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2 VALE ROAD, NORTHFLEET

PILING RISK ASSESSMENT





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Revision and Date	Amendment Details	Revision Author	Revision Reviewer





1.0 INTRODUCTION

- 1.1 Lustre Consulting Limited (Lustre) has been commissioned by BRT Properties Ltd to undertake a Piling Risk Assessment for the proposed redevelopment of a site located off Vale Road, Northfleet, Kent.
- 1.2 The subject site, irregular in plan, is centered at National Grid Reference 562810, 173609, and occupies an approximate area of 0.2 ha, as shown in Figure 1. The subject site is currently disused and has been cleared of all former building infrastructure. It is situated along the eastern boundary of a larger site area owned by BRT Properties; the majority of the wider site area is also disused and has been cleared of building infrastructure.

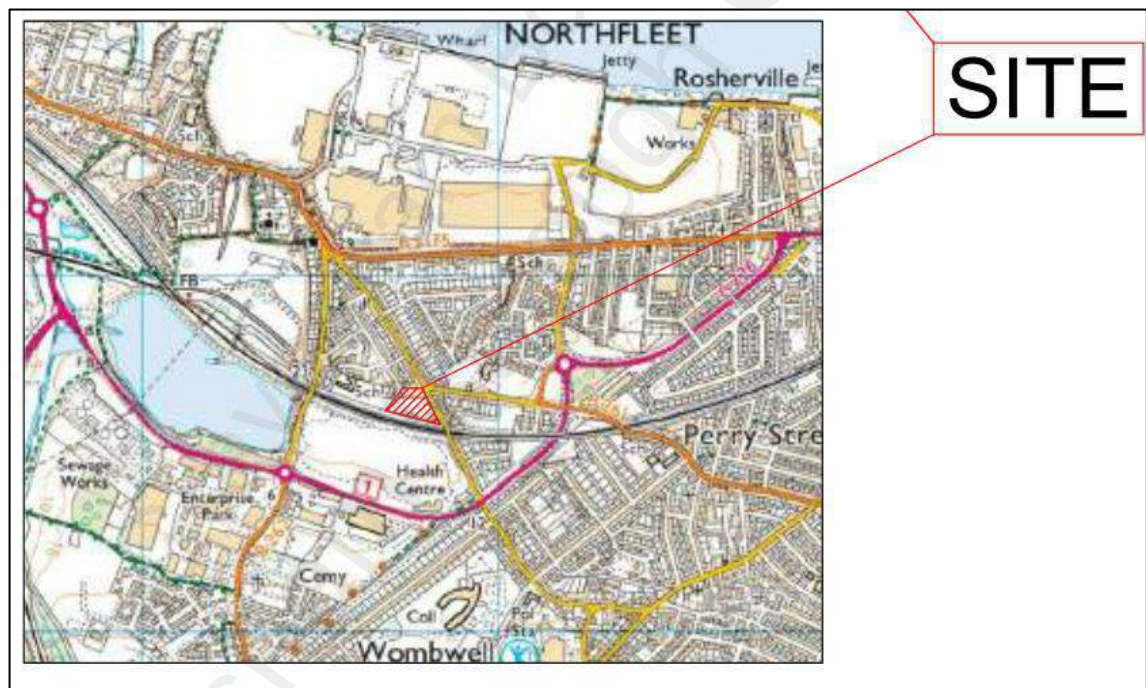


Figure 1: Extract from Desk Study Assessment Report undertaken by Brownfield Solutions Ltd showing wider site area owned by BRT Properties hashed in red

- 1.3 Planning permission has been granted with conditions (ref: 20190727) by Gravesham Borough Council for the redevelopment of the subject site to comprise *'Erection of a two-storey building within rooms in the roof space to provide 10 x two bedroom self-contained flats with associated access, car parking and amenity space.'* Soft landscaped areas include soft verges, communal gardens and park / public play areas; no private gardens are proposed. Figure 2 illustrates the proposed development scheme





Objective

1.4 This Piling Risk Assessment has been prepared, in line with Planning Condition 18, to assess the potential risks posed to controlled waters during construction phase works. The risk assessment gives consideration to:

- the potential creation of preferential pathways allowing contaminants within the infilled Made Ground to migrate downwards into the underlying, sensitive chalk aquifer;
- the potential for contaminated soils to be driven/mobilised downwards into the underlying aquifer; and
- the potential for contaminated arisings being brought to the site surface.



- 1.5 This Piling Risk Assessment has been prepared in accordance with current legislation, the Water Resources Act 1991 and the Groundwater Regulations 2009 and makes particular reference for the protection of Controlled Waters. This document also acknowledges the responsibilities of the developer as stated in Planning Policy Statement 23. The Piling Risk Assessment has also been prepared taking into consideration recommendations set out in the Environment Agency Report 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention'¹.
- 1.6 This report should be read in conjunction with the following assessments:
- Desk Study Assessment Report by Brownfield Solutions Ltd (reference BM/C3476/6655) dated February 2017;
 - Geo-Environmental Assessment Report by Brownfield Solutions Ltd (reference PD/C3476/8382 Rev A) dated June 2019;
 - Supplementary Phase 2 Site Investigation Report by Lustre Consulting (reference 3869 - 210913 – ML, dated October 2021; and
 - Remediation Strategy Report by Lustre Consulting (reference 3869 - 210916 - ML) dated October 2021.
- 1.7 These reports have considered risk to receptors in the context of the proposed development and have been used to generate a conceptual site model which is summarised in Chapter 2.

¹ Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention. National Groundwater and Contaminated Land Centre Report NC/99/73, Environment Agency 2001.





2.0 CONCEPTUAL SITE MODEL

Introduction

- 2.1 The conceptual model was developed and refined through the three phases of site investigation (Desk Study, Phase 2 Site Investigation and Supplementary Phase 2 Site Investigation) undertaken between 2017 and 2021. The key elements are detailed below.

Former Site Uses and Potential for Contamination

- 2.2 At the time of writing, the site is disused and all former above ground infrastructure has been cleared from the site. Former site uses identified during the Phase 1 Desk Study were allotments, a chalk pit (subsequently infilled), a garage / Petrol Filling Station (PFS) that included underground storage tanks (USTs) and use of the site for vehicle storage
- 2.3 Potential onsite sources of contamination were identified by Phase 1 Desk Study which included underground storage tanks, infill materials, and Made Ground associated with previous construction works. Offsite sources included railway land, infilled chalk pits, a historical landfill, garages, a power station and various works.

Investigation of USTs

- 3.1 The site investigation identified that USTs were present outside of the subject site boundary. Only the associated pipework between tanks and former fuel pumps is located within the subject site boundary.
- 3.2 The tanks were observed to be in good condition with no evidence of hydrocarbon contamination within surrounding soils. Laboratory data and assessment (soils and leachate) demonstrate that there is no risk to either human health or groundwater quality for hydrocarbons associated with the soils around the USTs.

Geology, Hydrology and Hydrogeology

- 2.4 Site investigation works identified that ground cover at the site comprised a mixture of asphalt and concrete. This was underlain by Made Ground which varied considerably in depth ranging from 0.4m to 18.8m bgl.





- 2.5 Made Ground comprised a mixture of cohesive and granular material. Anthropogenic materials included brick, concrete, metal and glass. In addition, within the majority of investigation locations inclusions of ash, clinker and organic deposits were limited and localised. Deeper ash deposits were, however, recorded at one location (BH201) in the northwest of the site.
- 2.6 Along the eastern boundary of the site Made Ground was noted to be limited in thickness and was underlain by a thin layer of superficial deposits. This area of the site was considered to be outside the area formerly used as a chalk pit and then subsequently infilled.
- 2.7 Chalk was encountered beneath either the Made Ground or superficial deposits and remained unproven at the base.
- 2.8 Groundwater was recorded within the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated at a depth of 20.15m bgl (2.52 m AOD). No evidence of perched groundwater was recorded within the Made Ground.
- 2.9 As groundwater was only encountered in a single borehole location flow direction was not able to be determined. However, based on surrounding topography groundwater flow is thought to be towards the north / northwest.
- 2.10 The site is located within a groundwater Source Protection Zone (SPZ) - Zone 1 (Inner Catchment). The Environment Agency classifies the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) as a Principal Aquifer.

Geochemistry

- 2.11 Testing of the soil and groundwater was carried out during the two phases of intrusive ground investigation. The key elements are summarized below.

Soils

- 2.12 Chemical assessments of soils identified the presence of asbestos fibres, as well as elevated concentrations of lead, polyaromatic hydrocarbons (PAHs) and total petroleum hydrocarbons (TPHs). PAHs and TPHs were identified to be associated with shallow asphalt impacted soils whereas lead was encountered within deeper fill materials. Coal tar was also identified as being present within asphalt surfacing materials. There was no indication, however, of volatile contamination as PID readings remained low and elevated concentrations of volatile and semi-volatile organic compounds (VOC / SVOC) compounds were not identified.





2.13 A separate buried concrete assessment was also undertaken during the initial Phase 2 Investigation. This included laboratory assessment for pH and sulphate testing within 13 samples of made ground and 2 samples of chalk bedrock.

- Made Ground - The data set had over ten results and as such the mean of the highest 20% of the test results has been taken as the characteristic value which is 1.593g/l. The characteristic value of the lowest 20% of the pH of the samples is 8.07.
- Chalk - The data set had between less than five results and as such the highest sulphate value and lowest pH value were taken as characteristic values. The characteristic value for soluble sulphate is 0.33g4/l and the pH is 8.5.
- The site is underlain by impermeable deposits therefore the groundwater has been classified as static.

2.14 Overall, the results of laboratory pH and sulphate content indicate that ACEC Class AC-2s and sulphate class DS-3 conditions prevail in accordance with BRE Special Digest 1 "Concrete in aggressive ground" 2005. The specific concrete mixes (the Design Concrete Class) to be used on site will be determined by the site specific concrete requirements in terms of the durability and structural performance. These are assessed in terms of the Structural Performance Level (SPL) and any need for Additional Protective Measures (APM) detailed in Part D of BRE Special Digest 1 with further guidance in Pt E and F.

Leachate and Perched Groundwater

2.15 Four samples of Made Ground from BH201 underwent leachate testing. Samples were selected to target Made Ground which contained high proportions of anthropogenic materials as well as soils in close proximity to groundwater.

2.16 Samples underwent 10:1 leachate preparation followed by chemical analysis for the following determinands pH, inorganics and metals, BTEX, TPH, PAH and SVOCs. The water quality risk assessment adopted in this review is based on the conceptual model of the site and the potential use of, and risks to, controlled waters. The water quality standards have been implemented in the following hierarchy: UK DWS then EQS FW and then WHO DWS.

2.17 The assessment identified that the following determinands pose a potential risk to groundwater quality:

- Lead (UK DWS 10µg/l) in two samples from BH201 as follows 11.0-11.1m bgl at 17µg/l and 17.0-17.1m bgl at 25µg/l;





- Nickel (UK EQS Freshwater 1 µg/l) in all four samples from BH201 concentrations ranged from 2.4 to 8.4 µg/l; the maximum concentration was identified in two samples taken at a depth of 17-17.1m bgl and 18.5-18.6m bgl; and
- Zinc (UK EQS Freshwater 75 µg/l) in two samples from BH201 as follows 17-17.1m bgl at 92 µg/l and 18.5-18.6m bgl at 110 µg/l.

2.18 No evidence of leachable concentrations of TPH, BTEX, PAH or SVOCs was identified in any of the soil samples collected from BH201; all results were recorded as less than limited of detection (<LOD).

2.19 In summary, leachate analysis has identified that metals have the potential to be liberated from Made Ground within BH201 at concentrations with potential to impact groundwater quality. Further consideration of the risk to controlled waters from onsite soil contamination is therefore required (as set out below).

Groundwater within the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation

2.20 Groundwater samples were collected on two occasions from BH201 which was screened within the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation and analysed for a range of contaminants. BH201 is located within the northwest area of the site and is considered to be down-gradient of the proposed building.

2.21 Of the contaminants analysed for the majority were recorded below laboratory detection limits. Where concentrations exceeded laboratory detection limits they were remained below the UK DWS.

2.22 Minor elevations of two metals, nickel and boron, were identified above one of their respective water quality standards (UK EQS Freshwater for nickel and WHO for boron). It is noted that groundwater at the site is sensitive due to its abstraction / use as potable water and therefore the DWS are considered the most relevant WQS. Given that this groundwater aquifer is locally unlikely to support freshwater environments, the presence of nickel above the EQS FW criteria is not considered a concern. Also, the presence of boron above the WHO criteria is not considered an issue as this is likely naturally occurring boron loading of the dissolved phase within the chalk aquifer.





Controlled Waters Risk Summary

- 2.23 The groundwater risk assessment has demonstrated that the infilled ground in its current state is not giving rise to a significant deterioration in groundwater quality. Considering that the groundwater data recovered demonstrates lower concentrations of contaminants than the leachate assessment, this supports the observation that the existing site conditions, which largely prevents infiltration of surface water, is assisting in preventing the deterioration of groundwater quality





3.0 PILING RISK ASSESSMENT

Pile Type and Method

- 3.1 A preliminary foundation design was undertaken by Brownfield Solutions Ltd as part of their Geo-environmental Assessment Report. This identified that shallow foundations were not considered feasible and that a piled foundation solution would be required. It was considered that CFA piles were likely to be the most suitable given the site's location within a residential and commercial land use setting. In addition, an indicative pile layout design has been prepared by Considine Structural Engineers. These are shown on drawings 3474-CON-01-00-DR-S-0001, 3474-CON-01-00-DR-S-0002 and 3474-CON-01-00-DR-S-0100.
- 3.2 A detailed pile design will be undertaken by a specialist pile contractor prior to the construction phase of works.

Piling Risk Assessment

- 3.3 Six possible pollution scenarios are identified and described by the Environment Agency, representing situations where there is potential that piling operations could cause pollution:
1. Creation of preferential pathways, through a low permeability layer to allow potential contamination of an underlying aquifer;
 2. Creation of preferential pathways, through a low permeability surface layer, to allow upward migration of landfill gas, soil gas or contaminant vapours to the surface;
 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 with contaminated soil or leachate causing degradation of pile materials;
 5. The driving of solid contaminants down into an aquifer during piling; and
 6. Contamination of groundwater and subsequently surface water by concrete, cement paste or grout.
- 3.4 Based on the proposed pile design, the depth of the fill material encountered across the area of the site where the building will be situated, the presence of elevated PAHs, TPHs, lead and





asbestos within this material and the presence of leachable properties identified for metals, the following pollution scenarios are considered to be potentially viable:

- The creation of a preferential pathway allowing contaminated leachates (from the Made Ground) to migrate downwards into the underlying Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated).
- Contaminated arisings brought to the surface by piling work, with risks of exposure to site workers and construction workers.
- Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials.
- Contamination of groundwater by concrete, cement paste or grout.

- 3.5 The creation of a preferential pathway allowing contaminated perched groundwater within the Fill Material to migrate downwards into the underlying chalk aquifer has been discounted based on the absence of groundwater identified within Made Ground during site investigation works and return monitoring visits.
- 3.6 The creation of preferential pathways, through a low permeability surface layer, to allow upward migration of landfill gas, soil gas or contaminant vapours to the surface; is not considered to be viable as the Phase 2 Site Investigation and ground gas monitoring by Brownfield Solutions Ltd has determined that there are no elevated concentrations of ground gases or vapours beneath the site which could be disturbed by the piling process.
- 3.7 The driving of solid contaminants down into the aquifer during piling has also been discounted as the proposed piling method will involve the extraction of the soils prior to the placing the piles, with limited potential for the drag down of soils.
- 3.8 A qualitative risk assessment, using a combination of the likelihood of a pollution event to occur (taking account of the presence of a hazard and integrity of a pathway) versus the consequence of a pollution occurrence has been formulated to assess each of the potential adverse environmental impacts in turn. The risk assessment, summarised in Table 1, is based on the suggested approach set out in the available guidance



Table 1: Foundation Works Risk Assessment

Adverse Environmental Impact	Receptor	Likelihood of Occurrence	Consequence (severity)	Potential Risk
Creation of preferential pathway, allowing contaminated leachates from the soils to migrate downwards into the underlying Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated). A risk has been identified as fill material comprises elevated concentrations of lead, PAH and TPH and pile depths are likely to penetrate beneath the groundwater table. However, leachate assessment undertaken on fill materials identified that with the exception of lead, contaminants within the fill were not readily leachable at concentrations that would pose a risk to groundwater. In addition, while Lead, was identified as posing a risk to groundwater, the concentration was noted to be only marginally in excess of UK DWS standard. Based on this it is considered that contaminants within the fill material have limited potential to negatively impact groundwater quality within the chalk aquifer. The proposed CFA piling methods are therefore considered sufficient to minimise the risk of creating a preferential pathway.	Principal Aquifer (Chalk)	Unlikely	Medium	Low
Contaminated soil arisings and groundwater brought to the surface by piling work, with risks of exposure to site workers and construction workers. Contamination limited to Made Ground only. Arisings to be segregated into separate stockpiles to aid handling and minimise mixing of contaminated and clean soils. All contaminated arisings to be disposed offsite to a suitably licensed landfill. Use of appropriate personal protection equipment (PPE) and an awareness of the potential risks would lower the risk to acceptably low levels. All contractors to be made aware of the potential for ACM to be encountered within the fill and appropriate measures taken to prevent the release of air borne fibres.	Site Workers	Low Likelihood	Medium	Moderate/Low
	Construction workers	Low Likelihood	Medium	Moderate/Low
Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials. Elevated concentrations of PAHs, TPHs and lead have been identified within fill materials. In addition, aggressive ground conditions have also been identified in relation to pH and sulphate. ACEC Class AC-2s and sulphate class DS-3 were recorded during Brownfield Solutions Phase 2 Assessment.	Future buildings and structures	Likely	Medium	Moderate
Contamination of groundwater within the chalk aquifer by concrete, cement paste or grout. Loss of wet concrete, cement paste or grout may occur in fast-flowing groundwater present within jointed rocks such as Chalk. Risk of migration is present during the setting period of the concrete which typically occurs over a few minutes; however, this can increase to a few hours when retarder additives are used. Under most circumstances the impact (if any) is likely to be localised.	Principal Aquifer (Chalk)	Likely	Medium	Moderate/Low





4.0 CONCLUSIONS

- 4.1 Due to the limited leaching potential of contamination within the Made Ground, the application of the proposed CFA piling methodology is considered adequate to prevent contaminant mobilisation and migration into the underlying Principal Aquifer.
- 4.2 However, elevated risks (moderate/low and above) have been identified in relation to the following pathways:
- Contaminated soil arisings and groundwater brought to the surface by piling work, with risks of exposure to site workers and construction workers.
 - The potential for direct contact of the piles with the contaminated soil or leachate causing degradation of pile materials due to elevated concentrations of contaminants.
 - Contamination of groundwater within the chalk aquifer by concrete, cement paste or grout.
- 4.3 In order to reduce the identified risks to an acceptably low level and to facilitate the use of CFA piling at the site it is recommended that the mitigation measures detailed below are implemented, either prior to the commencement of the piling works, during the piling works or as part of wider site redevelopment.

Mitigation Measures

Measures to minimise exposure of site workers and construction workers to contaminated soil arisings and groundwater brought to the surface by piling work,

- 4.4 Appropriate management of all pile arisings including segregation of fill material and natural soils, pre – treatment (including screening for potential ACMs) appropriate storage of the stockpiled material on site and suitable off-site disposal to a suitable landfill. In addition to appropriate PPE should be implement during the piling works. Details of these should be included within the method statements and Quality Assurance and Quality Control procedures provided by the appointed piling contractor and within the detailed site Remedial Plan. Appropriate measures should also be put in place to prevent the release of air borne asbestos fibres when piling through the Made Ground, where there is the potential for ACMs to be present.
- 4.5 Use of correct personal protective equipment (PPE) throughout redevelopment works particularly when in contact with potentially contaminated pile arisings.





Measures to prevent the degradation of pile materials due to direct contact with contaminated soil or leachate or LNPAL

- 4.6 Pile materials should be selected taking into account the aggressive ground conditions related to pH and sulphate previously identified. Concrete will need to be suitable for ACEC Class AC-2s and sulphate class DS-3.
- 4.7 In addition, the use of sleeve piles or protective coverings on the reinforcement cage could also be considered in order to reduce the risk of degradation posed by presence of elevated PAHs, TPHs and metals identified within the fill materials.

Measures to prevent contamination of groundwater within the chalk aquifer by concrete, cement paste or grout.

- 4.8 To minimise potential of grout / cement loss into the fast-flowing chalk aquifer, use of permanent casing will be required.
- 4.9 In addition, the use of retarder additive within the concrete / cement paste / grout should not be permitted. This is to ensure that setting occurs quickly (within a few minutes) minimising potential for migration of concrete/cement paste/grout to occur.

Groundwater Monitoring

- 4.10 A dedicated groundwater monitoring programme will be required associated with any proposed piled foundation design. To demonstrate the protection of deeper groundwater during piling, an additional deep groundwater borehole will be required, located in the south-eastern part of the site; at present only a single groundwater monitoring borehole is available (BH201). Clean drilling techniques must be used in the advancement of this borehole in accordance with the British Drilling Associations clean drilling guidelines. This borehole must be included in the pre-piling monitoring rounds.
- 4.11 The Piling Phase Groundwater Monitoring should be split into three phases – pre-piling, during piling and post-piling. The pre-piling monitoring will comprise one round of monitoring, with the monitoring undertaken during piling on a weekly basis for the duration of piling. Post-piling groundwater monitoring will comprise two rounds of monitoring undertaken on a fortnightly basis after piling is complete.
- 4.12 Boreholes required for piling phase groundwater monitoring programme are as follows:





- BH201 (existing down gradient well, north-west of the proposed building)
 - BH202 (new upgradient well)
- 4.13 The location of the new groundwater monitoring borehole will need to take into account relevant site constraints relating to access and the construction phase works. The proposed location is shown on drawing 3689-003; this would position the well upgradient of the new building footprint in the south-eastern corner of the site as shown on drawing 3869-003.
- 4.14 During each Piling Phase Monitoring Round the following field observations, field parameters and laboratory analysis should be recorded / undertaken:
- Field observations: visual / olfactory evidence of contamination and visual observations of turbidity
 - Field parameters: pH, temperature, conductivity, dissolved oxygen and redox potential
 - Laboratory analysis: pH, Total Dissolved Solids (TDS), CLEA Metals, TPH CWG, speciated PAH

Conclusion

- 4.15 This Preliminary Piling Risk Assessment has been carried out to determine the potential risks posed to controlled waters and other receptors associated with a piled foundation design. Should there be revisions in the development proposals then a re – assessment of the risks should be carried out.
- 4.16 **It is the opinion of Lustre Consulting that the completion of the aforementioned mitigation measures will enable CFA piling to be undertaken without posing an unacceptable risk to controlled waters.**





DRAWINGS





**APPENDIX A:
CONTAMINATED
LAND NOTES**





CONTAMINATED LAND ASSESSMENT NOTES

LAND USE

This section establishes the former and current land uses which may have caused contamination or given rise to environmental concerns on the site. An inspection of the site has been undertaken to provide further details of the site and neighbouring activities and to observe environmental conditions.

Historical Maps

Information about the history of the site has been obtained primarily through an inspection of historical Ordnance Survey maps. These maps provide an excellent record of the historical uses of a site and can be very important in assessing potential liabilities. Historical maps can show past potentially contaminative uses at a site that would not necessarily be obvious during a site inspection, for example storage tanks or previous usage such as a gas works or quarry.

Public Record Information

Information concerning environmental regulations relating to the site has been obtained from a public register which has been accessed from a commercial database operated by the Landmark Information Group. This is the quickest means of gathering publicly available information. The data is supplied from within a 1km radius of a given National Grid Reference of a site. The database contains information from the Environment Agency (EA) and other statutory authorities responsible for monitoring environmental protection measures within the area of a site under existing legislation (see below).

Information has also been obtained directly from the environmental regulators in order to gauge the environmental characteristics of the site in more detail and to establish whether there have been any breaches of environmental regulations or pollution incidents associated with the site. This is used to support the publicly available information gathered from the commercial database. The time in which responses are returned can vary between statutory authorities.

Environmental Legislation

The principal environmental legislation in England consists of the Environmental Protection Act 1990 (EPA 90), the Water Resources Act 1991 and the Environment Act 1995 (EA 95). These Acts prescribe protection measures for all the environmental media (land, water and air) and are regulated by the EA and the Local Authority. Part 1 of the EPA 1990 sets out the statutory framework for Integrated Pollution Control (IPC) and Air Pollution Control (APC).

ENVIRONMENTAL SETTING

This section assesses the environmental sensitivity of the site location to contamination / pollution. It is important to establish the environmental setting because, irrespective of the level of contamination on the site, if its location is not 'sensitive' to this contamination / pollution there is a reduced risk of an environmental liability arising.

The sensitivity is assessed using British Geological Survey (BGS) information (such as geological maps and data from the EA (<http://www.environment-agency.gov.uk/homeandleisure/117020.aspx>)* on groundwater and surface water. Data on abstractions have been obtained from publicly available sources including information supply companies such as Landmark and GroundSure. The vulnerability of surface waters and groundwater is based on sensitivity to pollution, distance from abstractions, type and nature of groundwater and type of overlying strata.

Aquifer Designations





In 1 April 2010 the EA began using aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems.

The BGS maps are generally split into two different type of aquifer designation:

- **Superficial (Drift):** permeable unconsolidated (loose) deposits. For example, terrace sands and gravels.
- **Bedrock:** solid permeable formations e.g. sandstone, chalk and limestone.

The maps display the following aquifer designations, and the corresponding colours beside the text are also represented on the Environment Agency's website*:

Principal Aquifers (formally Major Aquifers)

 These are highly permeable layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may be highly productive and able to support large abstractions, public water supply and/or river base flow on a strategic scale.

Secondary Aquifers (formally Minor Aquifers)

These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Although these aquifers will not normally produce large quantities of water for abstraction, they are important for local supplies (such as irrigation) and supplying base flow to rivers. Secondary aquifers are subdivided into two types:

 **Secondary A:** permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers; and

 **Secondary B:** predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.

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

Unproductive Strata

These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Source Protection Zones (SPZs)

The EA have defined Source Protection Zones (SPZs) for 2000 groundwater sources such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area. **The closer the activity, the greater the risk.** The maps show three main zones (inner, outer and total catchment) and a fourth zone of special interest, which we occasionally apply, to a groundwater source.

Flood Risk





The Flood Map combines detailed local data with information from a new national model of England and Wales and indicates where flooding from rivers, streams and watercourses is possible. Under Section 105 of the Water Resources Act 1991 the EA has a duty to survey matters relating to flooding.

RISK ASSESSMENT

This section assesses the potential for the site to give rise to environmental risks and whether or not the risks are acceptable or if further assessment or remedial action is required.

The qualitative risk assessment firstly considers the source of contamination and potential contaminants associated with the source(s) (or hazards). As well as the type of source, the extent, concentration and availability of a contaminant is also assessed.

The effect of a hazard on an identified receptor is largely governed by the sensitivity of a receptor. Receptors may typically include people, buildings, animals, plants and local resources (such as groundwater, surface waters, mines etc.).

A change in the receptor should be considered if the end-use of the site changes, for example, if a commercial site is to be redeveloped into a residential housing estate as a residential occupier is considered more sensitive than a commercial occupier.

The presence of contamination (as a potential hazard) does not necessary mean that there is a risk. It is the exposure pathway and the quantity of contamination that reaches the receptor which may determine the effect on a receptor (such as the integrity of a barrier between a contamination source and receptor).

The risk classifications for both likelihood and consequence is based on methodology presented in Contaminated Land Risk Assessment, A Guide to Good Practice (CIRIA C552, 2001) and has been developed from procedures outlined in the EA's CLR11 Model Procedures. The Department for the Environment Transport and the Regions (DETR), with the EA and Institute of Environment & Health, has also published guidance on risk assessment (Guidelines for Environmental Risk Assessment and Management). The guidance states that the designation of risk is based upon a consideration of both:

- The magnitude of the potential consequence (severity) of risk occurring which takes into account both the potential severity of the hazard and the sensitivity of the receptor; and
- The likelihood of an event occurring (probability) which takes into account the both the presence of the hazard and receptor and the integrity of the pathway.

The magnitude of consequence (severity) and likelihood (probability) is defined in the CIRIA guidance, together with examples. The two classifications are then compared (as shown on Table 1) to obtain an estimation of risk for each pollution linkage, ranging from "very high risk" to "very low risk". A description of the risks and likely actions required is presented in Table 2. The benefit of estimating the risk in this way is that it can be revised after each investigation phase as the conceptual model and corresponding pollution linkages are refined.

		Consequence			
		Severe	Medium	Mild	Minor
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	Very low Risk

Table 1: Comparison of Consequence VS. Probability
Table 2: Description of the Classified Risks and Likely Action Required

Level of Risk	Description of Classification
Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or, there is evidence that severe harm to a designated receptor is currently happening. If this risk is realised, it is likely to result in significant environmental and financial liability to current and/ or future site owners/ occupiers. Urgent investigation (if not already undertaken) and remediation is likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. If risk is realised, it is likely to present a sizeable environmental and financial liability to current and/ or future site owners/ occupiers. Urgent investigation is required and remediation work may be necessary in the short term and likely over the longer term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely the harm would be relatively mild. Investigation is normally required to clarify the risk and determine the potential environmental liability. Some remedial works may be required over the longer term.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild. Limited investigation may be recommended to clarify the risk, dependant on the sensitivity of the receptor and view point of those of interest. Any remedial works are likely to be fairly limited.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is likely to be mild or minor.

The acceptability of risk will always depend upon the view point of those of interest, whether it is an occupier of a site, a regulator or stakeholder. As a result, it could be that action will be required to deal with a level of risk even if it is classified as very low.



**APPENDIX B:
NOTES ON
LIMITATIONS**

LUSTRE CONSULTING, ENVIRONMENTAL AND GEOTECHNICAL CONSULTANCY SERVICES

NOTES ON LIMITATIONS

General

Lustre Consulting have completed the attached report for the use of the Client detailed on the front cover and those parties to whom Lustre Consulting has agreed to provide and has provided an executed warranty agreement, or to whom an assignment of the benefit of this report has been agreed.

Third parties are not entitled to use or rely upon the contents of the report unless written approval has been given by Lustre Consulting; (due to legal requirements, a charge may be levied as a condition of such approval, in which case approval shall not be effective unless and until such a charge has been paid in full).

Lustre Consulting accepts no responsibility or liability for:

- a) any use of this report for any purpose or project other than that for which it was commissioned, and
- b) any use of this report by any third party to whom approval for use has not been given and any conditions applicable to such use have been met.

Phase I Environmental Risk Assessments, Desk Studies and Site Audits

The work completed and utilised to provide this report comprises a study of available documentation. The opinions and results presented in this report have been arrived at by utilising the finite amount of data available at the time of writing and are relevant only to the purpose for which the report was commissioned. The data which has been reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative information pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, Lustre Consulting reserves the right to review this information and, if warranted, to modify the opinions presented in the report accordingly.

It should be noted that the risks which are identified in this report are perceived risks based on the available information at the time of writing and that the actual risks associated can only be assessed following a physical investigation of the site.

Phase II Site Investigations

The intrusive investigation has been completed to provide information concerning the type and degree of contamination present along with ground and groundwater conditions which facilitates a reasonable risk assessment to be completed. The stated objectives of the ground investigation have been limited to assessing the proven risks which are associated with potential human targets, building materials, the environment (including adjacent land), and to surface water and groundwater.

The amount of exploratory work, chemical testing and monitoring completed as part of this project has potentially been restricted by the short timescale available, and the locations of exploratory holes undertaken have potentially been restricted to areas unoccupied by buildings(s) and buried services. A more comprehensive post demolition / decommission investigation may be required if the site is to be redeveloped. For these reasons any costs included in relation to site remediation must be considered as tentative only at this time.

The exploratory holes investigate only a small volume of the ground in relation to the size of the site and therefore, can only provide a "snap shot" or general indication of ground conditions located on the site. The fact that the site has been investigated does not preclude the existence of localised "hotspots" of contamination where concentrations may be significantly higher than those actually encountered.

The risk assessment and opinions provided in this report take into account currently available guidance values relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values.

Gravesend Borough Council



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