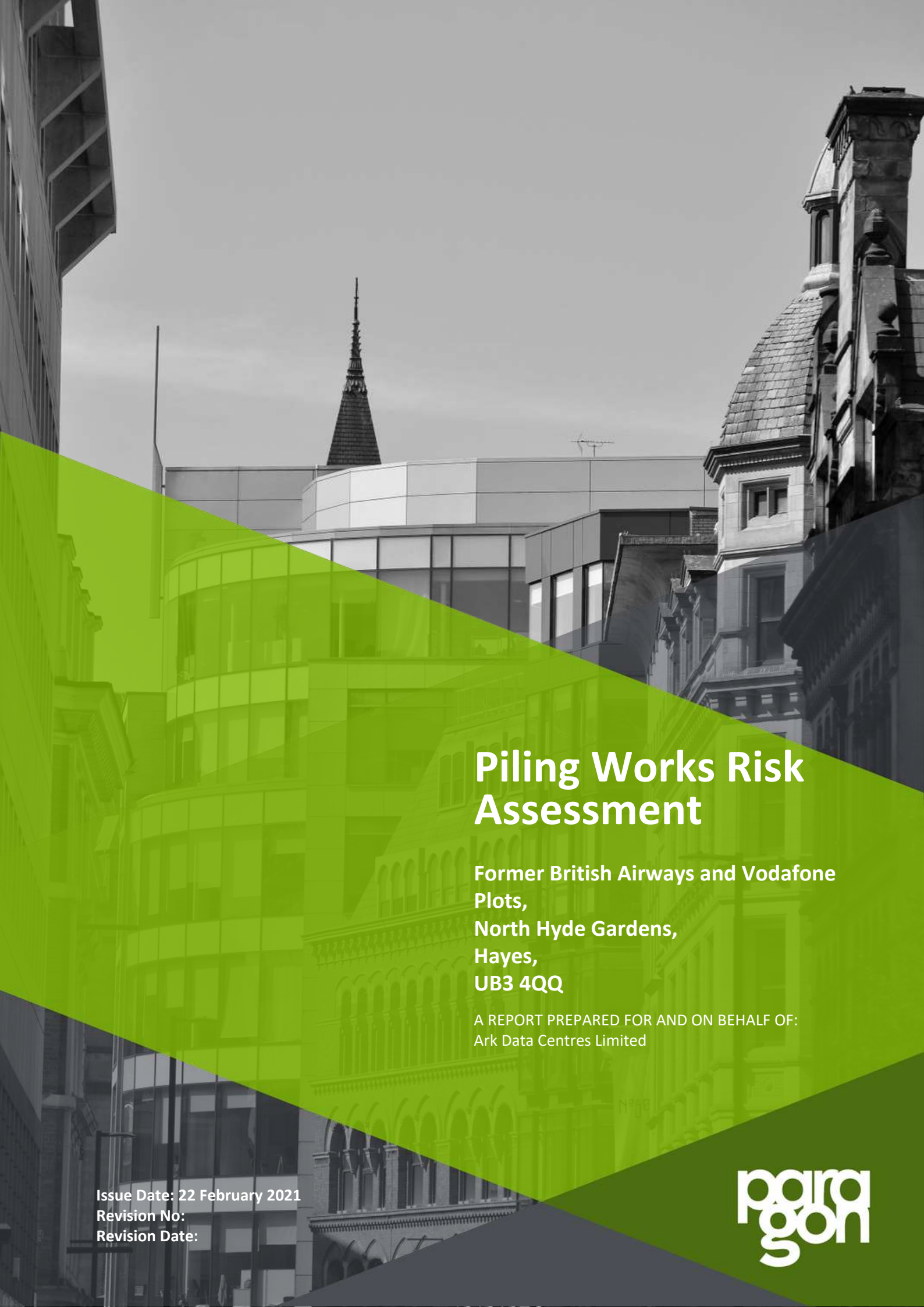




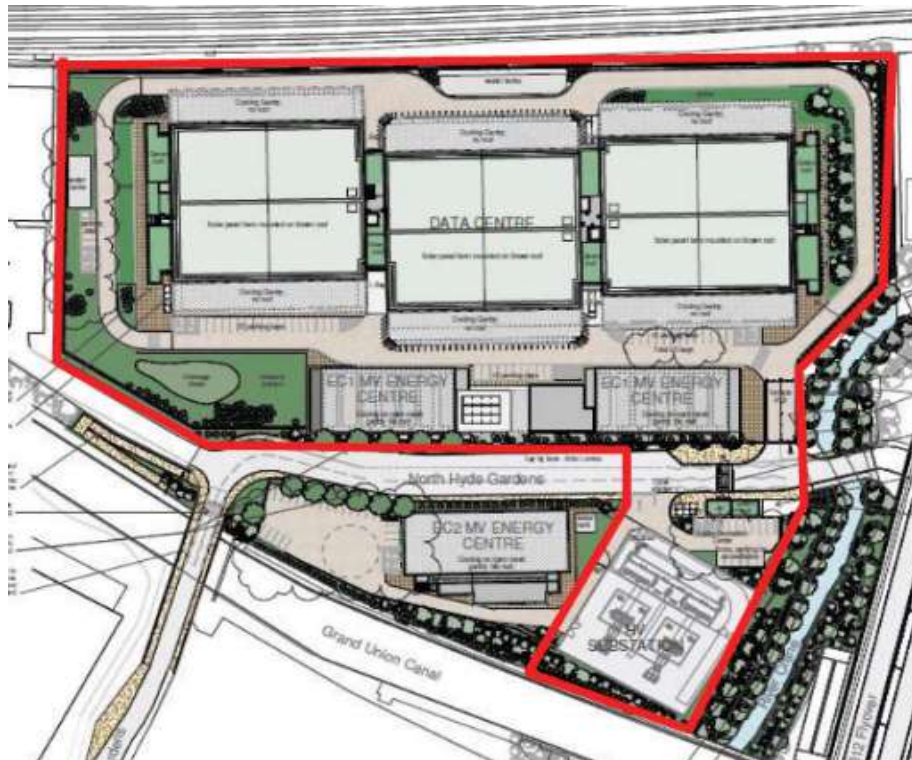
Piling Works Risk Assessment

Former British Airways and Vodafone
Plots,
North Hyde Gardens,
Hayes,
UB3 4QQ

A REPORT PREPARED FOR AND ON BEHALF OF:
Ark Data Centres Limited

Issue Date: 22 February 2021
Revision No:
Revision Date:

**para
gon**



Issuing Office:

Paragon, The Harlequin Building, 65 Southwark Street, London, SE1 0HR
Tel: 020 7125 0112

Date:

22 February 2021

Reference:

21.0198/CB/NW

Report Prepared By:

Charlie Bruinvels BSc MSc CEnv C.WEM

Signature:

Report Checked By:

Tim Cawood
MSc MBA CEng CEnv FCIWEM ASoBRA SiLC SQP

Signature:

For and on behalf of
Paragon Building Consultancy Limited

CONTENTS

1.0	INSTRUCTION AND SCOPE OF WORKS	1
2.0	INTRODUCTION	2
3.0	BACKGROUND INFORMATION	3
4.0	PILING DESIGN	11
5.0	PILING RISK ASSESSMENT	14
6.0	CONCLUSIONS	19
APPENDIX 1:	FIGURES	20
APPENDIX 2:	CONTAMINANTS OF CONCERN	21
APPENDIX 3:	PILING CONTRACTOR METHOD STATEMENT – CENTRAL PILING (BA PLOT)	22
APPENDIX 4:	PILING CONTRACTOR METHOD STATEMENT – SCREWFAST FOUNDATIONS (VODAFONE PLOT)	23
APPENDIX 5:	CONCEPTUAL MODEL – PILING	24
APPENDIX 6:	EXTENT OF SURVEY AND LIMITATIONS	25

PILING WORKS RISK ASSESSMENT

CLIENT NAME: Ark Data Centres Limited

PROPERTY ADDRESS: Former British Airways and Vodafone Plots,
North Hyde Gardens,
Hayes,
UB3 4QQ

INSPECTION DATE: N/A



1.0 INSTRUCTION AND SCOPE OF WORKS

- | | |
|------------|---|
| 1.1 | <p>Paragon Building Consultancy Limited (Paragon) was instructed by Concert on behalf of Ark Data Centres Limited on 12 February 2021 to complete a Piling Works Risk Assessment (PWRA) for a site referred to as Former British Airways and Vodafone Plots, North Hyde Gardens, Hayes, UB3 4QQ. The purpose of the PWRA is to consider six pollution scenarios identified for piling operations by the Environment Agency. These are in relation to the site specific ground conditions encountered and the final piling solution to be adopted. The pollution scenarios are as follows:</p> <ol style="list-style-type: none"> 1. Creation of preferential pathways through a low permeability layer (aquitard) to allow potential contamination to an underlying aquifer; 2. Creation of preferential pathways through a low permeability surface layer to allow either upward migration of landfill gas, soil gas or contaminant vapours to the surface or infiltration of surface water thereby causing leachates in contaminated soils; 3. Direct contact of site workers and others with contaminated soil arisings which have been brought to the surface; 4. Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials (where the secondary effects are to increase the potential for contaminant migration); 5. The driving of solid contaminants down into an aquifer during pile driving; and 6. Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout. |
| 1.2 | <p>This assessment has been completed in connection with redevelopment of the site with a data centre with MV energy centre on the former British Airways (BA) plot and a substation on the former Vodafone plot.</p> |

1.3	This report has been prepared to meet the requirements of the Environment Agency. Reference has been made to the Environment Agency's guidance 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention (2001)', EA's Guide Piling into Contaminated Sites (2002) and 'Piling in Layered Ground: risks to groundwater and archaeology – Science Report SC020074/SR'.
1.4	Due regard to the following is made in preparation of the PWRA: • Water Resources Act 1991; • Groundwater Regulations 1998 (amended January 2009); • National Planning Policy Framework (NPPF); and • EU Water Framework Directive (WFD).
1.5	The requirements of the Remediation Strategy have also been considered.

2.0 INTRODUCTION

2.1	Site Location and Description
2.1.1	The site is located at Bulls Bridge Industrial Estate, North Hyde Gardens, Hayes, UB3 4QQ.
2.1.2	The wider industrial estate comprises five main parcels of land that are referred to throughout this report as: Vodafone, British Airways (BA), Abellio, Addison Lee and Conway (Maintenance Yard). Neither the FM Conway nor Addison Lee plots are subject to this application. The access road: North Hyde Gardens is also within the wider site's demise. This Piling Works Risk Assessment only refers to the Vodafone and BA plots.
2.2	Proposed Development
2.2.1	The development proposals for the application (BA and Vodafone plots only) include site clearance and preparation, including the demolition of remaining buildings, and the redevelopment of the site to provide: a new data centre, MV Energy Centre (including stand-by generation plant and gas storage), a HV Sub-Station, a visitor reception centre, plant, the creation of a new footpath and cycleway link to the canal towpath, works to the highway, car parking, cycle parking, associated infrastructure, enclosures and necessary physical security systems, hard and soft landscaping (including works to the River Crane) and ancillary uses, as well as associated external works.
2.2.2	A preliminary drawing of the data centre has been provided by the client for guidance, however we understand this may be subject to change. The proposed layout is shown in Appendix 1.
2.3	Planning Condition
2.3.1	This document has been prepared to support the planning application ref. 75111/APP/2020/1955 and discharge of pre-commencement condition 32 for Piling Method Statements.

2.3.2

Condition 32 states:

“No piling shall take place until a Piling Method Statement (detailing the depth and type of piling to be undertaken and the methodology by which such piling will be carried out, including measures to prevent and minimise the potential for damage to subsurface sewerage infrastructure, and the programme for the works) has been submitted to and approved in writing by the local planning authority in consultation with Thames Water, the Environment Agency, Network Rail and the National Grid. Any piling must be undertaken in accordance with the terms of the approved piling method statement”.

2.4

Previous Reports

2.4.1

The following reports have been used to provide supporting information for this document; all of the reports are referenced for the site address Bulls Bridge, North Hyde Gardens, Hayes, UB3 4QQ:

- Paragon (2019) Phase 1 Preliminary Risk Assessment, ref 19.0633/CB/NW dated 29 August 2019 – Rev C, Revised December 2020 (for planning purposes).
- Paragon (2020) Phase 2 Ground Investigation Report, ref 20.0023, dated 6 March 2020 – Rev C, Revised December 2020.
- Paragon (2020) Detailed Quantitative Risk Assessment (DQRA), ref 20.0023/CK/KJH dated 10 July 2020 – Rev B, Revised December 2020.
- Paragon (2020) Remediation Strategy, ref 20.0023/CK/DCN dated 17 March 2020 – Rev C, Revised December 2020.

3.0 BACKGROUND INFORMATION

3.1

Summary of Previous Reports

3.1.1

The following information is summarised from the earlier reports listed above. The full documents should be read in conjunction with this report.

3.2

General Description and Current Site Use

3.2.1

The site is centred around National Grid Reference 510423, 179309 and is approximately 6.8Ha. The approximate elevation of the site is 31m Above Ordnance Datum (mAOD). The Phase 2 investigation by Paragon included drilling boreholes within the Vodafone and BA plots. A summary of each parcel of land is described below.

Table 1. Occupant Descriptions

Occupant	Brief description of site activities
Vodafone	At the time of the Phase 2 investigation the plot comprised a detached office block arranged over three floors with a reception atrium at ground floor and a roof terrace at 3rd floor level. The plot had a car park with bin store and diesel powered backup generator. The building on the Vodafone plot was demolished in 2020 and the generator has been removed.
British Airways	The former BA building was demolished in 2019 and the plot currently forms an area of open land.

3.2.2	The River Crane (also known as the Yeading Brook) runs adjacent to the east of the BA and Vodafone plots. The river is situated within the wider site boundary, along the southeast boundary and north through the northeast part of the site (Conway's plot). The Grand Union Canal is a manmade canal, situated 5m to the south of the Vodafone plot.
3.3	Historical Land Use
3.3.1	The earliest available map from 1865 shows the site as mostly vacant with a river running north to south along the eastern part of the site. This map also shows a railway and creosoting works in the northeast corner. Excavations and ground workings were noted from 1910. By 1932, the creosoting works had extended onto the site and a building was shown in the centre. The creosoting works were no longer shown by 1973 and a power station with chimney was shown in the western part of the site by 1983. By 2002, the power station was no longer shown and the British Airways building were shown. The Vodafone building was shown by 2010. A review of planning applications indicate that no environmentally significant conditions were attached to the application to redevelop the site in 1998.
3.3.2	The surrounding area has supported various industrial (potentially contaminative) land uses, including factories, brick fields, mills, railway, electricity substation, creosoting works, and rubber works.
3.3.3	Historical landfilling has been identified on site and east of the River Crane/Yeading Brook since 1936 and records indicate the landfill accepted commercial waste. In addition, the British Geological Survey (BGS) artificial ground mapping covers the entire site.
3.4	Geology
3.4.1	From a review of BGS mapping (map sheet numbers: 255, 256, 269, and 270), the geology of the subject site is reported to be formed of the Lynch Hill Gravel underlain by the London Clay Formation. The mapping also shows Artificial Ground, Langley Silt and Alluvium within 50m of the site. The Alluvium runs in the location of the river with deposits shown to be absent either side of the river. This is likely to be due to the slope on either bank. The Langley Silt may encroach onto the southern part of the site.
3.4.2	The BGS borehole records show a deep third-party borehole was drilled approximately 100m east of the site (Ref:TQ17NW114). The ground conditions are summarised as: Made Ground to 0.91m below ground level (bgl), over Loam and Gravel to 6.10mbgl, over London Clay to 62.79mbgl, over Reading Beds to 82.65mbgl, over Chalk to the base of the borehole at 152.40mbgl.
3.4.3	The surrounding area is known for being historically mined to extract the gravel. As such, there are many landfills and reservoirs in this area. It is therefore possible that the gravel deposits were largely extracted which allowed the landfilling to occur.
3.4.4	The ground conditions recorded during the Phase 2 Investigation are presented in Table 2 below. This investigation comprised eight boreholes drilled by sonic drilling methods to depths of between 10 and 35m below ground level (bgl).

Table 2. Ground Conditions

Depth From (min/max) (m)	Depth To (min/max) (m)	Soil Type	Description
0.0	0.1 / 0.05	Concrete / Tarmacadam	Concrete / Tarmacadam hardstanding
0.05 / 0.1	1.5 / 5.8	Made Ground	Variable Made Ground comprising soft to firm, dark brown, gravelly clay. Gravel is brick, suspected slag, clinker, timber fragment, concrete and mixed lithologies.
1.5 / 5.8	5.7 / 10.2	Gravel	Yellowish orange brown sandy GRAVEL. Gravel is sub-rounded to well-rounded fine to coarse mixed lithologies. Lynch Hill Gravel
5.7 / 10.2	Unproven	Clay	Firm to stiff silty CLAY. London Clay

3.4.5 The geology across the site comprised Made Ground beneath hardstanding that was a black, sandy gravel with brick, flint and clinker. The Made Ground was underlain by Alluvium, Langley Silt and Lynch Hill Gravels. The investigation did not encounter the London Clay, which is likely to be found at depths greater than 6m bgl. An area of peaty clay was identified in TP3 between 1.70m and 2.75m bgl, this may be part of an alluvial deposit or deposited within the landfill.

3.4.6 By reviewing the logs from various phases of investigation, the Made Ground has been found to vary significantly across the site. The desk study has indicated that the site was historically a landfill with industrial and commercial wastes being placed up to circa 1936. It is considered likely that the landfilling occurred as a result of gravel abstraction which was common place in the surrounding area. The deepest areas of Made Ground were identified within the west and southern parts of the site. In addition, buried obstructions were identified.

3.4.7 The Made Ground was predominantly underlain by Lynch Hill Gravel which was generally a granular material described as a grey, black, orange brown, sandy gravel. Sand was found to be coarse and gravel was angular to sub-rounded flint. However, in some areas cohesive deposits were encountered directly beneath the Made Ground. These were found in areas where shallow Made Ground was present and could have represented materials that were not economically viable to abstract. These cohesive deposits have also been interpreted as Lynch Hill Gravel and were generally described as a brown clayey gravel. Example exploratory holes of where the cohesive Lynch Hill Gravel was encountered include TP4, TP5 and WS02. Typically the granular lenses of the Lynch Hill Gravel were only around 1.8m thick on average.

3.4.8 Records indicate that the area in general has a moderate risk of subsidence hazards as a result of shrinking/swelling of underlying clay.

3.5	Hydrogeology
3.5.1	The Lynch Hill Gravel is classified as a Principal Aquifer of high permeability and the London Clay Formation is classified as an Unproductive Stratum. The previous investigation identified groundwater levels between 1.80mbgl and 4.90mbgl within the Made Ground and Lynch Hill Gravel and identified the direction of flow was generally towards the Yeading Brook/River Crane.
3.5.2	The only potentially significant pathway identified is groundwater flow in the shallow aquifer (Lynch Hill Gravel Member). However, the granular lenses of the Lynch Hill Gravel were only around 1.8m thick on average.
3.5.3	The London Clay was encountered at approximately 5.7m bgl at its shallowest and its base was not encountered (maximum drilled depth of 35m). The thickness of the London Clay is anticipated to be >50m based on third party boreholes obtained from BGS records.
3.5.4	The site is not situated within a Groundwater Source Protection Zone (SPZ).
3.5.5	There is one licensed groundwater abstraction within 1km of the subject site. This is located approximately 530m southeast of the site for evaporative cooling by Virtus Hayes Limited. No potable groundwater abstractions have been identified within 1km.
3.6	Hydrology
3.6.1	The River Crane/Yeading Brook runs southwards through the eastern part of the site. The Grand Union Canal is located 10m south of the site and runs eastwards. No surface water abstractions have been identified within 1km of the site.
3.6.2	The River Crane is considered to be the primary controlled waters receptor for the Bulls Bridge site. Based on site investigation data for the site, it is considered that the groundwater flowing beneath the site will discharge into the River Crane and not pass beyond it. This is on the basis that shallow groundwater levels monitored in boreholes in the vicinity of the River Crane are at a similar level to the river and are constrained from downward flow by the London Clay.
3.6.3	There are three discharge consents within 250m of the site. These relate to records approximately 10m north for miscellaneous discharge to land, 85m south and 95m south of the site from trade discharges to the River Crane/Yeading Brook.
3.7	Unexploded Ordnance (UXO)
3.7.1	Online information indicates that there were several bomb strikes recorded around the site during World War II. As such, a specialist assessment was undertaken by Brimstone Site Investigation Limited and comprised a Stage 2 Detailed UXO Risk Assessment (Dated: 3 July 2019, Ref DRA-19-1105) to identify constraints on the proposal. This has been reported separately and a summary is provided below.

3.7.2 The report reviewed the original London bomb plot maps covering the entire German bombing campaign. The data confirmed the wider study area was bombed on at least eight separate occasions, resulting in 29 large 'iron' bombs and one parachute mine within 500m of the site. One 'iron' bomb strike is located within the site boundary. In addition, no records were made for the first month of the 1940 Blitz and areas of soft landscaping would disguise entry points and be unobserved. As such, there is the potential for more unidentified bombs to be present.

3.7.3 The risk assessment within the report suggests that the construction of the power station may have required deep foundations, and as such UXO could have been encountered and removed. However, in other undeveloped areas of the site, buried German dropped bombs would likely remain in-situ.

3.7.4 The report concluded there was a low to moderate risk from UXO and recommended mitigation measures. The risk mitigation measures included UXO safety awareness briefings, onsite supervision during excavations in the southern part of the site and a magnetometer probe survey if piling is to be implemented.

3.8 Site Specific Soil and Groundwater Contamination

3.8.1 Geochemical testing was completed on samples collected from the Made Ground and natural strata during the investigations. A contaminant of concern layout plan included in Appendix 2 and a summary is presented below.

British Airways

3.8.2 Within the BA plot, the contaminants of concern included:

Table 3. Contaminants of Concern within the BA Plot

Contaminant Type	Contaminant	Location
Soil Contamination	Asbestos	WS3, TP6, WS6A, BH02, and TP201
Soil Vapour	Naphthalene	BH08
Contaminants within Leachate	Metals (Chromium (total), copper, lead, mercury) Polyaromatic hydrocarbons (PAH) (recorded as total PAH, naphthalene, and anthracene) Petroleum hydrocarbons (tested as total petroleum hydrocarbons).	TP208, BH08, BH07, and TP204
Groundwater Contamination	Metals (Copper, nickel) Total Phenols Polyaromatic hydrocarbons (PAH) (recorded as total PAH, anthracene and fluoranthene) Petroleum hydrocarbons (tested as total petroleum hydrocarbons).	WS5, BH08, BH07, and BH02
Groundwater (VOC)	VOC including: Benzene, toluene, ethylbenzene, p & m-Xylene, O-Xylene, isopropylbenzene, 1,3,5-Trimethylbenzene and 1,2,4-Trimethylbenzene.	BH08 and BH02

Vodafone

3.8.3 Within the Vodafone plot, the contaminants of concern included:

Table 4. Contaminants of Concern within the Vodafone Plot

Contaminant Type	Contaminant	Location
Soil Contamination	Asbestos	WS8
Groundwater Contamination	Metals (Nickel) Polyaromatic hydrocarbons (PAH) (recorded as total PAH)	WS7
Gas	Methane and carbon dioxide	WS7

3.9 Phase 2 Ground Investigation Summary

3.9.1 The soil and groundwater samples recovered from the boreholes were submitted for laboratory testing for a range of contaminants in line with the historical uses of the site and findings of the previous investigations.

3.9.2 The results identified asbestos fibres were present within the shallow Made Ground across the site. The extensive hardstanding mitigates risks to site users in the current site layout, however when construction commences and hardstanding is broken out there will be a potential release of fibres to air. As such, careful management of the soils will be required throughout the construction phase to mitigate risks to construction workers and off-site receptors.

3.9.3 The concentrations of Polycyclic Aromatic Hydrocarbons (PAH) and Total Petroleum Hydrocarbons (TPH) within the groundwater exceeded the Environmental Quality Standards (EQS), which were used to assess the risks to the River Crane (considered the most sensitive Controlled Water assessment). As such, additional investigation and remediation is likely to be required as part of the development.

3.9.4 The results from the gas monitoring and vapour analysis have identified slightly elevated concentrations of carbon dioxide and methane, and elevated concentrations of the naphthalene in one location. As such, there is a potential gas and vapour risk.

3.9.5 Geotechnical design parameters for the strata encountered have been provided. The parameters have been derived based on in-situ and ex-situ tests and published empirical relations. Geotechnical testing has included standard classification testing including plasticity index, moisture content, particle size distribution and strength testing including SPTs, undrained unconsolidated triaxial testing and hand shear vane testing. A design groundwater level has also been derived based on groundwater strikes encountered and monitoring results from the current site investigation. DS and ACEC classifications are also provided for the Made Ground and Lynch Hill Gravel Member.

3.9.6 The recorded groundwater strikes and monitoring results appear to show that groundwater flows towards the Grand Union canal and River Crane. A design groundwater level of 29mOD is recommended.

3.9.7	Based on the above, recommendations were made for the following: • Complete a Detailed Quantitative Risk Assessment (DQRA) to understand the risks to the River Crane and provide parameters for remediation purposes; • Consideration of in situ or engineered remediation techniques should the DQRA establish intolerable risks to the surface water courses; • Capping layers in soft landscaped areas; • Gas (methane and carbon dioxide) and vapour resistant membranes within future structures; • Asbestos control measures and materials management; • Personal Protective Equipment; • New pipework; • Piling Works Risk Assessment; • Remediation and Verification reporting; and • Discussion with piling contractors to design a piled foundation solution.
3.10	DQRA Summary
3.10.1	As part of the recommendations from the Phase 2 investigation, a DQRA was undertaken. The findings of the DQRA are summarised below.
3.10.2	Monitoring of surface water in the River Crane has indicated that it is generally free of contamination, with the exception of Ammonia. This was found to be present upstream and downstream of the site, with the concentrations dropping slightly from upstream to downstream. This may indicate that the site is not having a tangible effect on the river.
3.10.3	Groundwater monitoring at the site has indicated that degradation of contamination is taking place, with several lines of evidence supporting this.
3.10.4	Detailed Quantitative Risk Assessment (DQRA) undertaken using the Remedial Targets Methodology has shown that the site does not pose any significant risks to controlled waters (River Crane).
3.10.5	Following the site investigations and DQRA undertaken to date it is considered unlikely that the contamination identified in site soils or groundwater would warrant remediation. Also, due to the presence of high levels of Ammonia already in the River Crane, it is unlikely that any remediation carried out on the Bulls Bridge site would result in a measurable benefit to the River Crane.

3.11	Remediation Strategy Summary
3.11.1	Based on the findings of the Phase 2 and DQRA, a Remediation Strategy was completed. As no significant and grossly contaminated soils or groundwater were limited, the remediation strategy is relatively minor and follows best practice. The report highlighted the need for the following: 1. Site Clearance and Preparation; 2. Maintain a watching brief/discovery strategy throughout the works; 3. Management of asbestos in soil i.e. method statements, personal protective equipment, dust suppression etc.; 4. Provision of a waste management procedure / reuse strategy; 5. Provision of a capping system in areas of soft landscaping; 6. Installation of gas protection measures (CS2); 7. Long term monitoring of groundwater is to be undertaken to ensure that no adverse impacts to the river are caused during development; 8. Piling Works Risk Assessment; 9. Decommissioning of boreholes; 10. Installation of barrier pipework for new water pipes; 11. Concrete foundation design (Made Ground and Lynch Hill Gravel: DS-2 and AC-2 and London Clay: DS-2 and AC-1s); and 12. Provision of a Verification Report.
3.12	Additional Hazards
3.12.1	Based on the foregoing, the following hazards associated with piling at the site have been identified: 1. Minor contamination within the soils; 2. Minor contamination within the groundwater; 3. UXO; 4. Buried obstructions (e.g. relic foundations / structures); 5. Chemical attack on buried concrete; 6. Thames Water Sewer; 7. The River Crane; 8. The Grand Union Canal; and 9. Nearby railway line.
3.12.2	Specific risk assessments such as services identification, access/egress, health and safety and working restrictions has been assessed by the piling contractor within their own method statements.

4.0 PILING DESIGN

4.1 Development Design

4.1.1 The BA plot will comprise the data centre buildings in the centre, water tanks in the northern and western parts of the plot and the energy centre in the southern part of the plot. All buildings are to utilise CFA piling with pile caps or rafts. Further information is provided in section 4.2.

4.1.2 The Vodafone plot will comprise the substation and control room. The control room is to be constructed on stilts and sit above ground.

4.1.3 The development and preferred piling options are different in each development plot. The parties involved are set out in Table 5.

Table 5. Piling Contractors

Development Plot	Developer	Piling contractor
British Airways	Sweet Projects	Central Piling
Vodafone	JSM	ScrewFast Foundations

4.2 Foundation methodology – British Airways Plot

4.2.1 Within the British Airways plot, the preferred piling option is Continuous Flight Auger (CFA) piling. The method statement provided by Central Piling is provided in Appendix 3, and the key points are outlined below. The pile layout plan for the BA plot is shown in Appendix 1.

4.2.2 Piling constraints were identified during the Phase 2 investigation. These included UXO, obstructions within the ground, the presence of the Thames Water sewer, the proximity to the railway and the adjacent River Crane. It is understood that enabling works are to be completed prior to piling to remove the obstructions. In addition, a UXO survey is to be completed using cone penetration testing and a magnetometer. Due to the presence of the Thames Water sewer in the eastern part of the site, a separate sewer impact assessment has been undertaken. Furthermore, a ground movement and slope stability analysis report has been completed to assess the risk to network rail land. This report has been prepared to address the concerns from the Environment Agency.

4.2.3 The permanent piled foundations are formed of 350mm, 450mm and 600mm diameter continuous flight auger (CFA) piles under raft foundations (Water Tank 1 and 2) and pile caps with ground floor slab (data centre buildings 1,2 and 3). The piling works will necessitate the installation of a piling platform with a thickness of about 600mm, drilling and concreting the CFA piles, while the construction of the raft foundation and pile caps will require excavations of up to 2mbgl. The maximum pile depth is 30mbgl.

4.2.4 The proposed development requires the installation of piled foundation in proximity of the railway embankment. The closest piles to the railway (Water Tank 1) are to be installed approximately 12m away from the nearest rail track and 4m from the embankment edge. Excavation works of up to 2mbgl for the construction of the pile caps and ground floor slab will also be required.

4.2.5	The construction sequence in the BA plot includes: 1. Installation of the piling mat; 2. Installation of CFA piles; 3. Removal of the piling mat and excavation to formation level; 4. Construction of the pile caps/raft foundation; and 5. Loads from the structure applied to the piles and transfer to the ground.
4.2.6	The piles are to terminate at a maximum depth of 30mbgl and will therefore pass through the Made Ground and Lynch Hill Gravel, and will terminate within the London Clay Formation.
4.2.7	The Method Statement provided by Central Piling highlights the environmental controls to be in place throughout the works. Due to the presence of the water course (river/canal), the following controls are to be put in place: 1. At no point will the Piling Rig be positioned in such a way that it can surcharge the canal wall. An exclusion zone is to be marked on site. 2. A fence will be emplaced at the canal/river edge to ensure that no personnel or equipment can fall in. Debris netting will be emplaced at a height of 3m along the watercourse edge. 3. Extra vigilance will be taken by the Rig Driver when removing spoil from the auger string with the auger cleaner to ensure that none is flicked over the debris netting. 4. A bund formed from sandbags and polythene is to be established to stop waste water from entering the watercourse at any stage. The method statement indicates the removal of this waste water will be undertaken in a safe and controlled manner to reduce risk of breaching the bund. 5. Spill kits will be kept on the piling rig and near the diesel bowser. Blankets will be used to catch any spillages when refuelling. Refuelling is to take place over areas of hardstanding/spill tray and away from the watercourse. 6. Drip trays will be placed under all static plant, and any spillages will be collected in spill blankets and returned in blue contaminated bags to the contractor's yard for disposal. 7. All contaminated liquids are to be placed into waste oil drums and returned to the contractor's yard for disposal.
4.2.8	Additional controls are set out in the method statement in relation to the Thames Water sewer and the railway. These involve the use of exclusion zones and movement/banksman operations.
4.3	Foundation Methodology – Vodafone Plot
4.3.1	Within the Vodafone plot, a helical foundation solution is to be utilised. The method statement provided by ScrewFast Foundations with example schematics is provided in Appendix 4, and the key points are outlined below. The pile layout plan for the Vodafone plot is shown in Appendix 1.

4.3.2	Constraints identified within the Vodafone plot include the Thames Water Sewer, the presence of a temporary Vodafone mast, the adjacent river and the adjacent canal. It is understood that JSM have consulted with Thames Water and Vodafone. JSM have also consulted with National Grid in relation to establishing the HV Energy Centre. This report has been prepared to address the concerns from the Environment Agency.
4.3.3	The piles are to be installed using a tracked excavator with attachment fitted for screwing in the foundation. The piles are formed of an auger section, a central pile and the pile cap. The installation requires the working area to be excavated to a depth of 300mm below formation level.
4.3.4	The construction sequence in the Vodafone plot includes: 1. Establish a working area; 2. Set out pile locations; 3. Installation of helical piles; 4. Construction of the pile caps; and 5. Loads from the structure applied to the piles and transfer to the ground.
4.3.5	The piles are to terminate at a maximum depth of 10-15mbgl and will therefore pass through the Made Ground and Lynch Hill Gravel, and will terminate within the London Clay Formation.
4.3.6	The Method Statement provided by ScrewFast Foundations highlights the environmental controls to be in place throughout the works: 1. Avoid stock piling of material for long periods as this becomes a desirable habitat for reptiles. 2. A spill kit will be available at all times. 3. All plant used on site will be supplied with drip trays. Drip trays will be used under “static” plant at all times. 4. Only metallic petrol/diesel containers will be used on site and will be stored safely in the works vehicle when not in use. 5. Refuelling (if required) will not be carried out near storm drains or watercourses. 6. All COSHH items shall be stored and disposed of in the correct manner. (Refer to the relevant COSHH sheet/s)
4.4	Piling Mat
4.4.1	The piling mat within the BA plot is to be constructed of 6F2 produced as part of the demolition works. The piling mat within the BA plot is to be formed of a 600mm thickness of 6F2 graded material.
4.4.2	A pile mat is not required within the Vodafone plot.
4.4.3	In the event that the importation of materials is required, these should be scrutinised via provenance and on site testing to ensure that contaminative materials are not being brought to site. Detailed records of volumes and duty of care records should be maintained by the Main Contractor.

4.5	Conceptual Model - Piling
4.5.1	A Conceptual Site Model (CSM) indicating the geology, hydrogeology and details of piling is provided in Appendix 5. This shows a cross section identifying details of the proposed piles, vertical variations in ground conditions, potential pathway linkages and the Controlled Waters receptors.
4.5.2	The key receptor is considered to be the River Crane.

5.0 PILING RISK ASSESSMENT

5.1	Introduction
5.1.1	The intention of the PWRA is to ensure that the proposed piling method will not create new, preferential pathways for the migration of contamination, previously identified at the site, to Controlled Water resources. Other pollution pathways are considered by the PWRA, however, the impact to water resources is the main concern.
5.2	Hazard identification: Potential Adverse Environmental Impacts
5.2.1	The above referenced EA guidance on piling into contaminated sites sets out that the Source–Pathway–Receptor (S-P-R) linkages associated with piling and ground improvement works must be considered in a site-specific context. The guidance indicates that the EA’s response to proposals for piling on contaminated sites will be based on the overall level of risk that piling presents, the techniques, mitigation measures and the quality assurance and control (QA/QC) methods proposed.
5.2.2	Based on the above, a Conceptual Site Model (CSM) has been prepared for the BA and Vodafone plots.
5.3	British Airways CSM
	<u>Sources</u>
5.3.1	Sources of contamination identified in the previous phases of investigation are outlined in Table 3 and in summary included asbestos in soil, soil vapour, soil leachate, and contaminants in groundwater.
5.3.2	Whilst asbestos and soil vapour has been identified as contaminants of concern within the BA plot, they are not considered to have a significant impact on the Controlled Water Receptors. They have therefore been excluded from the assessment. The assessment has therefore focused on elevated concentrations of leachable contaminants within the soil and groundwater contamination.
	<u>Pathways</u>
5.3.3	The piling scheme for the BA plot is to found the CFA piles to a depth of 30m within the London Clay. The piles will pierce through the Made Ground and Lynch Hill Gravels, but will not extend through the base of the London Clay.

Receptors

5.3.4 Receptors include the Lynch Hill Gravel (Principal Aquifer) and the River Crane. The Grand Union Canal is not considered to be a receptor as it is a man made, concrete lined canal.

Plausible Pollutant Linkages

5.3.5 Based on the above, the plausible pollutant linkages have been presented in Table 6 below.

Table 6. Plausible Pollutant Linkages with the BA Plot

Source	Pathway	Receptor	Risk Rating	Comment
Leachable contaminants from soil (Metals including total chromium, copper, lead, mercury, PAH and TPH)	Vertical migration of leachable contaminants from the soil, mobilised by the action of piling.	Principal Aquifer – Lynch Hill Gravel	L	The thickness of the aquifer is limited due to historical gravel extraction at the site. In addition the Lynch Hill Gravel was identified to be predominantly cohesive in nature and therefore not considered to be a significant groundwater resource in this area. Furthermore, the site is not situated in a groundwater source protection zone, and no groundwater abstractions have been identified within 1km of the site.
Leachable contaminants from soil (Metals including total chromium, copper, lead, mercury, PAH and TPH)	Vertical migration of leachable contaminants from the soil, mobilised by the action of piling and lateral migration through the Lynch Hill Gravel.	River Crane	L	The thickness of the aquifer is limited due to historical gravel extraction at the site. In addition the Lynch Hill Gravel was identified to be predominantly cohesive in nature
Groundwater Contamination (Metals including copper and nickel, total phenols, PAH, TPH and VOCs.	Vertical migration of dissolved phase contamination by groundwater flow along a preferential pathway created by piling into the Principal Aquifer (Lynch Hill Gravel).	Principal Aquifer – Lynch Hill Gravel	L	The thickness of the aquifer is limited due to historical gravel extraction at the site. In addition the Lynch Hill Gravel was identified to be predominantly cohesive in nature and therefore not considered to be a significant groundwater resource in this area. Furthermore, the site is not situated in a groundwater source protection zone, and no groundwater abstractions have been identified within 1km of the site.
Groundwater Contamination (Metals including copper and nickel, total phenols, PAH, TPH and VOCs.	Vertical migration of dissolved phase contamination by groundwater flow along a preferential pathway created by piling and lateral migration through the Lynch Hill Gravel and into the River Crane.	River Crane	L	The thickness of the aquifer is limited due to historical gravel extraction at the site. In addition the Lynch Hill Gravel was identified to be predominantly cohesive in nature.

Piling Materials (soluble constituents of concrete)	Lateral migration of soluble piling materials.	Principal Aquifer and River Crane	L	Care to be taken during piling activities.
Potential unidentified contaminants	Vertical and lateral migration of previously unidentified contaminants to the Principal Aquifer and River Crane.	Principal Aquifer and River Crane	L	Based on the investigations completed to date, potential areas of additional contamination are considered to be low.

5.4 Vodafone CSM

Sources

5.4.1 Contaminants of concern identified in the previous phases of investigation are outlined in Table 4 and in summary included asbestos in soil, contaminants in groundwater and ground gas.

5.4.2 Whilst asbestos and ground gas have been identified as contaminants of concern within the Vodafone plot, they are not considered to have a significant impact on the Controlled Water Receptors. These have therefore been excluded from the assessment. The assessment has therefore focused on elevated concentrations of nickel and PAH within the groundwater of WS7.

Pathways

5.4.3 The piling scheme for the Vodafone plot is to found the helical piles to a depth of 10-20m within the London Clay. The piles will pierce through the Made Ground and Lynch Hill Gravels, but will not extend through the base of the London Clay.

Receptors

5.4.4 Receptors include the Lynch Hill Gravel (Principal Aquifer) and the River Crane. The Grand Union Canal is not considered to be a receptor as it is a man made, concrete lined canal.

Plausible Pollutant Linkages

5.4.5 Based on the above, the plausible pollutant linkages have been presented in Table 7 below.

Table 7. Plausible Pollutant Linkages with the Vodafone Plot

Source	Pathway	Receptor	Risk Rating	Comment
Groundwater Contamination (Metals including nickel and PAH including Total PAH)	Vertical migration of dissolved phase contamination by groundwater flow along a preferential pathway created by piling into the Principal Aquifer (Lynch Hill Gravel).	Principal Aquifer – Lynch Hill Gravel	L	The thickness of the aquifer is limited due to historical gravel extraction at the site. In addition the Lynch Hill Gravel was identified to be predominantly cohesive in nature and therefore not considered to be a significant groundwater resource in this area. Furthermore, the site is not situated in a groundwater source protection zone, and no groundwater abstractions have been identified within 1km of the site.
Groundwater Contamination (Metals including nickel and PAH including Total PAH)	Vertical migration of dissolved phase contamination by groundwater flow along a preferential pathway created by piling and lateral migration through the Lynch Hill Gravel and into the River Crane.	River Crane	L	The thickness of the aquifer is limited due to historical gravel extraction at the site. In addition the Lynch Hill Gravel was identified to be predominantly cohesive in nature.
Potential unidentified contaminants	Vertical and lateral migration of previously unidentified contaminants to the Principal Aquifer and River Crane.	Principal Aquifer and River Crane	L	Based on the investigations completed to date, potential areas of additional contamination are considered to be low.

5.5**Hazard Assessment**

5.5.1

This is assessed against the six pollution scenarios, which the EA has identified that are of particular concern. The hazard assessment is included below, in Table 8, in relation to the proposed use of CFA and helical piles.

5.5.2

Table 8: Hazard Assessment

Pollution Scenario	Applicability to site	Risk	Hazard Assessment
1. Creation of preferential pathways through an aquitard to allow potential contamination of an aquifer.	Potential for contaminants within the Made Ground to impact the underlying aquifer.	L	Contaminated Made Ground has been identified at the site. However, the piles will terminate in the London Clay Formation, and will not reach the Chalk aquifers below. Whilst the Made Ground is underlain by the Lynch Hill Gravel, the gravel is not considered to be a significant groundwater resource in this area due to its limited thickness and predominantly cohesive nature. Furthermore, the piling technique will auger contaminated soils to the surface as arisings. The concrete cast during auguring will also seal the potential migration pathway for contaminants.
2. Creation of preferential pathways through a low permeability surface layer, allowing migration of landfill gas, soil gas or contaminant vapours to the surface.	Potential for gas and vapour to reach the surface.	L	The concentrations of gas and vapour within the Made Ground are low and there are no low permeability surface layers that are currently trapping the gases beneath the surface. As such, piling will not change the current conditions onsite.
3. Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface.	Potential for contaminated soil arisings to impact site users	L	Contaminants have been identified onsite. Asbestos was identified within the Made Ground of both BA and Vodafone plots. As such, piling contractors will be required to enforce an appropriate Risk Assessment and Method Statement to protect site workers and others. This is to include the use of personal protective equipment and safe storage and disposal of arisings.
4. Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of materials.	Potential for contaminated soil to impact piles and cause degradation.	L	Concentrations of contaminants are considered to be low and therefore unlikely to cause degradation of materials. Furthermore, the design of the concrete in relation to sulphates is to be in line with recommendations within the Phase 2 ground investigation report.
5. The pushing of solid contaminants down into an aquifer during pile driving.	Pile techniques are to include CFA and helical piles. These are both auguring techniques. As such the likelihood of contaminants being driven into an aquifer is limited.	L	Pile techniques are to include CFA and helical piles. These are both auguring techniques. As such the likelihood of contaminants being driven into an aquifer is limited.

	6. Contamination of groundwater and, subsequently, surface waters by wet concrete, cement paste or grout.	Injection of wet concrete is to take place on the BA plot as part of the CFA process.	L	The thickness of the aquifer is limited due to historical gravel extraction at the site. In addition the Lynch Hill Gravel was identified to be predominantly cohesive in nature and therefore not considered to be a significant groundwater resource in this area. Furthermore, the site is not situated in a groundwater source protection zone, and no potable groundwater abstractions have been identified within 1km of the site.
5.6	Other Hazards			
5.6.1	In relation to UXO, prior to piling, a UXO magnetometer survey is being undertaken.			
5.6.2	In relation to buried obstructions, enabling works are to be undertaken to remove these obstructions.			
5.6.3	In relation to the Thames Water Sewer, as outlined above, a stability assessment has been completed and foundations have been designed over the sewer.			
5.6.4	In relation to the railway, it is understood that Network Rail have been consulted and a separate ground stability assessment has been completed.			

6.0 CONCLUSIONS

6.1	Conclusions
6.1.1	The use of shallow foundations is not an option for the site due to the nature of the underlying ground conditions with a significant thickness of Made Ground and the structural loadings imposed by the building.
6.1.2	The hazard assessment in Table 8 has identified that a low environmental risk exists from the potential for piling to create a preferential pathway for any contaminants to migrate downwards to the underlying sensitive aquifers, and a low risk for gases to migrate upwards.
6.1.3	Furthermore, the hazard assessment has identified a low risk of pile degradation due to the soil environment provided, and appropriate concrete mix used for the site. Whilst the technique will bring potentially contaminated materials to the surface, site workers will be protected by employing the use of PPE, as stated above. Pile arisings will be subject to testing (as appropriate) and management for off-site disposal in line with the waste producer's management plans. Duty of Care records will be maintained for all arisings destined for off-site disposal.
6.1.4	Quality Assurance and Quality Control methods will also be completed by the piling contractor whilst on site to enable workmanship to be closely monitored.

London

The Harlequin Building
65 Southwark Street
London SE1 0HR
T: +44 (0)20 7125 0112

Edinburgh

9 Alva Street
Edinburgh
EH2 4PH
T: +44 (0)131 300 0070

Manchester

Fretrade Exchange
37 Peter Street
Manchester M2 5GB
T: +44 (0)161 260 0500

Bristol

Unit 1 Temple Studios
Temple Gate
Bristol BS1 6QA
T: +44 (0)117 301 7800

Esher

Warwick House
1 Claremont Lane
Esher, Surrey KT10 9DP
T: +44 (0)1372 469 985

Paragon is a trading name of Paragon Building Consultancy Limited.
Paragon Building Consultancy Limited is a limited company.
Registered in England and Wales No. 08482471. Registered Office:
The Harlequin Building, 65 Southwark Street, London, SE1 0HR

**para
gon**