



Remediation and Verification Strategy & Piling Risk Assessment

Island Road West, Reading

Presented to **Exton Estates**

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1.0 Introduction

1.1 Appointment

Delta-Simons Environmental Consultants Limited (“Delta-Simons”) was instructed by Exton Estates (the “Client”) to undertake the preparation of a Remediation and Verification Strategy (RVS) & Piling Risk Assessment for a proposed development site at Island Road West, Reading (the “Site”). The Site is subject to Reading Borough Council Planning Permission reference 170444.

1.2 Context & Purpose

The purpose of this document is to provide a formal statement for the likely scope of remediation requirements to facilitate the proposed development at the Site and to support the discharge of planning conditions relating to land contamination. This document also includes a piling risk assessment to support the discharge of planning conditions relating to piled foundations.

For information on the Site setting, and full details of intrusive investigations undertaken at the Site, this Remediation and Verification Strategy & Piling Risk Assessment should be read in conjunction with Delta-Simons’ previous report as follows:

- ▲ Delta-Simons, Geo-Environmental Site Assessment – Island Road West, Reading, dated 10/11/2016, Ref, 16-0447.01 (Issue 2).

1.3 Scope of Works

The scope of works undertaken for this assessment included:

- ▲ Undertake a review of the available information pertaining to land contamination on the Site;
- ▲ Identify the requirements for remediation in the context of the identified contamination and the proposed redevelopment;
- ▲ Detail the remediation measures to be undertaken;
- ▲ Identify the scope of any additional assessment works and in relation to verification of the remediation works to be undertaken; and
- ▲ Confirm the duties of specific parties (where known) for different aspects of the remediation and verification.

1.4 Limitations

This document sets out the measures that will be carried out during the construction to mitigate potentially significant risks as identified by the Site investigations in the context of the proposed end-use of the Site, it does not provide a verification or completion statement for the works. The standard limitations associated with this assessment are presented in Appendix A. In addition, there are the following specific limitations that apply to this assessment:

- ▲ This document is a strategy document and more detailed documentation in terms of a Contractor’s Remediation Method Statement(s) may need to be prepared.

2.0 Proposed Development and Planning Requirements

2.1 Proposed Development

It is understood the Site is proposed to be redeveloped with two warehouse buildings for commercial use. A proposed development plan is included as Figure 3. The development will require cut and fill earthworks to achieve the proposed development platforms in some areas of the Site. In addition, ground improvement and piled foundations will be required to provide suitable foundations for the development.

2.2 Planning Requirements

Planning Permission has been granted for the redevelopment of the Site for commercial use (Reading Borough Council Ref. 170444). The planning permission allows for the construction of two employment buildings with ancillary office and structures, service areas, access road, car parking and landscaped areas.

The Planning Decision Notice issued by Reading Borough Council in October 2017 imposes a number of conditions on the proposed development. Conditions 30 and 31 of the Permission relate to contamination risk and remediation, and piled foundations, as listed below:

Condition 30 – Contamination

No development approved by this planning permission shall commence until a remediation strategy to deal with the risks associated with contamination of the site has been submitted to, and approved in writing by, the Local Planning Authority. This strategy will include the following components:

- 1) A preliminary risk assessment which has identified:*
 - All previous uses;*
 - Potential contaminants associated with those uses;*
 - A conceptual model of the site indicating sources, pathways and receptors; and*
 - Potentially unacceptable risks arising from contamination at the site.*
- 2) A site investigation scheme, based on (1) to provide information for a detailed assessment of the risk to all receptors that may be affected, including those off site.*
- 3) The results of the site investigation and the detailed risk assessment referred to in (2) and, based on these, an options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken.*
- 4) A verification plan providing details of the data that will be collected in order to demonstrate that the works set out in the remediation strategy in (3) are complete and identifying any requirements for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action.*

Any changes to these components require the written consent of the Local Planning Authority. The scheme shall be implemented as approved.

Reason – To protect human health as well as water quality in the adjacent River Kennet and the underlying Chalk Aquifer and to ensure that the development is not put at unacceptable risk from, or adversely affected by, unacceptable levels of water pollution in line with paragraph 109 of the National Planning Policy Framework and Policy CS34. The proposed development is located upon Secondary Aquifer overlying the Chalk aquifer at depth. The Chalk aquifer supports an emergency public water abstraction at Fobney. The previous use of the proposed development site as landfill presents a high risk of contamination that could be mobilised during construction to pollute controlled waters and therefore the groundwater in this location needs to be protected from any contamination.

Condition 31 – Piling Foundations

Piling or any other foundation designs using penetrative methods shall not be permitted other than with the express written consent of the Local Planning Authority, which may be given for those parts of the site where it has been demonstrated that there is no resultant unacceptable risk to groundwater. The development shall be carried out in accordance with the approved details.

Reason – To ensure that the development is not put at unacceptable risk from, or adversely affected by, unacceptable levels of water pollution caused by mobilised contaminants in line with paragraph 109 of the National Planning Policy Framework and Policy CS34. Piling through the landfill with produce pollutant pathways for landfill leachate to reach the underlying Chalk aquifer.

Delta-Simons previous report *Geo-Environmental Site Assessment – Island Road West, Reading, dated 10/11/2016, Ref, 16-0447.01 (Issue 2)* addresses some of the requirements of these conditions in relation to site investigation and risk assessment.

The aim of this Report, therefore, is to assist in addressing the remaining requirements of these planning conditions in relation to construction phase remediation and mitigation measures. The implementation of the works outlined within this RVS will be completed and reported within a separate (Verification) stage of works.

3.0 Summary of Land Contamination Assessments

3.1 Findings of Investigations

The key findings of the Delta-Simons Geo-Environmental Site Assessment report are summarised below.

Investigation works comprised the drilling of 9 cable percussion boreholes up to 20 m in depth, with dual well installations in 8 locations and a single well installation in a 9th location, and excavation of 15 trial pits. Soil samples were collected from the trial pit and borehole arisings with a total of 37 soil samples tested, and one round of groundwater collecting 12 samples for testing was undertaken. Ground gas and groundwater levels were monitored on six occasions following intrusive works.

3.1.1 Site Description and History

The Site covers an area approximately 3.2 hectares and was formerly landfilled with household, commercial, inert and liquid/sludge waste between 1970 and 1985. At the time of the previous site investigation works in 2016, the Site comprised a vacant plot of land with a central area of hardstanding, surrounded by areas overgrown by established vegetation and small trees. The hardstanding is believed to have been developed pre-2003 for use by Reading Borough Council. The eastern quarter of the Site is covered with open grassland. The northern third of the Site, bordering the River Kennet is covered by denser woodland which is understood to be protected under a Tree Preservation Order (TPO) and is a Construction Exclusion Zone. Masts and overhead phone cables are present.

The Site is bound by the River Kennet to the north, Island Road to the south, a commercial warehouse development to the east, and to the west a drainage ditch linking the Foudry Brook to the south of the Site with River Kennet to the north.

Environment Agency online data shows that the Site is located on the northern edge of an extensive area of former landfill and infilled gravel pits, extending to the west, south and east. Due to the age of the majority of these landfills, it is anticipated that these were constructed as 'dilute and disperse landfills' with no engineered liner at the base of the waste. A former landfilled area to the east has recently been developed as a three-unit industrial estate.

A Site Location Plan and a Site Layout Plan are provided as Figure 1 and Figure 2 respectively.

3.1.2 Geology, Hydrology and Hydrogeology

Published geology by the BGS indicates the Site is underlain by Alluvium and the Beenham Grange Gravel Member, over bedrock Lambeth Group and the Seaford and Newhaven Chalk Formation. The Alluvium, Beenham Grange Gravel and the Lambeth Group are all classified as Secondary A Aquifers by the Environment Agency, whilst the Seaford and Newhaven Chalk Formation is classified as a Principal Aquifer. The Site is not located within a Source Protection Area, and the nearest groundwater abstractions are located approximately 400 m west and 450 m southeast, both operated by Thames Water. Nearby groundwater source protection zoning indicates that the regional groundwater flow is towards the southeast, however this is likely to be locally influenced by the presence of the River Kennet, towards the north.

Ground conditions were found to comprise Made Ground to depths between 2.90 m and 6.70 m bgl (which in some areas includes a layer of "capping material"), over a succession comprising Alluvium to depths between 4.20 m and 6.70 m bgl, Beenham Grange Gravel to between 6.60 m and 10.00 m bgl, Lambeth Group to between 13.60 m and 14.60 m bgl, with Chalk proven to a maximum depth of 20.00 m bgl. Groundwater was encountered at various depths including perched between 1.50 m and 4.50 m bgl in the Made Ground, within the Beenham Grange Gravel between 3.40 m and 6.00 m bgl, and within the Seaford and Newhaven Chalk between 13.60 m and 14.60 m bgl.

Perched groundwater within the Made Ground was identified as standing approximately 1.50 m higher than groundwater within the underlying Beenham Gravel and Seaford and Newhaven Chalk. Due to the depth of the response zones for the monitoring well installations, it was not able to be conclusive regarding continuity

between the units, however continuity is considered likely due to the absence of a significant aquiclude layer noted in the logs.

3.1.3 Environmental Findings & Recommendations

Soil Contamination

Contaminants identified in soils mostly comprised TPH concentrations exceeding theoretical soil saturation limits (which indicate the potential for free-phase hydrocarbons) rather than the commercial Generic Assessment Criteria (GAC). Given the absence of any observations of free-phase hydrocarbons in the borehole and trial pit logs, these concentrations are not considered to represent a risk.

Only one exceedance of commercial GAC was identified relating to PCBs on the centre of the Site – this exceedance was noted to be marginal and at 1.60 m bgl.

Given the proposed commercial nature of the redevelopment, and the low volatility and low mobility of the soil contaminants, the risks to future users was determined to be low. Risks posed during construction and groundworks, to groundworkers and to off-Site receptors (by windblown dust), were concluded to be moderate however could be mitigated through implementation of suitable protocols and processes.

Groundwater and Surface Water Contamination

Groundwater concentrations of heavy metals including cadmium, mercury, nickel and zinc were identified in excess of the freshwater EQS values protective of surface water, although (with the exception of nickel) not in excess of the drinking water standards. The elevated concentrations were only identified in one or two locations indicating localised impact.

Concentrations of benzene and total TPH were found to exceed UK Drinking Water standards although not freshwater EQS values. M- and p-xylene was also identified in excess of EQS standards in one location.

Widespread elevated concentrations of ammonium and ammonia were identified across the Site in both shallow and deep groundwater along with less widespread concentrations nitrite also both in shallow and deep groundwater. These are indicative of biodegradation occurring under anoxic conditions within groundwater.

Comparatively, surface water samples also identified slightly elevated concentrations of nitrite present in all surface water samples, with elevated ammonium identified in the western drain. Given the inferred regional groundwater towards the southeast, and the potential for local influence towards the north by the River Kennet, the ammonium in the western drain can be considered up-gradient and therefore is unlikely to be the result of leachate release from the Site.

Given the presence of other areas of landfill off-Site, the absence of significant unsaturated soil contamination and the localised nature of the groundwater exceedances, the groundwater contamination identified is considered to be indicative of the wider groundwater quality in the vicinity of the Site and not a potential risk to proposed receptors.

Ground Gas Classification

During the six rounds of groundwater monitoring, maximum concentrations of 48.9% methane and 24.6% carbon dioxide were encountered with negligible flow rates encountered in unflooded wells (deeper wells recorded elevated flows however these are considered the result of changes in groundwater levels and flooded response zones). The Site classifies as a Characteristic Situation 2, requiring implementation of basic ground gas protection measures in line with current guidance.

Recommendations

Recommendations made in the report related to the following mitigation measures:

- ▲ Generation of a piling risk assessment and implementation of its recommendations;
- ▲ A clean-up of surface asbestos with off-Site disposal at a suitably licensed disposal facility;

- ▲ Implementation of a “discover Strategy” for any areas of previously unidentified contamination found during construction works;
- ▲ Installation of appropriate ground gas protection measures;
- ▲ Provision of appropriate PPE for groundworkers;
- ▲ Allowance for elevated costs above standard inert rates for disposal of any engineering arisings, hand-picked asbestos and potential medical waste;
- ▲ Implementation of appropriate dust suppression techniques during the construction works;
- ▲ A clean soil cover system in all landscaped areas;
- ▲ Potential installation of upgraded water supply pipework following liaison with the Local Water Authority;
- ▲ Clearance of Japanese Knotweed identified on-Site through on-Site or off-Site disposal; and
- ▲ Validation of the mitigation works

No specific remediation was determined to be required.

This report will describe the required measures mentioned above in greater detail.

3.2 Earthworks and Materials Management Plan

The redevelopment of the Site will require earthworks to be undertaken to level the Site suitably using the historically deposited waste soils materials. The earthworks will therefore need to be undertaken under a Materials Management Plan in accordance with the CL:AIRE Code of Practice to facilitate the reuse of these materials.

4.0 Discovery Strategy

4.1 Background

As with any 'Brownfield' development, there is a possibility that unknown localised areas of soil contamination (a 'Hotspot') may be encountered during development works. As such, a Discovery Strategy is required during the construction phase of the development. The purpose of the protocol is to provide a ready reference should such an area of contamination be identified by visual or olfactory means during the works.

4.2 Discovery Strategy

Should an area of contamination be identified by visual or olfactory means during development works, the following procedure shall be followed:

- ▲ Immediately stop all works in the area where contamination is suspected;
- ▲ Immediately inform the Site Agent who should then contact the Environmental Consultant;
- ▲ The Environmental Consultant shall provide a verbal response outlining immediate actions with regard to Site Health and Safety and to limit the potential for contaminants to migrate;
- ▲ The Environmental Consultant shall judge each occurrence on merit and should it be deemed necessary the Environmental Consultant shall attend Site to oversee the removal of the 'hotspot' and collect validation samples;
- ▲ Any excavated material should be isolated from all other material at the Site, on plastic sheeting and covered with plastic sheeting until the material can be tested for contamination and an appropriate disposal route can be identified;
- ▲ Any 'hotspot' stockpiles and excavations should be fenced off, have appropriate signage and their locations recorded on a Site drawing;
- ▲ Should any excavated material be required to be disposed of at an off-Site location, the material shall be isolated from all other material at the Site prior to disposal at a suitably licensed facility. All documentation associated with the movement and disposal of any such material shall be supplied to the Environmental Consultant shall, including waste transfer documentation;
- ▲ Subject to appropriate Site Health & Safety controls (typically comprising fencing off the excavation) the excavation will remain open until the validation has been completed. Alternatively, for Site Health & Safety reasons, it may be necessary to backfill the excavation with Site derived material. In this case, the location of the excavation will be accurately recorded and the excavation reopened if required, based on the validation results; and
- ▲ The Regulatory Authorities shall be informed by the Environmental Consultant shall of any remedial activities required and associated validation testing results. Representatives of these organisations may also wish to visit the Site.

Implementation of appropriate measures to deal with such finds remain the Contractor's responsibility.

A copy of the Discovery Strategy is also presented in Appendix B to be extracted and used on-Site.

5.0 Materials Management

5.1 Materials Management for Earthworks

The redevelopment will include earthworks which will require the excavation and placement of Made Ground / soils which contain contamination, albeit the concentrations within these soils are not considered to preclude them from re-use. No further testing of the soils on site is considered to be required.

The earthworks will therefore need to be undertaken under a Materials Management Plan (MMP) in accordance with the CL:AIRE Code of Practice to facilitate the reuse of these materials. The Contractor shall be responsible for the preparation of a MMP and obtaining appropriate sign off from a Qualified Person prior to the commencement of earthworks.

5.2 Asbestos in Soils – Earthworks

The assessments undertaken have identified that asbestos is present in soils at the Site, but not at concentrations which would preclude the use of the materials for earthworks purposes.

Prior to further vegetation clearance and earthworks a handpicking exercise should be undertaken to remove asbestos containing materials from the Site surface.

The groundworks Contractor should be made aware of the possibility of encountering potential Asbestos Containing Materials (ACM) within the Made Ground across the Site and an appropriate protocol to mitigate exposure of the workforce and general public should be in place with due respect to his duties under the Control of Asbestos Regulations 2012.

The Contractor will need to prepare a risk assessment and method statement which identifies a safe system of work to handle the asbestos containing soils which is likely to include asbestos awareness training, a protocol for unexpected finds (should significant volumes of asbestos material be identified) as well as safe working procedures such as damping down of excavations and stockpiles in line with general dust generation mitigation. The Contractor should determine the need for appropriate levels of PPE and/or RPE and any associated air monitoring as required.

The Contractor shall be responsible for providing appropriate documentation for inclusion within the Verification Report including details of any significant asbestos material encountered.

5.3 Asbestos in Soils – Post Earthworks

Risks to future Site users associated with the potential presence of asbestos within the soils following development will be mitigated through the presence of hardcover across the majority of the Site with clean cover soils in landscaped areas (described in further detail in Section 6).

5.4 Medical Waste in Soils – Earthworks

Previous investigations have identified medical wastes (syringes) within the landfill. Where this is encountered during the earthworks this material will be segregated within a designated quarantine area prior to appropriate off-Site disposal.

The Contractor will need to prepare a risk assessment and method statement which identifies a safe system of work to handle potential medical waste containing soils, a protocol for unexpected finds as well as safe working procedures. The Contractor should determine the need for appropriate levels of PPE and/or RPE and any associated air monitoring as required.

6.0 Certified Clean Topsoil / Subsoil Layer

6.1 Topsoil / Subsoil - Clean Cover

Given the nature of the Site's former use including the wastes disposed of on-Site, and the absence of any engineered capping layer, it is recommended that an engineered cap be installed in addition to the standard clean soil cover for landscaped areas.

Exposure of future site users to asbestos and other contaminants on the Site shall be prevented through the placement of a minimum 300 mm of imported topsoil and subsoil in the commercial development landscaping areas of the Site, overlying a 1 m thick clay cap or equivalent (e.g. reduced thickness of clay layer and bentonite geocomposite).

The clay cap will be placed to act as a separator layer between the clean imported materials and the underlying Made Ground, and to inhibit infiltration of rainwater into the underlying waste mass.

In addition, the topsoil / subsoil depth shall be validated by the Environmental Consultant on a 20 m grid basis following installation of the material to the appropriate finished levels.

Photographic evidence of this (measured against a levelling staff) shall be obtained for incorporation within the Verification Report.

6.2 Imported Materials and Verification

It is considered that there will be a requirement for topsoil / subsoil / fill be imported onto the Site. These materials shall be sourced by the Contractor and documentation submitted on its origin to the Environmental Consultant to confirm acceptability.

The Contractor will need to provide the following information for all topsoil **prior** to importing and placing materials on-Site (to be incorporated within the Verification Report):

- ▲ Details of the locations from which material have been sourced;
- ▲ Records on quantities of materials to be imported to the Site and proposed programme of works; and
- ▲ Chemical data for the soil material.

The soil materials considered for importation shall be sampled while stockpiled off-Site at their source or manufacture location. The Contractor or supplier shall carry out verification tests on the soil materials and await written approval from the Environmental Consultant prior to importing the soil to Site. If chemical data for the soil cannot be provided, then the Environmental Consultant shall arrange for testing to be undertaken.

Samples shall be analysed for a minimum suite of:

- ▲ Asbestos screening;
- ▲ pH, metals;
- ▲ Total petroleum hydrocarbons; and
- ▲ Speciated Polyaromatic Hydrocarbons (16 PAH).

The samples shall be truly representative of the soil to be offered.

One composite sample shall be taken for every 250 m³ of imported soil to be used, with a minimum of 3 No. samples of each soil type shall be tested from each source/supplier.

The chemical criteria against which any imported soils shall be assessed is based on relevant Generic Assessment Criteria applicable at the time of the works for a commercial end use (general fill materials) and a residential use (topsoil) to provide a conservative value in the absence of commercial landscaping specific values, alternatively, Delta-Simons Human Health Generic Assessment Criteria as presented in Appendix C shall be used.

7.0 Ground Gas Mitigation Measures

7.1 Requirements – Ground Gas

There is a requirement for ground gas protection measures to be installed for all confined spaces within the proposed warehouse buildings to mitigate against the elevated methane and carbon dioxide concentrations recorded at the Site. Ground gas protection measures shall be installed in accordance *BS8485:2015* guidance as appropriate.

The level of ground gas protection measures required is set out in *BS8485:2015* by building type with four categories defined. Under the guidance, it is anticipated that Building Type D will apply to the two proposed structures.

Building Type D is defined as an industrial style building having large internal space(s) that are well ventilated. It is noted that small rooms within should be categorized separately. Under the definitions, these would classify as Building Type C: commercial buildings with central building management and control of alterations, with small to large rooms either with active ventilation or good passive ventilation.

Under CS2 classification, Type C buildings require a minimum score of 2.5 under the scoring system in *BS8485: 2015*, with a minimum of two different system elements included to meet the score requirement. These system elements and their effective scores should be selected from Table 5 (structural barriers), Table 6 (ventilation protection measures) and Table 7 (gas resistant membranes) of *BS8485: 2015*.

The table overleaf summarises the options for achieving the minimum score, however reference to the *BS8485: 2015* document should be made to ensure full compliance.

It is recommended that the design and installation of the gas protection measures is required be carried out by a suitably qualified and experienced contractor to meet the requirements of the Local Authority and *BS8485: 2015*.

Details of the proposed design, construction details and materials to be used should be provided to the Environmental Consultant to form an Appendix to this RVS, for submission to the Local Planning Authority for approval prior to commencement of the works. At present, it is understood that an approach of a gas resistant membrane beneath the footprints of the buildings, with an additional geotextile void former blanket to provide additional passive sub-floor venting beneath the enclosed office spaces, is to be adopted.

7.2 Verification – Ground Gas

In order to meet the requirements of *BS8485:2015* it is recommended that the design, installation and verification of the gas protection measures is carried out by a suitably qualified and experienced specialist independent of the Contractor.

Engineer's drawings confirming the inclusion of gas protection measures are to be provided to the Environmental Consultant for inclusion within the Verification Report.

The Contractor shall provide verification certification/integrity testing as outlined in BS 8485:2015 and photographs of the installed gas protection measures, copies of which should be provided to the Environmental Consultant for inclusion within the Verification Report.

Table 2: Ground Gas Protection Options

Options			Solution Score
Structural Barrier Options	Precast suspended segmental subfloor (i.e. beam and block)		0
	Cast in-situ ground-bearing floor slab (with only nominal mesh reinforcement)		0.5
	Cast in-situ monolithic reinforced ground bearing raft or reinforced cast in-situ suspended floor slab with minimal penetrations (must be well-reinforced to control cracking and have minimal penetrations to qualify for the higher score)		1 or 1.5
Ventilation Protection Options	Pressure relief pathway (usually forced of low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building).	Whenever possible, a pressure relief pathway (as a minimum) should be installed in all gas protection measure systems. If the layer has low permeability and/or is not terminated in a venting trench (or similar) then the score is 0.	0.5
	Passive sub-floor dispersal layer with very good performance	Void filling medium may be a clear void, polystyrene void former blanket, geocomposite void former blanket, no fines gravel layer with gas drains or without gas drains The ventilation effectiveness of difference media depends on a number of difference factors including the transmissivity of the medium, the width of the building, the side ventilation spacing and type and thickness of the layer. Passive ventilation should be designed to meet at least "good performance", see guidance.	2.5
	Passive sub-floor dispersal layer with good performance		1.5
	Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution later, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers.	This system relies on continued serviceability of the pumps, therefore alarm and response systems should be in place. There should be robust management systems in place to ensure the continued maintenance of the system, including pumps and vents. Active ventilation should always be designed to meet at least "good performance".	1.5 to 2.5
	Active positive pressurization by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket.	This system relies on continued operation of the pumps, therefore alarm and response systems should be in place. The score assigned should be based on the efficient "coverage" of the building footprint and the redundancy of the system. Active ventilation should always be designed to meet at least "good performance".	1.5 to 2.5
Gas resistant membrane options	Gas resistant membrane meeting all of the following criteria: ▲ Sufficiently impervious to the gases with a methane gas transmission rate <40.0 ml/day/m²/atm (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometris method); ▲ Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; ▲ Sufficiently strong to withstand in-service stresses (e.g. settlement if place below a floor slab); ▲ Sufficiently strong to withstand the installation process and following trades until covered (e.g. penetration from steel fibres in fibre reinforced concrete, penetration of reinforcement ties, tearing due to working above it, dropping tools, etc); ▲ Capable, after installation, of providing a complete barrier to the entry to the relevant gas; and ▲ Verified in accordance with CIRIA C735.	The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation and integrity of joints. For examples a minimum 0.4 mm thickness (equivalent to 370 g/m ² for polyethylene) reinforced membrane (virgin polymer) meets the performance criteria.	2

8.0 Japanese Knotweed Clearance

8.1 Japanese Knotweed

Japanese Knotweed has been identified at the Site, therefore, specific mitigation and remediation measures will be required to ensure that all plant materials and soils contaminated with Japanese Knotweed are identified, segregated and appropriately treated to prevent further spread.

8.2 Management and Treatment options

Prior to any further vegetation clearance works the impacted areas will be identified by a specialist, surveyed and fenced off (including a 7 m buffer zone around vegetative growth) and appropriate hazard signage in place.

Vehicles must be prevented from tracking across potentially impacted areas.

If the Knotweed is located in areas that will not be affected by the earthworks (such as within the TPO belt) it is recommended that a programme of in-situ herbicide spraying is undertaken by a specialist contractor, with specific consideration of proximity to watercourses and used of approved herbicides in accordance with regulations and best practice. It is anticipated that a herbicide treatment programme will take between 3-5 years.

Where Knotweed is located within areas of the Site that will be affected by the earthworks this will require removal prior to commencement of the works. It is recommended that impacted soils are carefully excavated under the supervision of a specialist contractor prior to either on-Site disposal through deep burial within a root barrier membrane and/or off-Site disposal at an appropriately licensed facility.

The on-Site deep burial location should not be in a location that may be comprised by future dynamic compaction or piling works.

The on-Site burial should be agreed with the Environment Agency and Reading Borough Council in advance and the location fully surveyed and recorded within the site management documentation to inform the landlord, tenants and other stakeholders.

The Contractor will need to prepare a specific risk assessment and method statement which identifies a safe system of work to handle potential Japanese Knotweed impacted soils, including transport on or off-site and ensuring all vehicles are cleaned after use to ensure no rhizome or plant material remains.

9.0 Water Pipes and Below Ground Utilities / Structures

9.1 Background

Concentrations of organic contaminants in soils represent a potential risk to standard plastic water supply pipes. Following the 1992 Foundation for Water Research (FWR) report an update Guidance for the Selection of Water Supply Pipes used in Brownfield Land (UKWIR 2010) has been produced.

Careful selection, design and installation of water supply pipes is required on potentially contaminated sites to ensure that pipelines are satisfactorily installed.

To fully comply with the guidance a specific and detailed investigation of each pipe route is considered to be required, at the time of the investigations, no information on the specific pipe routes was available.

A specific investigation in compliance with the requirements of UKWIR 2010 and / or the local water supplier has not been undertaken, however, given the former use of the Site as a landfill it is anticipated that upgraded barrier pipes laid in clean service corridors will be required.

9.2 Standard Pipe Materials / Upgraded Pipe Material Requirements

It is recommended that the local water undertaker is consulted by the Client prior to ordering and placement of pipes in order to specify their specific requirements,

Details of any upgraded pipework should be provided to the Environmental Consultant for inclusion within the Verification Report.

9.3 Clean Service Corridors

Services and utility corridors should be backfilled with clean site won materials. In the event that imported materials are required, all material imported to Site for this use should be tested on a ratio of 1 sample per 250 m³ for a range of contaminants appropriate to the source of the material.

The Contractor shall be responsible for providing the documentation associated with the testing of the imported service trench fill to the Environmental Consultant.

9.4 Sulphate Resistant Concrete

A requirement for sulphate resistant concrete Design Sulphate Class DS-3 and ACEC Class AC-3 has been identified and the Contractor shall review and confirm the needs for sulphate resistant concrete.

10.0 Dust Suppression

10.1 Dust Mitigation Measures

Appropriate risk assessment and mitigation measures should be in place throughout the development. As a minimum this should include damping down of the Site surface, excavations and stockpiles to prevent the generation of dust; including:

- ▲ Stockpiles of potentially contaminated materials should not be greater than 2 m high if likely to be subjected to 'wind whip' causing potentially hazardous material to be blown from the pile;
- ▲ Dust monitoring stations will be set up and monitored by the contractor to record the dust concentrations during the works;
- ▲ The material should be placed on a suitable polythene membrane on hardstanding to prevent any leaching of materials to the underlying ground. Care should be taken not to pierce the sheeting when placing the bulky elements of the material;
- ▲ The stockpile should be dressed, dampened down or covered to prevent dust blowing off. The final choice should be made by the Contractor based on Site constraints, but the options include covering with plastic/polythene membrane, or by a layer of clean soil material;
- ▲ Following removal of potentially contaminated stockpiled materials the area will be inspected and if required remedial works undertaken to remove residues;
- ▲ Plant will be appropriately loaded to prevent spillages;
- ▲ The drop distance from excavator bucket to stockpile/process plant will be kept as short as reasonably practicable;
- ▲ Appropriate signage should be displayed so that Site workers/visitors are alerted to the potential hazards associated with the material to be stored on-Site; and
- ▲ Roadways within the Site will be kept moist by water bowser.

11.0 Groundwater and Surface Water Monitoring

11.1 Introduction

Monitoring of selected existing boreholes will be undertaken prior to, during and immediately following the completion of the development. These works are required by the head lease agreement between the Client and Reading Borough Council to demonstrate that the construction activities have not had an adverse impact on pre-existing conditions.

It is understood that the construction programme is for 44 weeks, commencing in January 2018 and expected to be completed in November 2018. To provide a reasonable number of monitoring events before, during and after development activities it is proposed to undertake six monitoring events.

Due to the nature of the development and position of the proposed buildings it will not be possible to retain the existing monitoring wells throughout the development. Therefore, it is proposed to undertake the baseline monitoring (two rounds) from the existing boreholes – nominally CP102, CP104, CP106 and CP107, or suitable alternatives should these not be serviceable.

Given proposed earthworks and dynamic compaction to create the development platform it is anticipated that any existing boreholes will be removed or damaged. Therefore, it is proposed to install replacement groundwater monitoring wells on completion of the dynamic sampling and before commencement of piling (as far as possible). Subsequent monitoring rounds will be undertaken during piling and the remaining development programme.

11.2 Replacement Boreholes

It is proposed that four borehole will be installed to provide groundwater monitoring points during the piling and development phase. The proposed locations are shown on Figure 4 (these are subject to on-Site confirmation on access).

Subject to ground conditions encountered it is anticipated that the boreholes will comprise:

- ▲ Cable percussion boreholes to a maximum depth of 15 m bgl, drilled using clean drilling techniques;
- ▲ Installation of dual gas and groundwater monitoring wells to target deep and shallow/perched groundwater (if present).

11.3 Monitoring Frequency and Analysis

The groundwater monitoring will be dictated by the development programme, however, based on the current anticipated timescales the following frequency is proposed:

- ▲ December 2017 – Round 1 - Baseline (pre-clearance works);
- ▲ April – June 2018 – Rounds 2, 3 & 4 – Monitoring during and on-completion of piling;
- ▲ August 2018 – Round 5 - Post piling;
- ▲ October 2018 – Round 6 – Completion of main development.

In addition to the monitoring boreholes, selected surface water samples would be collected. Two locations within the River Kennett, above and below the Site would be identified with safe access points. Provisional locations are indicated on Figure 4.

Groundwater samples would be collected using low flow sampling techniques and surface water samples collected with a telescopic sampler poles.

Samples would be provided to a suitably accredited laboratory for metals (inc. arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc), TPH (speciated), VOC, SVOC, nitrate and nitrite, pH, sulphate, and total ammonium.

Monitoring results will be collated and reviewed throughout the project. The Environment Agency will be provided with updates on progress and monitoring results as the development progresses. Should results indicate a need to revise the monitoring programme or construction methods this will be discussed with the regulators.

12.0 Verification Reporting Requirements

12.1 General

Following completion of works detailed in Sections 4.0 to 11.0, for each phase of development, the Environmental Consultant shall prepare a Verification Report on the works for submission to the Local Authority to satisfy relevant planning conditions.

The Verification Report will comprise:

- ▲ Details of waste disposal of any material from the Site including waste transfer documentation and details of the receiving treatment/landfill facility;
- ▲ Details of ground gas protection design and independent verification;
- ▲ Confirmation of installation of appropriate potable water pipes;
- ▲ Evidence of appropriate Japanese Knotweed disposal;
- ▲ Confirmation of the chemical results, and transfer notes detailing the place of origin of any imported topsoil/ subsoil/ fill;
- ▲ Results of groundwater and surface water monitoring undertaken prior to, during and on completion of the earthworks and piling phases;
- ▲ Validation of the clean cover layer placement across the Site, including photographic documentation of the depth of placed materials, and the presence of the underlying clay cap; and
- ▲ A record of any 'hotspots' found during construction and groundworks and the associated actions taken to remove them. This will include details of the chemical analysis of samples taken from these areas, verification that the entire hotspot has been removed as necessary, appropriate classification of the waste, waste transfer documentation, and details of the receiving disposal facility.

13.0 Piling Risk Assessment

13.1 Development Proposals

This section is concerned with the deep piled foundations which are required to support the proposed new commercial buildings.

The deep landfill materials present at the Site are considered unsuitable for accommodating the loads required for the new buildings. As a result, piled foundations are required, in addition, ground improvement across the majority of the Site using dynamic compaction will also be undertaken.

13.2 Foundation Options

Based on the Contractors experience on the adjacent development site (which has very similar ground conditions) it is considered that there are two potential piling solutions appropriate for the Site:

- ▲ Pre-cast Driven Piles; and
- ▲ Continuous Flight Auger Piles (CFA).

Other piling options such as cast in-situ or stone columns have been discounted due to the potential for creating preferential pathways or technical difficulties arising from the soil and groundwater conditions.

Of the two viable options, CFA piles are considered less favourable due to the production of a large volume of arisings generated through the augering process which will require off-Site disposal with associated additional vehicle movements and costs.

Therefore, the option of pre-cast driven piles has been chosen as the preferred solution for the Site. This is a displacement foundation, resulting in very little arisings being brought to the surface, keeping disposal volumes low and reducing the likelihood of groundworkers coming into contact with potentially contaminated soils. Recent research has also evidenced that downward displacement of soils by pre-cast driven piles is limited to a few centimetres with further mitigation possible through pile shape and size selection, as such the risk of driving contaminants down into the underlying aquifer is low. The pre-cast piles will be manufactured with a pointed tip to further reduce the potential for downward displacement of potential contamination.

13.3 Conceptual Site Model

Delta-Simons produced a Geo-Environmental Site Assessment in 2016 which included a Conceptual Site Model. In accordance with UK best practice and in line with the EA guidance on piling on land affected by contamination, the potential environmental hazards created by piling on the Site have been considered in the context of the following CSM risk assessment based on the identified sources, pathways and receptors.

In accordance with current UK best practice and in line with the EA guidance on piling on land affected by contamination, the potential environmental hazards created by piling on the Site have been considered in the context of the following CSM risk assessment, based on the source-pathway-receptor principle.

Sources

Sources of contamination on-Site is limited to landfilled materials.

Receptors

Receptors during the piling works include the groundworkers, the underlying aquifers and the nearby River Kennet.

Pathways

Potential pathways include:

- ▲ Direct contact or ingestion of contaminants by groundworkers from soils brought to the surface;

- ▲ Inhalation of contaminated dust by groundworker from soil brought to the surface;
- ▲ Lateral or vertical migration of potentially contaminated perched water within the waste mass to the underlying aquifers; and
- ▲ Site surface run-off into the nearby River Kennet.

13.4 Plausible Pollutant Linkages

From the above source-pathway-receptor assessment, the following plausible pollutant linkages have been identified, in relation to the proposed pre-cast driven piling works, or other deep foundation methods, on the Site:

Plausible Pollutant Linkages		
Source(s)	Pathway(s)	Receptor(s)
Contaminated soils beneath the Site	Vertical migration of leachable contaminants, mobilised by the action of piling through impacted soils.	Shallow aquifer.
	Vertical migration of leachable contaminants, mobilised by the action of piling through impacted soils and lateral migration to the nearby watercourses.	Ponds and nearby streams / drainage ditches.
Asbestos fibres in the Made Ground.	Mobilisation to air through the groundworks, including the driven pile installation.	Groundworkers and off-Site users.

13.5 Piling Risk Assessment

Based on the above plausible pollutant linkages, the following assessment of the risk that piling represents is discussed below.

13.5.1 Areas of Soil Contamination

Given the previous investigation results for the Site indicating only isolated pockets of soil contamination present, the risk posed to the underlying Beenham Grange Gravel Member and the Seaford and Newhaven Chalk is considered to be low.

Earthworks are anticipated to take place prior to piling to prepare the Site to founding level, as such implementation of the mitigation measures including the Discovery Strategy, dust suppression and appropriate toolbox talks and PPE for groundworkers are anticipated to be undertaken prior to the piling works taking place. Any shallow contamination presenting a risk to groundworkers and off-Site receptors identified during that time will be dealt with under these measures.

13.5.2 Pre-Cast Driven Piles

The EA guidance (Piling and Penetrative Ground Improvement Methods on Land effected by Contamination) on piling on land affected by contamination states that..."provided the pile is formed or placed in intimate contact with the surrounding soil there should be no formation of preferential pathways".

Given the displacement method of piling and the presence of less permeable layers of the Alluvium and Thanet Sand Formations, it is considered that the piling will not create any preferential pathways to the deeper groundwater from the geology above them. Any potential for agitation of contamination within the saturated soils is considered likely to be limited and of short duration.

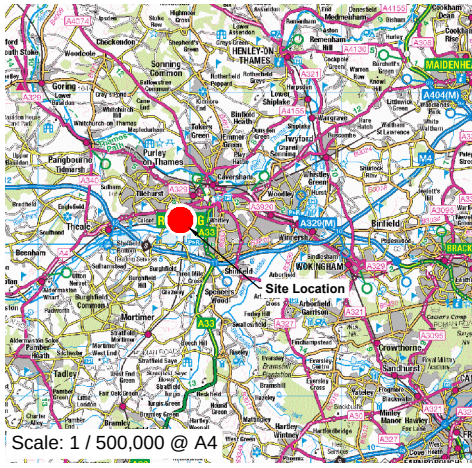
It is recommended that a programme of monitoring be undertaken on existing monitoring wells and the adjacent River Kennet to confirm the condition of the underlying aquifers prior to, during and after the construction works. It is understood that the principle of this monitoring programme has been agreed between the Client and Reading Borough Council to demonstrate that the construction works do not have an adverse impact on existing conditions.

13.6 Conclusions

At the time of this report, no detailed plans for foundations have been made available for assessment, however it has been indicated that the foundation solution of pre-cast driven piles is the preferred option, with a pile depth of up to 13 m with a base in the dense granular deposits of the Lambeth Group. It is understood that some piles may need to extend deeper to ensure the required bearing capacity. It is understood the contractor has installed the same piling solution on the adjacent Site.

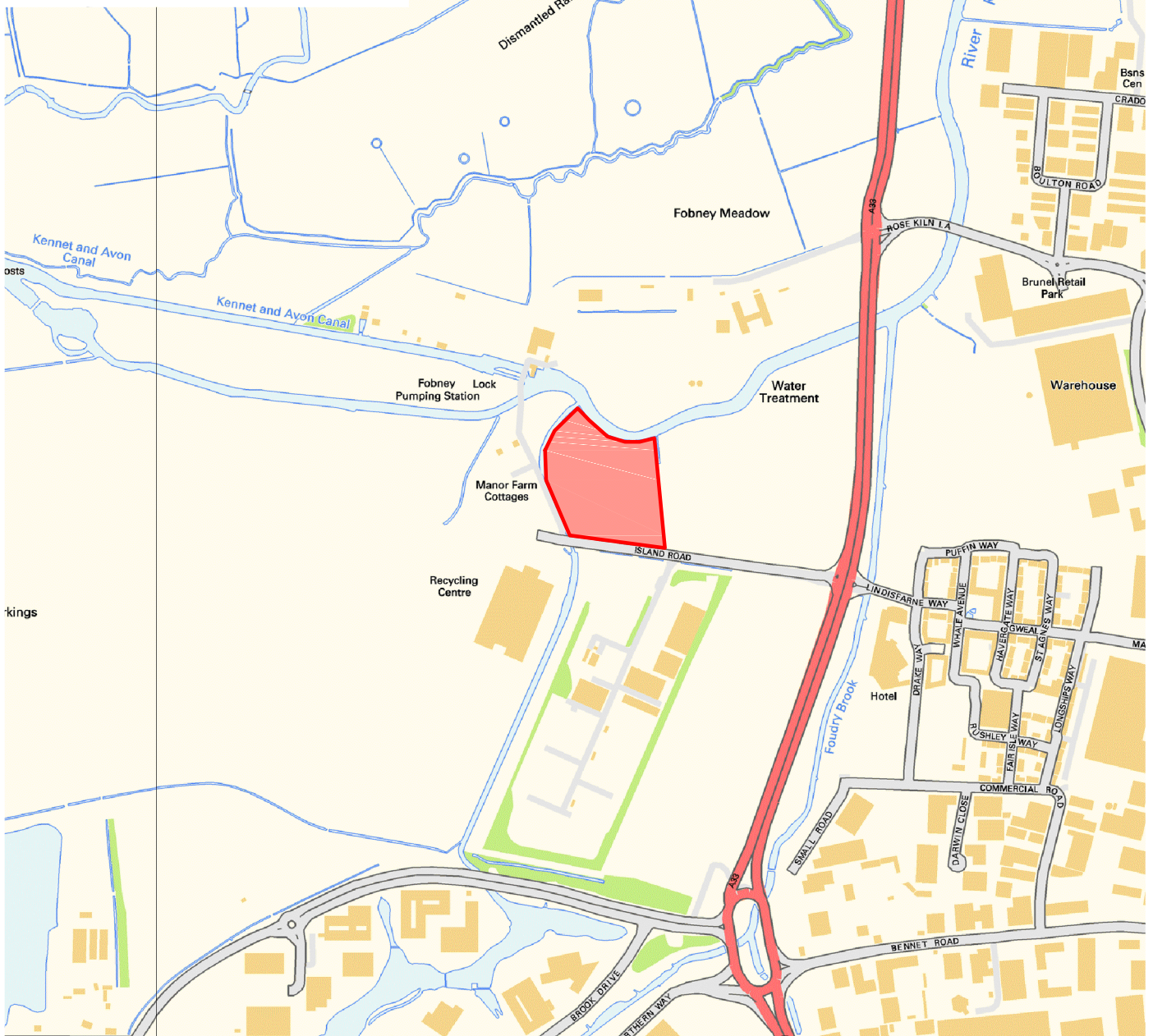
This piling risk assessment and the results of Delta-Simons previous investigations has shown that there is negligible risk of mobilising significant contamination through a preferential pathway. The piles are manufactured with a pointed tip to displace materials and eliminate risks of carrying material down into lower strata and clay layers will provide a seal around the pile.

Figure 1 – Site Location Plan



LEGEND

 Site Boundary



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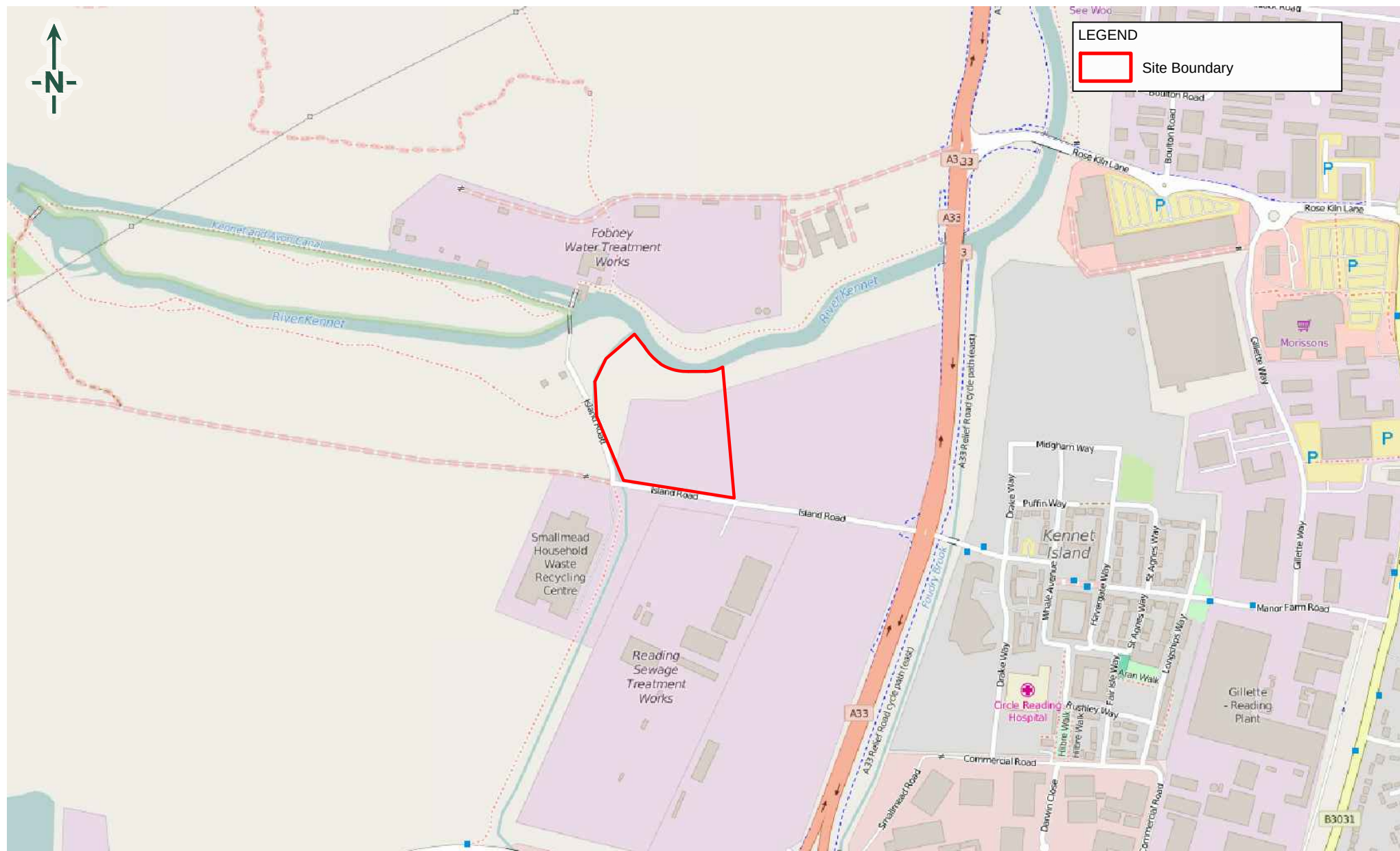
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Site Location Map
Island Road West
Reading

DRAWN BY:
EN
CHECKED BY:
PS
DATE:
21-11-17

SCALE:
To Scale@A4
REVISION:
1

PROJECT NO:
16-0447.04
FIGURE NO:
1

Figure 2 – Site Layout Plan



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Figure 3 – Proposed Development Plan

Figure 4 – Replacement Borehole and Monitoring Plan

Appendix A - Limitations

Limitations

The recommendations contained in this Report represent Delta-Simons professional opinions, based upon the information listed in the Report, exercising the duty of care required of an experienced Environmental Consultant. Delta-Simons does not warrant or guarantee that the Site is free of hazardous or potentially hazardous materials or conditions.

Delta-Simons obtained, reviewed and evaluated information in preparing this Report from the Client and others. Delta-Simons conclusions, opinions and recommendations has been determined using this information. Delta-Simons does not warrant the accuracy of the information provided to it and will not be responsible for any opinions which Delta-Simons has expressed, or conclusions which it has reached in reliance upon information which is subsequently proven to be inaccurate.

This Report was prepared by Delta-Simons for the sole and exclusive use of the Client and for the specific purpose for which Delta-Simons was instructed. Nothing contained in this Report shall be construed to give any rights or benefits to anyone other than the Client and Delta-Simons, and all duties and responsibilities undertaken are for the sole and exclusive benefit of the Client and not for the benefit of any other party. In particular, Delta-Simons does not intend, without its written consent, for this Report to be disseminated to anyone other than the Client or to be used or relied upon by anyone other than the Client. Use of the Report by any other person is unauthorised and such use is at the sole risk of the user. Anyone using or relying upon this Report, other than the Client, agrees by virtue of its use to indemnify and hold harmless Delta-Simons from and against all claims, losses and damages (of whatsoever nature and howsoever or whensoever arising), arising out of or resulting from the performance of the work by the Consultant.

Appendix B – Discovery Strategy

Protocol for Addressing Previously Unidentified 'Hotspots' of Contamination

As with any Brownfield development, there is a possibility that an unknown area of soil contamination may be encountered during excavation works. Should an area of contamination be identified by visual or olfactory means the following procedure will be followed:

- ▲ Immediately stop all works in the area where contamination is suspected;
- ▲ Immediately inform the Site Agent who should then contact the Environmental Consultant;
- ▲ The Environmental Consultant will provide a verbal response outlining immediate actions with regard to Site Health and Safety and to limit the potential for contaminants to migrate;
- ▲ The Environmental Consultant will judge each occurrence on merit and should it be deemed necessary. The Environmental Consultant will attend Site to oversee the removal of the 'hotspot' and collect validation samples;
- ▲ Any excavated material should be isolated from all other material at the Site, on plastic sheeting and covered with plastic sheeting until the material can be tested for contamination and an appropriate disposal route can be identified;
- ▲ Any 'hotspot' stockpiles and excavations should be fenced off, have appropriate signage and their locations recorded on a Site drawing;
- ▲ Should any excavated material be required to be disposed of at an off-Site location, the material will be isolated from all other material at the Site prior to disposal at a suitably licensed facility. All documentation associated with the movement and disposal of any such material will be supplied to The Environmental Consultant, including waste transfer documentation;
- ▲ Subject to appropriate Site Health & Safety controls (typically comprising fencing off the excavation) the excavation will remain open until the validation has been completed. Alternatively, for Site Health & Safety reasons, it may be necessary to backfill the excavation with Site derived material. In this case, the location of the excavation will be accurately recorded, and the excavation reopened if required, based on the validation results; and
- ▲ The Regulatory Authorities shall be informed by the Environmental Consultant of any remedial activities required and associated validation testing results. Representatives of these organisations may also wish to visit the Site.

Appendix C – Generic Assessment Criteria



Generic Assessment Criteria – Imported Soils

Island Road, Reading

Compound	Imported General Fill Commercial GAC	Topsoil/Sub-soil (upper 300 mm) Residential GAC	Source
General			
Asbestos	Absent	Absent	-
All imported soils to be free of visual or olfactory evidence of contamination. No imported fill materials should increase the potential contaminant load at the Site.			
Metals			
Arsenic	640	40	LQM
Boron	240000	11000	LQM
Cadmium	190	85	LQM
Chromium III	8600	910	LQM
Chromium VI	33	6	LQM
Copper	68000	7100	LQM
Lead	2300	310	C4SL
Mercury (inorganic)	1100	56	LQM
Nickel	980	180	LQM
Selenium	12000	430	LQM
Zinc	730000	40000	LQM
Hydrocarbons & VOC			
Aliphatic EC5-EC6	TPH not to exceed 5000 mg/kg and should not contain detectable concentrations of VOCs and short chain hydrocarbons <C10. The source of all imported general fill materials, other than virgin aggregates should be confirmed with Delta-Simons prior to use with test data provided for review.	42	LQM
Aliphatic >EC6-EC8		100	LQM
Aliphatic >EC8-EC10		27	LQM
Aliphatic >EC10-EC12		130	LQM
Aliphatic >EC12-EC16		1100	LQM
Aliphatic >EC16-EC35		65000	LQM
Aliphatic >EC35-EC44		65000	LQM
Aromatic >EC5-EC7		370	LQM
Aromatic >EC7-EC8		860	LQM
Aromatic >EC8-EC10		47	LQM
Aromatic >EC10-EC12		250	LQM
Aromatic >EC12-EC16		1800	LQM
Aromatic >EC16-EC21		1900	LQM
Aromatic >EC21-EC35		1900	LQM
Aromatic >EC35-EC44		1900	LQM
Aromatic and Aliphatic >EC44-EC70		1900	LQM
TPH	TPH not to exceed 5000 mg/kg		-
Polycyclic Aromatic Hydrocarbons (PAH)			
Naphthalene	190	2.3	LQM
Acenaphthylene	83000	2900	LQM
Acenaphthene	84000	3000	LQM
Fluorene	63000	2800	LQM
Phenanthrene	22000	1300	LQM
Anthracene	520000	31000	LQM
Fluoranthene	23000	1500	LQM
Pyrene	54000	3700	LQM
Benzo[a]anthracene	170	11	LQM
Chrysene	350	30	LQM
Benzo[b]fluoranthene	44	3.9	LQM
Benzo[k]fluoranthene	1200	110	LQM
Benzo[a]pyrene	35	3.2	LQM
Indeno[123-cd]pyrene	500	45	LQM
Dibenz[ah]anthracene	3.5	0.31	LQM
Benzo[ghi]perylene	3900	360	LQM