Piling Works Risk Assessment

Former Abellio Bus Garage
North Hyde Gardens,
Hayes,
UB3 4QQ

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

Issue Date: 18 October 2022
Revision No:
Revision Date:

Business

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Date:	18 October 2022
Reference:	21.1423/CB/LC
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For and on behalf of
Paragon Building Consultancy Limited

CONTENTS

PILING WORKS RISK ASSESSMENT

CLIENT NAME: Ark Data Centres Limited

PROPERTY ADDRESS: Former Abellio Bus Garage
North Hyde Gardens,
Hayes,
UB3 4QQ

INSPECTION DATE: N/A

1.0 INSTRUCTIONS AND SCOPE OF WORKS

1.1	**Scope of Work**
1.1.1	Paragon, a Colliers Company (Paragon) has been instructed by Concert on behalf of Ark Data Centres Limited to complete a Piling Works Risk Assessment (PWRA) for a site referred to as the Former Abellio Bus Garage, 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: 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.
1.1.2	This assessment has been completed in connection with the redevelopment of the wider site into a data centre. For the avoidance of doubt, this report relates to Energy Centre 2 which is situated in the Former Abello Plot only, and the wider development already has a PWRA.

1.1.3	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'.
1.1.4	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).
1.1.5	The requirements of the Remediation Strategy completed for the wider development have also been considered.

2.0 INTRODUCTION

2.1	**Site Location and Description**
2.1.1	The site is located at the Former Abellio Bus Garage, North Hyde Gardens, Hayes, UB3 4QQ.
2.1.2	The Former Abellio plot is situated in the southern part of the wider development and extends to roughly 0.47Ha.
2.1.3	The Former Abellio plot is surrounded by North Hyde Gardens to the north with the former British Airways (BA) plot beyond. In addition, the former Vodafone plot is situated to the east, the Grand Union Canal is situated to the south and the North Hyde Gardens bridge is situated to the west. The BA and Vodafone buildings have been demolished and are undergoing redevelopment as part of the wider scheme.
2.1.4	There is a Thames Water sewer which runs along the eastern boundary of the Abellio plot at a depth of ca. 12m below ground level (mbgl).
2.2	**Proposed Development**
2.2.1	The plot is to be redeveloped into an Energy Centre, which is known as EC2 for the wider development.
2.2.2	A site plan showing the proposed development is shown in Appendix 1.
2.3	**Planning Conditions**
2.3.1	The planning application for the wider development is application ref. 75111/APP/2020/1955. It should be noted that the original application had a pre-commencement condition for a Piling Method Statement (condition 32). This has been completed for the BA and Vodafone plots.

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*".
2.3.3	The Local Authority has provided a partial discharge notice under application 75111/APP/2021/1506, which states "the details required to discharge Condition 32 in relation to the Abellio Site are outstanding".
2.3.4	As such, this report aims to meet the requirements of Condition 32 for the Abellio Plot/EC2.
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 D, Revised November 2021 (for planning purposes). • Paragon (2020) Phase 2 Ground Investigation Report, ref 20.0023, dated 6 March 2020 – Rev D, Revised November 2021 (for planning purposes). • Paragon (2020) Detailed Quantitative Risk Assessment (DQRA), ref 20.0023/CK/KJH dated 10 July 2020 – Rev C, Revised November 2021 (for planning purposes). • Paragon (2020) Remediation Strategy, ref 20.0023/CK/DCN dated 17 March 2020 – Rev E, Revised November 2021 (for planning purposes). • Paragon (2020) Phase 1 Environmental Audit, ref 20.0054/CB/DCN, dated 27 February 2020. • Paragon (2021) Phase 2 Ground Investigation Report (for Abellio Bus Garage), ref 21.1177/CB/NW, dated 5 November 2021 – Rev A. • Paragon (2021) Abellio Bus Garage, Unexploded Ordnance Survey Letter Report, ref 21.2244/CB/KJH, dated 17 February 2022.

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 approximately at National Grid Reference: 510435, 179211, and extends to 0.47Ha. The approximate elevation of the site is 31m Above Ordnance Datum (mAOD).
3.2.2	At the time of the investigation, the Abellio plot comprised a warehouse used as a bus garage with associated two-storey office area operated by Abellio. The warehouse had an internal car wash and repair garage. There was a small Petrol Filling Station at the site entrance and this was fed by an above ground diesel storage tank (AST). The pipework was observed to run above ground. In addition, an Ad-Blue tank and pump was situated at the entrance to the site. These have since been disconnected and removed from the site.
3.2.3	The site has multiple parking areas for the site staff and buses in the central and eastern part of the site. The hardstanding at the site comprises of concrete and tarmac. There was some residual staining on the ground surface which has been assumed to be from leaks from parked buses.
3.2.4	There is a small service yard to the rear of the building in the western part of the site. Two small waste oil tanks (both ASTs) were observed to be present within this area. During drilling, a spill had occurred in this area and spill kits were placed on the ground surface to contain the oil.
3.2.5	The Grand Union Canal is a manmade canal, situated 5m to the south of the plot.
3.3	**Historical Land Use**
3.3.1	The site formed open land from as early as 1868 until around 1935, where the site was part of a creosoting works, which extended offsite into the land to the north and east. By 1963, the site was shown as a pond, with embankments which were considered to be likely to be due to infilling activities. By 1982, the site was shown as being levelled but undeveloped. The current layout was shown by 2010.
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 (269 and 270), the geology of the subject site is reported to comprise mostly of the Lynch Hill Gravel underlain by the London Clay Formation. The Langley Silt superficial deposits reportedly cover the south-western part of the site (yard at the rear of the building). The mapping also shows Artificial Ground and Alluvium within 75m of the site.
3.4.2	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.
3.4.3	The ground conditions found during the investigation are presented in Table 1.

3.4.4 ***Table 1. Summary of Ground Conditions found during the 2021 Investigation***

Depth From (min/max) (m)	Depth To (min/max) (m)	Soil Type	Description	Notes
0.0	0.05 / 0.20	Tarmacadam / Topsoil	Tarmacadam hardstanding / topsoil	
0.05 / 0.20	3.50 / >5m	Made Ground	Variable Made Ground comprising very loose to medium dense brown and black sandy gravel. Gravel is concrete, brick, flint, glass, clinker, tile and mixed lithologies.	Concrete obstructions were encountered in WS01, WS01a-b and WS03 from depths between 0.20mbgl and 0.45mbgl.
3.50 / 4.50	4.80 / 5.00	Clay	Soft grey and black gravelly peaty clay. Gravel is mixed lithologies. Alluvium	Encountered in BH01 and WS05.
4.80	>5	Gravel	Medium dense, orange and brown sandy gravel. Gravel is flint. Lynch Hill Gravel Member	Only encountered in WS05.
5.00	7.50	Clay	Soft to firm brown, blue and grey clay. Weathered London Clay	Only encountered in BH01.
7.50	>35	Clay	Firm to stiff brown, blue and grey clay with selenite crystals. Weathered London Clay	Only encountered in BH01.

3.5 Hydrogeology

3.5.1 The Lynch Hill Gravel is classified as a Principal Aquifer of high permeability, while the Langley Silt Member is classified as a Secondary (A) Aquifer, and the London Clay Formation is classified as Unproductive Stratum.

3.5.2 The site is not located within Groundwater Source Protection Zone (SPZ).

3.5.3 There is one groundwater abstraction within a 1km radius which is approximately 530m southeast of the site and is used for evaporative cooling.

3.6 Hydrology

3.6.1 Grand Union Canal is located directly south of the site, and the River Crane is located approximately 75m to the east of the site. No surface water abstractions have been identified within 1km of the site.

3.6.2	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 indicated that there were several bomb strikes recorded around the site located adjacent to the north 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.
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. No bomb strikes were recorded 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 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 and a magnetometer probe survey if piling is to be implemented.
3.7.4	Brimstone were present during the investigation and identified an anomaly in one location. As such, it was recommended that this area was excavated to inspect the anomaly in case it was UXO. Paragon has previously prepared a report which states that it was a metal chain and no UXO was identified.
3.8	**Phase 2 Ground Investigation Summary**
3.8.1	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.
3.8.2	A Geoenvironmental Risk Assessment was carried out on the chemical laboratory test data and a revised Conceptual Site Model was presented. Chemical test data found that the concentrations of contaminants testing within the Made Ground and natural soil were below the Generic Assessment Criteria (GAC) for a commercial land use. However, asbestos was encountered in two locations and was quantified at <0.001%.
3.8.3	The results of the groundwater analysis found marginal exceedances of the Environmental Quality Standards for PAH and Heavy Metals. Nevertheless, the exceedances were marginal and no gross contamination was encountered. Therefore, the risk to Controlled Waters was considered to be low.
3.8.4	Three rounds of gas monitoring were completed as part of this investigation and the results identified that the elevated levels of carbon dioxide and methane. Based on a preliminary assessment using BS 8485:2015+A1:2019 '*Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*', the site falls within Characteristic Situation (CS) 2, whereby gas protection measures are required.

3.8.5	The report concluded that the concentrations of contaminants within soil and groundwater are considered to be suitable for the proposed end use of the development, and no further remediation is required. Nevertheless, recommendations were made for the following: • Capping layers in soft landscaped areas; • Gas (methane and carbon dioxide) and vapour resistant membranes within future enclosed structures; • Asbestos control measures and materials management; • Personal Protective Equipment; and • Remediation and Verification reporting.
3.8.6	Geotechnical design parameters for the strata encountered were provided within the report. The parameters were 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, strength testing including SPTs, and undrained unconsolidated triaxial testing. A design groundwater level was 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.
3.8.7	In summary, given the thickness and variability of the Made Ground and existing obstructions, shallow foundations were not recommended. As such, piled foundations were recommended. It was also recommended that floor slabs should be suspended.
3.8.8	The recorded groundwater strikes and monitoring results appear to show that groundwater flows towards the Grand Union canal and River Crane/Yeading Brook. A design groundwater level of 29.50mOD is recommended.
3.9	**Detailed Quantitative Risk Assessment (DQRA) Summary**
3.9.1	A Detailed Quantitative Risk Assessment was completed for the wider development due to the nature of the contamination identified in the former BA plot. The report identified that the wider development site does not pose any significant risks to Controlled Waters (the River Crane). Furthermore, as no significant risks to Controlled Waters was identified from the investigation on the Abellio plot, no further works are required.

3.10	**Remediation Strategy Summary**
3.10.1	Based on the findings of the original investigation for the BA and Vodafone plots, 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: • Site Clearance and Preparation; • Maintain a watching brief/discovery strategy throughout the works; • Management of asbestos in soil i.e. method statements, personal protective equipment, dust suppression etc.; • Provision of a waste management procedure / reuse strategy; • Provision of a capping system in areas of soft landscaping; • Installation of gas protection measures (CS2); • Long term monitoring of groundwater is to be undertaken to ensure that no adverse impacts to the river are caused during development; • Piling Works Risk Assessment; • Decommissioning of boreholes; • Installation of barrier pipework for new water pipes; • Concrete foundation design (Made Ground and Lynch Hill Gravel: DS-2 and AC-2 and London Clay: DS-2 and AC-1s); and • Provision of a Verification Report.
3.10.2	As no significant contamination was encountered during the investigation on the Abellio plot, no formal remediation strategy was required for that plot. Instead the recommendations within the report were to be followed which include: • Capping layers in soft landscaped areas; • Gas (methane and carbon dioxide) and vapour resistant membranes within future enclosed structures; • Asbestos control measures and materials management; • Personal Protective Equipment; and • Remediation and Verification reporting.
3.10.3	Documentation stating the above has been completed is to be provided by the developer to Paragon so that a verification report can be submitted.

3.11	**Additional Hazards**
3.11.1	Based on the foregoing, the following hazards associated with piling at the site have been identified: 1. Made Ground; 2. UXO; 3. Buried obstructions (e.g. relic foundations / structures); 4. Chemical attack on buried concrete; 5. Thames Water Sewer; and 6. The Grand Union Canal.
3.11.2	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	**Foundation Methodology**
4.1.1	The Abellio plot is to be redeveloped into an energy centre (known as EC2). The building will be supported on 149 no. Continual Helical Piles (CHD) at 400/700mm diameter. The piling is to be completed by Roger Bullivant, and their method statement is presented in Appendix 2. In addition, the pile layout plans for the plot are shown in Appendix 1.
4.1.2	Piling constraints were identified during the Phase 2 investigation. These included the potential for UXO, obstructions within the Made Ground, and the presence of the Thames Water sewer.
4.1.3	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. In addition, a sewer impact assessment was completed for the wider development.
4.1.4	The construction sequence in the Abellio plot includes: 1. Installation of the piling mat; 2. Installation of CHD 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.
4.1.5	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.

4.1.6	The Method Statement provided by Roger Bullivant highlights the following environmental controls to be in place throughout the works: 1. Noise: a. All piling works will be done in normal working hours (08.00 – 18.00), any works done outside these hours will be authorised by the principle contractor. b. P.P.E will be issued and worn by all working in the vicinity of the machine in line with the warning signs posted on the machine. 2. Vibration: a. Vibration can be monitored if requested, if vibration is causing or suspected of causing damage to the railway or infrastructure, work will stop until a seismograph is on site to measure the levels of vibration from the piling operation. 3. Refuelling and storage of fuel a. All fuel will be stored in double bunded bowsers with the bund capable of storing 125% of the bowser capacity, the bund is enclosed so rainwater will not be able to collect. b. All fuel stored on site will be stored at least 10m from any drain and 50m from any open hole. c. All refuelling of plant will be done using a pump, with spill kits at the point of refuelling, no pouring from buckets or containers will be permitted. 4. Spoil and muck away a. This method of piling has been selected because it does not generate spoil, the ground been identified as contaminated so the risk of contaminated spoil being moved on and off site has been negated. 5. Contaminated Spoil a. Although the piling method does not generate spoil, all personnel will wear P.P.E at all times, no consumption of food will be done on site and the need for washing of hands must be emphasised.
4.2	**Piling Mat**
4.2.1	A pile mat is anticipated to be used as part of the piling methodology. It is suggested that the piling mat is to be formed of 6F2 graded material.
4.2.2	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.

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 receptors. 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 Abellio plot.
5.3	**Conceptual Site Model**
	<u>Sources</u>
5.3.1	Few sources of contamination were identified during the ground investigation. In summary, the results of the soil analysis found the concentrations of contaminants within the soils were below the criteria for a commercial land use. As such, no specific remediation was required. Whilst asbestos was noted within the Made Ground, it was quantified at <0.001% (i.e. the limit of detection) and is therefore not considered to be a significant risk. Ground gas was also identified albeit at low levels. Furthermore, the results of the groundwater analysis found marginal exceedances of the Environmental Quality Standards for PAH and Heavy Metals. Despite this, the exceedances were marginal and no gross contamination was encountered. Therefore, the risk to Controlled Waters was considered to be low.
5.3.2	Based on the foregoing no significant contamination has been identified at the site.
	<u>Pathways</u>
5.3.3	The piling scheme for the Abellio plot is to found the CHD piles to a maximum 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.
5.3.4	Whilst there is the potential for groundwater migration to occur within the Lynch Hill Gravel, no significant contamination has been identified.
	<u>Receptors</u>
5.3.5	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

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

5.3.7 ***Table 2. Plausible Pollutant Linkages with the BA Plot***

Source	Pathway	Receptor	Risk Rating	Comment
Leachable contaminants from soil	Vertical migration of leachable contaminants from the soil, mobilised by the action of piling.	Principal Aquifer – Lynch Hill Gravel	L	No gross contamination has been identified. In addition, the thickness of the aquifer is limited due to historical gravel extraction at the site and it is 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.
	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	No gross contamination has been identified. 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	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	No gross contamination has been identified In addition, the thickness of the aquifer is limited due to historical gravel extraction at the site and it is 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.
	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	No gross contamination has been identified. 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	Whilst unlikely to present a significant risk, care is 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 Hazard Assessment

5.4.1 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 3, in relation to the proposed use of CHD and helical piles.

5.4.2 ***Table 3: 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 not been identified at the site to date. In addition, 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.
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	Significant volumes of arisings are not anticipated. Furthermore, gross contaminated soils have not been identified. However, low levels of asbestos were identified. 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 or personal protective equipment.
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 CHD.	L	Pile techniques are to include CHD piles which is an auguring technique. As such, the likelihood of contaminants being driven into an aquifer is limited.

5.4.3 ***Table 3: Hazard Assessment (continued)***

Pollution Scenario	Applicability to site	Risk	Hazard Assessment
6. Contamination of groundwater and, subsequently, surface waters by wet concrete, cement paste or grout.	Injection of wet concrete is to take place.	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.

5.5 Other Hazards

5.5.1 In relation to UXO, prior to piling, a UXO magnetometer survey is recommended to be undertaken.

5.5.2 In relation to buried obstructions, enabling works are to be undertaken to remove these obstructions.

5.5.3 In relation to the Thames Water Sewer, as outlined above, a stability assessment has previously 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 energy centre.

6.1.2 The hazard assessment in Table 2 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.