



Land at North Street, Reading, RG1 7DA

**REMEDIATION OPTIONS APPRAISAL AND
METHOD STATEMENT**



Beard Construction Limited

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REPORT ISSUE AND TRACKING

ISSUE	DATE	Written by	Comment
1	11/03/2021	Stephen J Fisk BSc FGS	-
		Reviewed and approved by	
		Matt Paddock MSc FGS	
2	12/03/2021	Stephen J Fisk BSc FGS	Updated to consider tree protection areas
3	31/03/2021	Matt Paddock MSc FGS	Updated with comments from client.

1.0 INTRODUCTION

Paddock Geo Engineering Limited (PGE) was instructed by Beard Construction Limited; the Client, to undertake a supplementary contamination assessment and prepare a Remediation Options Appraisal and Method Statement (RMS) as Stage 2 (formerly referred to as Phase 3) of a Site Contamination Assessment for the proposed development of the subject site, referred to Land at North Street, Reading, RG1 7DA.

The site covers an area of approximately 0.23Ha and comprises a roughly rectangular parcel of land which is relatively level in topography with a slightly slope rising to the south. The site is surfaced with hardstanding of macadam with concrete present representing the floor slab or former structures and parking areas. An abandoned caravan was present on site along with significant fly tipped refuse.

The subject area is located in a mixed use area in the northern outskirts of Reading town centre with an ambulance station to the north, high density residential properties to the south and west and an industrial estate to the east.

A Site Location Plan is presented in Appendix A.

1.1 Terms of Reference

- British Standard (BS) 10175:2011 Investigation of Potentially Contaminated Sites – Code of Practice.
- British Standard (BS) 8485:2015+A1:2019 Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings.
- British Standard (BS) 5930:1999+A2:2010 Site Investigation Code of Practice.
- British Standard (BS) 8576:2013 Guidance on Investigations for Ground Gas - Permanent Gases and Volatile Organic Compounds (VOC)
- NHBC report No 10627-R01(04) Guidance on development proposals on sites where methane and carbon dioxide are present, March 2007
- CIRIA C665 Assessing Risks Posed by Hazardous Ground Gases to Buildings. CIRIA 2007.
- CIRIA C735 Good Practice on the Testing and Verification of Protection Systems for Buildings Against Hazardous Ground Gases, CIRIA 2014.
- CLR7 Assessment of Risks to Human Health from Land Contamination, 2002, DEFRA / Environment Agency (*currently withdrawn*).
- CLR8 Potential Contaminants for the Assessment of Land, 2002, DEFRA / Environment Agency (*currently withdrawn*).
- and Contamination Risk Management (LCRM), 2020, Environment Agency
- Land Contamination Risk Management (LCRM), 2020, Environment Agency
- Environmental Protection Act: 1990 – Contaminated Land Statutory Guidance, April 2012, DEFRA.
- GPLC1 Guiding Principles for Land Contamination, 2010, Environment Agency.

- PPG23 (PPS23) Planning and Pollution Control (contaminated land aspects), 2002 (*currently withdrawn*).
- SC030114/R1 Verification of Remediation of Land Contamination Guidance Document, 2010, Environment Agency.

1.2 Overview of Previous Works

A Phase 1 Contaminated Land Assessment (equivalent to Preliminary Contamination Risk Assessment or PRA) and a Phase II Ground Investigation (GI) and Site Contamination Assessment (SCA) were produced for the site by WSP UK Ltd on behalf of Reading Borough Council. We understand that Beard Construction Limited (Beard) have been appointed as Principal Contractor for the proposed works for which those reports were commission and have reliance upon these report as appointed by the Council. PGE have not had sight of the Phase I report, however, the Phase II report, of which we have received a copy, summarises the finding of the Phase I and is considered to supersede the earlier report.

Further to the above, additional works were undertaken by Paddock Geo Engineering Limited (PGE) in 2021 at the request of Beard with respect to geotechnical design of the project. During the geotechnical works potential contamination was identified and follow on works were carried out to confirm and delineate the contamination identified and provide a supplementary contamination assessment to augment the initial finding of the WSP report and advise if further consideration of the proposed remediation works recommended was required. The findings of this assessment have not been incorporated into this report.

The geotechnical works undertaken will not be referred to here, except where appropriate and relating to the potential contamination identified during the works.

The former WSP works are summarised in the following reports which should be read in conjunction with this RMS. The conclusions and assessment of this report are predominantly based upon these report, excepting the potential hydrocarbon contamination identified and assessed by PGE and no liability can be accepted by PGE for omission or errors in the third party report.

- Phase I Contaminated Land Assessment by WSP UK Ltd, Report reference 70012984-006 Issue 2, dated September 2017
 - Phase II Geo-Environmental Risk Assessment by WSP UK Ltd, Report reference 7012984-020, dated March 2020
- **Phase I - 70012984-006, dated September 2017 by WSP UK Ltd.**

The Phase I report was summarised within the forwarded Phase II report. A copy was not forwarded to PGE. The Phase 1 report was indicated to be used to produce a preliminary Conceptual Site Model (CSM) which identified potentially complete Source-Pathway-Receptor linkages and required further consideration and works to confirm the model assumption.

Potential sources of contamination were identified as;

- Made Ground associated with past development (on-site)
- Historical coal-fire ash disposal (on-site)
- Industrial land to the north and east (off-site)

Potential receptors that could be impacted by contamination were identified as;

- Current and future users of the site (future residents / visitors)
- Off-site works and adjacent site users (residential and commercial)
- Controlled waters (Secondary A Aquifer / Principal Aquifer)
- Controlled waters (Potable abstraction – closest 300m southeast)
- Controlled waters (Off-site surface water – to north)
- Foundations and services associated with the new residential building (not pertinent to human health – not considered further).

Potential Pathways between source and receptor were identified as;

- Direct Dermal Contact (Proposed soft landscaping within development)
- Direct Ingestion (Proposed soft landscaping within development)
- Inhalation (Migration and build-up of volatile contaminants and ground gases)
- Leaching of contaminants into controlled waters

Given that potential viable pollution linkages were identified a Phase II ground investigation including contamination testing and assessment was recommended and carried out to confirm the findings of the Phase I assessment.

- **Phase II - 7012984-020, dated March 2020 by WSP UK Ltd.**

The main fieldworks were carried out between 13th to 21st January 2020 and comprised the forming of 3no. boreholes using track-mounted percussion liner sampling techniques, and 3no. rotary boreholes. The exploratory boreholes were undertaken to assess the ground conditions and recover samples for subsequent laboratory testing.

Additional geotechnical works were carried out such as shallow dynamic probing however these will not be discussed as are not deemed relevant to the assessment of the contamination profile of the site.

The percussion liner sample boreholes were formed to depths of between 3.0m and 4.0m below existing ground level (begl). The rotary boreholes were progressed to depths of between 15.5m and 17.0m bgl.

Combined ground gas and groundwater monitoring wells were installed within the boreholes and a series of 6no. return monitoring visits undertaken. The installation pipes were former using 50mm diameter HDPE pipe with pea gravel filter pack and bentonite seal. Full details of the well construction are given within the WSP report. The response zones for the three deeper rotary boreholes are within the Seaford Chalk Formation. Response zones within the shallow boreholes are located within the Alluvium (WS101 and WS103) and the Made Ground (WS102).

Samples were recovered in suitable containers for chemical analysis from the top metre of soils from the general site area and further samples recovered from areas of the site which were highlighted as having or located adjacent to potentially contaminative land uses within the associated Preliminary Risk Assessment. Shallow samples were also screened olfactorily and using headspace analysis and a PID for VOCs.

The boreholes showed a similar profile across the site with hardstanding at surface of between 0.05m and 0.36m in thickness over variable Made Ground to between 0.50m and 2.0m.

The natural soils encountered directly underlying the Made Ground comprised highly variable fine and coarse grained Alluvium to between 1.60m and 5.90m depth over coarse grained Taplow Gravel within one location only (BH102) underlying the Alluvium between 1.60-2.65m depth.

Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) deposits were encountered across the site at depths of between 2.65m and 5.90m bgl and was recovered as a mixture of matrix and clast dominated structureless Chalk to the base of all boreholes.

Further details on the geological profile encountered and the boreholes logs are presented within the WSP report.

The report states;

“No olfactory evidence and minimal visual evidence of contamination was observed during the ground investigation. Visual evidence generally consisted of brick and concrete within the Made Ground other notable evidence consisted of isolated coal fragments within WS102 between 1.30m to 1.50m bgl.

No PID readings were recorded above 0.1ppm across the Site.”

Groundwater was encountered within BH103 at 3.20m rising to 2.90m in 20 minutes during the initial investigation. Groundwater was also recorded within WS102 at 2.70m upon completion of drilling. No groundwater strikes were recorded within the other boreholes; however, it is noted that water was added to aid drilling, which can mask minor groundwater seepages and slow inflows.

Subsequent monitoring of the monitoring installation indicated groundwater levels of between 36.43m AOD and 38.91m AOD. The report states;

“Groundwater within the chalk was detected between 36.43m and 36.82m AOD. No true groundwater was detected within the shallow boreholes (WS101 to WS103), groundwater recorded is likely residual drilling water at the base of the wells or seepage from surface.

The resting level of the groundwater within BH101 to BH103 all installed within the underlying chalk strata is similar during each monitoring round. Within BH101 and BH103 the groundwater is resting within the alluvium while BH102 groundwater is resting in the chalk suggesting a degree of hydraulic conductivity between the alluvium and chalk.”

The soil samples from the boreholes were subject to a suite of chemical contamination testing which indicated that elevated concentration of **lead** and **beryllium** were encountered within several samples of the near surface Made Ground soils subject to testing. In addition, one sample of seven subject to testing indicated positive for the presence of asbestos. The sample from BH103 at 0.40-0.50m recorded trace **chrysotile asbestos** present with subsequent quantification testing indicated a concentration of <0.001%.

Contamination sampling and testing was also undertaken concentration within groundwater samples were generally in the same order of magnitude or below the LOD within all three boreholes.

On the basis of the elevated metals and asbestos within the Made Ground and the presence of soft landscaping within the proposed development, the soils on site were deemed to pose a potential risk to the proposed end users of the site. As such the report concluded that;

“In order to provide a suitable growing medium and provide a barrier between end users and the shallow soils in areas of proposed landscaping, it is recommended that a suitable thickness of topsoil/soil-forming material is imported to Site. Following installation of these measures, there will be no direct exposure pathway between future site users and the substances present in the shallow soils.”

As no volatile contamination was identified and as the building footprint and hardstanding will cover significant areas of the site and would sever any potential pollutant linkages remediation due to contamination within the sub-surface soils is only deemed necessary within open soft landscaped area of the site.

Ground gas monitoring was undertaken on six occasions during January and February 2020. The results showed a maximum concentrations of carbon dioxide between 3.20% and 5.3% with the highest flow rate of 1.80l/hr, however, this was a short initial burst and dropped to a steady rate of 0.2l/hr which was used for calculations. The calculated worst case GSVs recorded for the site was 0.011l/hr which would allow a site classification of characteristic Situation 1 (CS1) or Green under the NHBC Traffic Light System. One of the monitoring visits was undertaken at a period of low pressure (<1000mb).

As CO₂ concentrations of >5% were recorded it is recommended that the site is classified as Characteristic Situation 2 (CS2) or Amber 1 in accordance with NHBC Traffic Light System.

Groundwater samples were also recovered from the deeper boreholes (BH101, BH102 and BH103) within the Chalk strata during the monitoring phase. The samples were recovered using low flow sampling techniques and decanted into appropriate containers for subsequent laboratory testing. A chain of custody was maintained during the transport from site to the testing laboratory.

The testing was compared to a number of thresholds including, Freshwater Environmental Quality Standards (EQS) 2015, for surface water receptors and UK Drinking Water Standards (UK DWS), for groundwater receptors; and World Health Organization Standards (i.e. for MTBE and Xylene), in the absence of UK based criteria for groundwater receptors.

The testing of the groundwater indicated concentration generally below the limit of detection (LOD) or at low detectable levels for the majority of determinands. The sample from BH103 indicated elevated Nickel, however, the most conservative threshold for nickel assuming 100% bioavailability was used and as such is considered high conservative. As such this single marginal elevation is not considered to present a significant risk. Ammoniacal nitrogen was noted to exceed both the EQS and DWS criteria, however, as the leachable concentration indicate low level of Ammoniacal nitrogen across the site, this was conjectured to be from an off-site source.

In addition to the above all Aliphatic / Aromatic hydrocarbons and BTEX compounds were below the LOD within the groundwater samples.

1.3 Supplementary Contamination Assessment

A series of additional cable percussion boreholes were in January 2021 for the purpose of geotechnical assessment on the site. During the drilling of one of the boreholes (CP3) some blue grey staining and hydrocarbon odours were noted at a depth of c.4-5m depth. This was conjectured to potentially be undegraded diesel fuel.

As such, the client was consulted and advised that supplementary investigation would be prudent to confirm and potentially delineate the hydrocarbon contamination.

An additional 6no percussion liner sample boreholes (WS1-WS6) were undertaken on 17th February 2021 in an expanding circle around the initial discovery borehole BH03. The boreholes were targeted to a depth of 6.0m as the previous indication of potential contamination was identified at c.4-5m depth.

Within these boreholes similar profile was encountered to that previously identified on site with a thin veneer of Made Ground to between 0.30-0.80m depth over variably firm sandy gravelly CLAY and clayey SAND and GRAVEL considered to be Taplow Gravel Member

Localised bands of soft dark brown sandy gravelly CLAY considered to be Alluvium were encountered within WS2 (0.30-1.0m) and WS4 (0.45-0.80m).

Underlying the site at depth (Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) was encountered within all six boreholes from depths of 1.55m and 2.90m bgl and proven to the base of all six boreholes. The Chalk comprised Structureless CHALK composed of cream slightly sandy slightly gravelly SILT. Gravel is extremely weak to very weak low to medium density angular to sub-angular chalk and frequent fine to coarse flint.

Localised blue grey staining with an associated fresh diesel range hydrocarbon odour was observed within all six of the boreholes, typically at depths of around 3.35-4.65m with deeper staining and odours noted within WS2 down to 5.95m depth.

Samples were recovered in suitable containers for chemical analysis targeting the stained and odorous zones.

Samples were also screened olfactorily and using headspace analysis and a PID for VOCs. The VOC results indicated reading of between 0 and 59.2.

A total of 6no. soil samples were sent to an external laboratory to obtain Speciated TPH Aliphatic / Aromatic splits as per the TPH CWG Methodology, BTEX and MTBE.

All samples indicated concentration of that MTBE and BTEX were below the limit of detection (LOD).

The light Aliphatic and Aromatic fractions, similarly to the PID screening, indicate that if present, concentrations were very low and below the LOD. Some of the heavier Aliphatic and Aromatic (C10 and above) fraction indicated detectable concentration, however, these were generally low and are all below the relevant Generic Assessment Criteria based upon the Contaminated Land Exposure Assessment (CLEA) methodology as detailed within LCRM 2020. The assessment criteria employed are based on the proposed final land use of the site. For this site, a worst-case proposed land use of 'Residential with Home Grown Produce' has been employed for the site which is an overall conservative approach as some soft landscaping areas are included within the proposed development.

On the above basis, the minor hydrocarbon staining identified at below 3m depth is not considered likely to represent a significant source of contamination and unlikely to pose a significant risk to the site end users as end users are unlikely to come into contact with impacted material within typically use of soft landscaping areas.

The hydrocarbons identified were typically of the heavier fractions and as such are less likely to present a vapour risk; however, as ground gas protection measures are to be installed on the site it is recommended that a suitable hydrocarbon resistant membrane is employed as a precautionary measure.

The initial limited delineation works were inconclusive and did not highlight a clear source or direction of the contamination.

The levels of identified soil hydrocarbon concentrations are low and as the previous WSP investigation did not identify any elevated hydrocarbon concentrations within the groundwater beneath the site, this source is not considered to be impacting the underlying controlled water.

1.4 Regulatory Liaison

The Local Planning Authority were consulted by the Client for comment. It is understood that the previous Phase I and Phase II reports have been forwarded to them for review.

2.0 PROPOSED DEVELOPMENT

The proposed development is indicated by the Client to involve the construction of 41no residential units in a single multi wing structure along with soft landscaping areas, access and parking and associated infrastructure.

Proposed development plans are presented in Appendix A.

3.0 PARTIES AND RESPONSIBILITIES

The parties involved in the design, construction and operation of the remediation are categorised according to their roles as follows:

Current Owner	Reading Borough Council
Developer	Beard Construction Limited
Architects / Designers	Unknown
RQA Supervision	Paddock Geo Engineering Limited (PGE)
Remediation Design	Paddock Geo Engineering Limited (PGE)
Regulators	Reading Borough Council Environment Agency
Analytical Testing Laboratory	I2 Analytical Limited, Watford (UKAS Accredited Testing Laboratory No. 4041)
Waste Haulier	To be confirmed
Waste Disposal Site	To be confirmed
Ground Gas Protection Installer	To be confirmed
Remediation Contractor	To be confirmed

4.0 RISK MANAGEMENT OPTIONS APPRAISAL

4.1 Introduction

The proposed development (as detailed in Section 2.0) will include the development of the site with residential dwellings including associated access, parking, infrastructure and soft landscaping. The nature of the proposed development is considered highly sensitive due to the residential nature of the proposed development.

The Phase II Ground Investigation and associated contamination assessment indicated that elevated concentration of metals and asbestos was present within the Made Ground soils on site. It was concluded following the ground investigation that it would be necessary to put in place measures to ensure that this soil is not able to be contacted by the end users of the site.

In addition, ground gas monitoring indicated that the site should be classified as Characteristic Situation 2 / Amber 1 and ground gas protection measures would be required.

Subsequent investigation indicated that hydrocarbon impacted soils are located at depth beneath the site. Laboratory testing indicated that the hydrocarbon contamination is at low levels and is unlikely to pose a significant risk to the end users or underlying controlled aquifer; however, this soil contamination may result in an odour nuisance from ingress into the proposed new structure. To mitigate this it is recommended that a hydrocarbon resistant membrane be used as part of the required ground gas protection measures.

4.2 Remedial Objectives

Remedial works are regarded as a form of risk management, the aim of which is to demonstrably break the chain of any potentially unacceptable pollutant linkages that connect contaminant sources to receptors via pathways on site. The aims of the remedial works are:

- To ensure that human health (site end-users including future residents, visitors and ground workers including construction and future maintenance workers) are not exposed to elevated concentrations of hazardous substances on site.
- Ensure that any remedial works overcome any perceived risks or blight associated with the previous use of the site and any potential associated contamination.

4.3 Source, Pathway and Receptor Management

A Source Pathway Receptor Conceptual Ground Gas Model was produced for the site within the former WSP Phase II investigation. There are three potential options to break the pollutant linkages at the site. These options are presented below:

4.3.1 Source Reduction

This involves the reduction, removal, modification or destruction of the contamination source. Applicable techniques include:

- Source removal through excavation and disposal of contaminated soils and any associated contaminated infrastructure.
- In-situ or ex-situ physical, chemical, biological and thermal source reduction methods.

4.3.2 Pathway Management

This involves the prevention of movement of contaminants on route to receptors. Applicable techniques include:

- Removal or destruction of contaminants e.g. bioactive zones.
- Preventing pathways from operating e.g. ground gas protection membrane.

4.3.3 Receptor Protection

This protects the receptor by modifying activities and behaviour to reduce exposure and is not normally classed as remediation, but as risk reduction. It is generally a less favourable method for mitigating the risk from contamination. Applicable techniques include:

- Restricting or changing the land use e.g. change to residential use without gardens.

- Changing the design, layout or the proposed construction e.g. adding hardstanding to problem areas.
- Restricting access of the receptor e.g. fencing or walls.

4.4 Viable Remediation Techniques

As with any proposed remedial works, the size, scale and nature of the site, site characteristics, quantity, type and extent of contaminated material present in soils and groundwater, the time frame, cost / benefit analysis and value and the sustainability of the remedial method must all be considered when exploring remedial options. A Remediation Option Matrix for the site is presented in Appendix C.

A range of remedial technologies exist and have been explored and the methods considered most viable for the site are listed below.

4.4.1 Excavation and Disposal

Excavation and disposal (colloquially known as dig and dump) is the most basic of remedial techniques, but often most effective. Contaminated soils and any associated infrastructure i.e. buried pipework and impacted materials such as concrete bases are removed either in their entirety or to acceptable levels to allow the inclusion of an inert capping layer. Contaminated materials are generally disposed of to landfill void, material recovery or soil treatment facilities.

The drawback of this technique is the potential for spiralling costs due to unknown and potential non-sustainable quantities of material and increased disposal costs. This method is also generally not considered suitable for deep contamination deeper than 2m bgl due to large volumes which would require disposal and the potential for ground instability from such an excavation.

Due to the relatively small and limited depth of Made Ground on site where metal and asbestos contamination was identified the excavation and disposal of these soils is considered a viable remedial approach as only limited quantities of soil will require removal and replacement. This is considered to be a practical, cost effective and environmental-friendly approach.

4.4.2 Cover System

A cover system is generally employed along with Excavation and Disposal of contaminated soils to separate end site users from impacted soils which remain at depth on the site due to their low risk of mobilisation to impact off site receptors.

A cover system comprises a cover of clean soil, often imported to the site, with a marker layer at its base often comprising a differing colour soil layer than the host soil and/or a geomembrane barrier to physically limit direct contact with the remaining impacted soils.

A minimum 300mm thick topsoil layer is generally included at surface in areas of the site which are proposed to be soft landscaped.

The thickness of the cover system depends on the concentrations of contaminants present on the site and the background concentrations of the contaminants within the cover soils. The

depth is calculated using the BRE Cover Systems spreadsheet¹ however, as the contaminant identified is asbestos the BRE Cover System spreadsheet is not applicable to specify the required depth in this case.

This is considered to be a suitable approach for the site as an addition to excavation and disposal of the impacted soils.

4.4.3 Soil Stabilisation

Soil stabilisation is achieved by the reaction of contaminants with reagents to promote sorption, precipitation or incorporation into crystal lattices.

This is not deemed viable at the site due to the presence of residential garden areas on site.

4.4.4 Solidification

Solidification is a remediation technology that involves the addition of reagents to a contaminated material to impart physical and dimensional stability to contain contaminants in a solid product and reduce access by external agents (e.g. air and rainfall).

This technology is not viable within the proposed residential garden areas or within or close to the residential dwelling building footprint due to potential drainage and possible geotechnical issues.

4.4.5 Chemical Oxidation

In its simplest form, chemical oxidation remediation comprises the introduction of an oxidation agent into the ground or a stockpiled material to allow an oxidation reaction to occur (in soil and groundwater) and convert the contaminants to a lower risk form.

For in-situ treatment, this method requires permeable soils to allow the circulation of treatment chemicals which are generally in an aqueous form. This method is not suitable due to the nature of the contaminants (asbestos) and the poor permeability of the near surface Made Ground.

4.4.6 Monitored Natural Attenuation

This method comprises the natural attenuation of contaminants in soil and groundwater through various means such as natural bio-gradation, abiotic oxidation, sorption, volatilisation and dispersion, with monitoring to assess the progress of the attenuation. For this method to be viable, the affected soil must be physically and chemically suitable and demonstrate that natural attenuation is occurring or could have the ability to occur.

Due to the nature of the contaminant present on site this option is only deemed viable for the degradation of the identified hydrocarbon contamination at depth beneath the BH3 area of the site.

¹ Based on worst case lead and PAH concentration and:

Cover systems for Land Regeneration: Thickness Design of Cover Systems for Contaminated Land, BRE. 2004.

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4.4.7 Gas Protection Measures

The elevated concentration of ground gases identified on the site are considered likely to be from an off site source and as such it is not possible to reduce the source within the development site. Therefore, a pathway management system is required to prevent build up and ingress of ground gases within structures that will protect the end site users. This is a guidance prescribed process based on the levels of gases identified and is explained in further detail in Section 5.3 below.

4.5 Remedial Sustainability

As discussed in Section 4.0, a range of remedial options have been investigated and several factors considered within the option appraisal process including; efficiency and effectiveness of the remedial technique, potential costs, haulage movements on and off-site and potential carbon emissions, other environmental factors, accurate focusing of remedial works, timescales and the general overall benefits.

4.6 Most Viable Remedial Option

It is considered that the most viable soil remediation method for the site, given the asbestos contamination identified is the excavation of the Made Ground materials within the proposed soft landscaping areas and replacement with imported clean suitable Topsoil material. This will prevent the proposed site users coming into contact with the potential metal contamination and asbestos within the Made Ground soils.

None of the remaining remedial options outlined in Section 4.0 are considered practical or suitable for the site with respect to the metal and asbestos contamination within the Made Ground.

With respect to the ground gas risk, specific ground gas protection measures are prescribed within the relevant guidance, which effectively equate to a form of pathway management. The relevant guidance is listed below;

- BS 8485:2015. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings. British Standard Institute. 2015
- BRE414: 2001 Protective measures for housing on gas-contaminated land. Building Research Establishment: 2001
- BS8576: 2013. Guidance on Investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs). British Standard Institute. 2013.
- CIRIA C665 Assessing risks posed by hazardous ground gases to buildings. CIRIA 2007
- NHBC report No 10627-R01(04) Guidance on development proposals on sites where methane and carbon dioxide are present, March 2007
- CIRIA C735 Good Practice on the Testing and Verification of Protection Systems for Buildings Against Hazardous Ground Gases, CIRIA 2014.

5.0 REMEDIATION ACTION REQUIRED

5.1 Introduction

The remedial measures required are detailed in this section of the report and comprise the removal of the shallow Made Ground containing metals and low levels of asbestos in the proposed soft landscaping areas and replacement with imported clean soils including clean imported suitable Topsoil material at surface, to provide a separation between these impacted soils and the end site users to allow a break of the related S-P-R linkages.

In addition, the installation of suitable ground gas protection measures, to provide a physical barrier between the ground gases identified within the soils underlying the site to prevent ingress and build-up within the proposed properties, to allow a break of the related S-P-R linkages.

5.2 Remedial Action – Removal of near surface metal and asbestos impacted Made Ground in soft landscaping areas and Construction of Cover System

Low levels of asbestos and elevated lead and beryllium were recorded within the Made Ground across the site within the Phase II investigation.

A minimum of 600mm separation² from the end site users is required in open soft landscaped areas of the site given the impacted Made Ground materials identified on the site. It is anticipated that in many areas of the site the 600mm separation will effectively remove all of the Made Ground. The actual depth of excavation and soil removal to facilitate the cover system construction will depend upon the supervising Remediation Engineer and the final proposed site levels.

The remediation excavations will require backfilling to facilitate the development and construct the cover system. The required 600mm depth cover system should be constructed of clean soils. This should include a Topsoil cover layer of at least 300mm at surface in areas of general soft landscaping, or a clean Topsoil surface cover layer of at least 150mm within tree protection zones. In areas of the site where impacted Made Ground remains a geomembrane marker should be installed. This action should be directed on site by the Remediation Engineer.

Trees are located on or in the vicinity of the site which are subject to Tree Protection Orders and associated root protection no dig zones. These associated protection zone cover significant areas of the proposed soft landscaping on site, particularly within the southeast area. Due to the root protection zone of these trees, it is not possible to excavate impacted soils in these areas to construct the required cover system. These landscaped areas are of communal soft landscaping which are likely to be lawned and not used as productive garden areas. On the above basis, a surface dressing of 150mm Topsoil should be implemented within the root protection areas. As Made Ground will remain in these areas a geomembrane marker will be required at the base of the cover system.

A chemically and geotechnical suitable fill material will need to be used to construct the cover system and infill the remediation excavation upon completion. See Section 5.5 for remediation excavation backfill/cover system construction and material details.

A potential pathway between potentially asbestos impacted soils and other users of the site, such as construction and maintenance workers, could remain if any of the impacted Made Ground remains following the remedial cover system construction and as such works carried out on the where asbestos fibres have been identified must be carried out by a suitable contractor and a site specific Health and Safety Plan for site construction workers must be produced in line with CAR 2012².

A plan indicating the area of the site which require remediation is presented in Appendix D.

All soils excavated as part of the works on site should be loaded immediately into a haulage vehicle for removal or placed on bunded geo-membrane and covered to prevent the generation of wind-blown dust. The material should be removed off-site once the waste has been classified and a disposal destination selected.

Alternatively given the low levels of asbestos identified and the non-volatile nature of the metal contamination within the Made Ground soils, the material excavated could if physically suitable, be safely incorporated as sub-base beneath the areas of hardstanding such as the car park hardstanding. As such the overlying building or hardstanding will effectively act as a cover system preventing the proposed site users coming into contact with the potential asbestos within the Made Ground soils. If the material is replaced on the site a record of the locations should be kept.

It is recommended that the Client considers the use of a soil treatment facility as opposed to landfill, not only is this a more sustainable approach but also a more cost effective one.

5.3 Remedial Action – Ground Gas Protection Measures

Based upon the current guidance the calculated GSVs from monitoring undertaken to date the site falls into Characteristic Situation 2 (CS2) as per Table 2 within BS 8485:2015 or as Amber 1 based upon NHBC traffic light system outlined in NHBC report No 10627-R01(04).

Based upon Table 4 within BS8485:2015 and taking into account the type of building and the characteristic situation of the proposed development, a gas protection score of 3.5 would need to be achieved by the gas protective measures put in place.

When the minimum gas protection score has been determined for the building as a whole, or for each part of the building, then a combination of two or more of the following three types of protection measures should be used to achieve that score:

- the structural barrier of the floor slab, or of the basement slab and walls if a basement is present;
- ventilation measures; and
- gas resistant membrane.

Tables 5, 6 and 7 within BS8485:20015 outline the various measures for structural barriers, ventilation measures, and gas resistant membranes that produce points and can contribute

² Control of Asbestos Regulations 2012

to the total point score required for gas protection measures. No more than one element of each type (i.e. from each Table) should be combined to achieve the recommended gas protection score.

To achieve the appropriate Points Score required for Characteristic Situation (CS) 2 the protection measures should comprise:

For Characteristic Situation 2:

Structural Barrier – Precast suspended segmented floor, i.e. beam and block (0 point), Cast insitu ground bearing floor slab (0.5 point), or cast insitu monolithic ground bearing raft or reinforced cast in situ suspended floor slab (1 to 1.5 points)

Membrane – A suitable gas resistant membrane (2 points)

Ventilation – Pressure relief pathway (0.5 points), passive sub floor dispersal layer such as clear void, polystyrene void former blanket, geocomposite void former or no fine gravel layer with gas drains (1.5 to 2.5 dependent upon performance), an active dispersal layer usually comprising fans (1.5 to 2.5 point), active positive pressurization (1.5 to 2.5 point) or ventilated basement / undercroft car park (4 points).

Given the deeper hydrocarbon contamination identified within the supplementary investigation in February 2021 which presents a potential odour nuisance, a hydrocarbon resistant membrane should be employed as part of the ground gas protection measures.

The gas membrane should be fitted by a suitably qualified person and the fitment validated by the Remediation Engineer.

Where the NHBC classification is utilised as per Note 3 from Table 3 – Building Type within BS8485:2015 the NHBC guidance assumes these Type A categorised buildings utilised beam and block floor construction with clear void ventilation. As such the design choice variables are limited to decisions relating to the membrane specification and verification recommendations. Designers utilising this system therefore need to refer to the NHBC guidance to assess compliance for specific recommendations.

The protection measures should comprise:

For Amber 1

“Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414 (Johnson, 2001). Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.”

As outlined in CIRIA C665. Additional details are outlined within Table 1: Typical NHBC expectations and verification requirements of NHBC Technical Extra Issue 20 dated April 2016

Ventilation – subfloor venting to achieve at least one air exchange per day (minimum 150mm void height; 1500mm²/m air vent opening or 500mm²/m² floor area spaced at not more than 2m centres on at least two opposing sides).

Membrane – must be suitable for purpose.

Membrane installation / design – to achieve complete integrity across the entire building footprint. Penetration and joints sealed.

Given the deeper hydrocarbon contamination identified within the supplementary investigation in February 2021 in the BH3 area to the south of other site which presents a potential odour nuisance, a hydrocarbon resistant membrane should be employed as part of the ground gas protection measures.

The above recommendation and design approaches are subject to agreement by the relevant regulator.

A suitably qualified engineer or similar should be consulted to allow the detailed design of the proposed gas protection measures and ground floor interaction to be considered.

The gas membrane should be fitted by a suitably qualified person and the fitment validated by the Remediation Engineer.

5.4 Remedial Action – Watching Brief

Based upon the supplementary works that identified minor indication of hydrocarbon staining at depth within the Chalk it is possible that an unidentified source of hydrocarbon contamination could remain on site within the shallow soils. As such a watching brief should be maintained during the initial site strip and earth works during the development. Should any signs of contamination such as staining, brightly colour material or odorous soils be encountered during excavation, work should cease in that area and PGE should be contacted to advise.

5.5 Backfilling of Remediation Excavations

The remediation excavations will require backfilling to facilitate the development and construct the cover system. The required 600mm depth cover system should be constructed of clean soils. This should include a Topsoil surface cover layer of at least 300mm at surface in areas of general soft landscaping. The cover system can be reduced to a clean Topsoil surface cover layer of at least 150mm within tree protection zones.

In areas of the site where impacted Made Ground remains a geomembrane marker should be installed. This action should be directed on site by the Remediation Engineer.

In the first instance it is preferred to use site won soils and Topsoil sourced from the on-site groundworks/strip for backfilling, however, given the lack of suitable Topsoil type material on site this is unlikely to be a viable option on this site.

Any backfill soils must be certified clean before being reused from site or brought to site and it is recommended that Topsoil be imported from a reputable Topsoil supplier.

Topsoil employed should be a good quality growing medium and have been subjected to chemical testing (at the rate of a minimum of two samples per source and one sample per 1,000m³ thereafter).

The imported materials are required to meet the British Standard for Topsoil (BS 3822: 2015) and the PGE In-House total soil contaminant concentration GACs for a residential without plant uptake land-use scenario, which are included in Appendix E.

5.6 Remediation Quantities

It is unclear at the present how much material will need to be excavated and disposed as part of the remediation process. Calculations will be made in due course to enable appropriate cut and fill balance to be maintained at the site.

5.7 Waste Classification

Assessment of disposal of waste soils was outside the scope of the previous WSP and the current report.

5.4 Remediation Validation

The soil remediation works and the installation of the ground gas protection membrane shall be performed under the supervision of a suitably qualified person, who will fill the role of a Remedial Quality Assurance Engineer (RQA) which is required for validation purposes.

During the remedial works and following general site clearance, a watching brief shall be maintained such that should the sub-soil conditions in other areas of the site appear to be inconsistent with those found in the areas sampled, then this can be brought to the attention of the RQA Engineer and these recommendations reviewed.

The validation requirement for the installation of such membranes is detailed within the guidance document CIRIA C735 - Good Practice on the Testing and Verification of Protection Systems for Buildings against Hazardous Ground Gases, 2014 and the associated Yorkshire and Lincolnshire Pollution Advisory Group's document – Verification Requirements for Gas Protection Systems, 2016, which is an industry adopted guidance document which summarised the relevant CIRIA C735 standards to providing technical guidance for developers, landowners and consultants.

The membrane installation should be inspected at a frequency of 1 in 10 plots and verified by an independent party, with a minimum of 5 plots. The frequency of inspection can be reduced to 1 in 20 plots where the fitment and installation is undertaken by a qualified (relevant qualification is NVQ Level 2 in gas protection installation) and experienced installer (minimum one operative to hold qualification).

The objective of the Verification Report will be to document all aspects of the works undertaken and will include all records collected and maintained by the Client and their appointed construction team / remediation contractor/ membrane installer throughout the duration of the project.

Detailed records should be provided in line with the relevant guidance Remediation of Land Contamination (report SC030114/R1 dated 2010) and should include (but is not limited to) the following elements as a minimum;

Soil Remediation

- Details of the remediation arisings removed from the site following excavation and disposal destination (licensed facility).
- Details of imported soils and laboratory analysis results to classify
- A photographic record of the works.

Gas Protection Measures

- Description of gas protection measure installation including details of parties involved (designer, installer, and verifier) and copies of guarantees
- As built drawings showing the protection measures
- Details of the membrane selected (the supplier should usually be able to provide a data sheet for any such membrane sourced).
- Details of deviations from original design with relevant explanations / justification
- A photographic record of the installation of the membrane works
- Records of inspection of the membrane installation and records of faults rectified

Copies of the Validation Report will be provided to the concerned regulatory authorities, who will be asked to state whether they are satisfied with the level of detail provided and confirm that it appears to be reasonable given the data presented.

Based on the information supplied, they will then make a statement about whether the site is fit for its proposed residential end use to allow discharge of the related planning conditions.

Any substantial change to the remediation objectives will be agreed with the Local Planning Authority, as appropriate, prior to commencement and communicated to all relevant parties.

5.9 Health, Safety and Environmental Requirements

The construction operatives working on this site should take precautions commensurate with the degree of contamination identified in the previous contamination assessment reports produced for the site and detailed within the Construction Phase Health and Safety Plan.

Best practicable environmental protection should always be employed during the remediation and construction works.

Appropriate Health & Safety precautions including the use of signage, site inductions and toolbox talks to raise awareness of the risks on site, regular dampening down of stockpiles and site surfaces to minimise the generation of wind-blown dusts and the covering of stockpiles (where possible) and the use of PPE should be adopted. Respiratory PPE may be required for use by ground workers if suspect asbestos-containing materials are encountered.

Significant groundwater is unlikely to be encountered on site during the remedial works at the proposed depths. However, any groundwater encountered should be left in-situ if possible and if it is necessary to be removed off site, the water must be removed off site by a suitable tanker or treated, such as via the site oil / water interceptor system, prior to discharge.

6.0 REMEDIATION QUALITY ASSURANCE

The site remediation should be considered as a comprehensive process which requires clear and effective management. The Remediation Quality Assurance (RQA) procedures detailed in the Sections above have been included within the Remediation Method Statement to ensure that the objectives are achieved and that:

- The remediation is competent and of a high standard.
- The approach and actions taken are well documented.
- The Client should be confident that the remediation works are suitable for the indicated proposed end site use.

Following the installation of the clean cover system and correct fitment of the ground gas protection membranes a validation report shall be produce detailing all evidence of the above points.

REFERENCES

Investigation of Potentially Contaminated Sites – Code of Practice, British Standards Institution BS 10175:2001.

Code of Practice for Site Investigations, British Standards Institution BS5930: 1999+A2:2010

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National House-Building Council, NHBC Standards Chapter 4.2 'Building near Trees', 2003

CLR8 Potential Contaminants for the assessment of Land, 2002, DEFRA/Environment Agency.

BRE Special Digest 1 'Concrete in Aggressive Ground', 2001.

Contaminated Land Exposure (CLEA) Model version 1.03 developed by the Environment Agency, Department for Environment, Food and Rural Affairs and the Scottish Environment Protection Agency. 2008

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Land Contamination Risk Management (LCRM), 2020, Environment Agency

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Method for Deriving Site-Specific Human Health Criteria for Contaminants in Soil, SNIFFER, 2003.

Technical evaluation of the Intervention Values for Soil/Sediment and Groundwater, RIVM Report 711701 023, National Institute of Public Health and the Environment, 2001.

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Hydrogeological Risk Assessment for Land Contamination Remedial Targets Worksheet, release 3.1 – October 2006

Mobilising Natures Army: Monitored Natural Attenuation – dealing with pollution using natural processes, Environment Agency. 2004

Remediation Targets Methodology: Hydrogeological Risk Assessment for Land Contamination, Environment Agency. 2006

LFTGN01. Hydrogeological Risk Assessment for landfill and the derivation of groundwater control and trigger levels. Environment Agency 2003

NOTES AND LIMITATIONS

This report is produced for the sole use of the Client, and no responsibility of any kind, whether for negligence or otherwise, can be accepted for any Third Party who may rely upon it.

The conclusions and recommendations given in this report are based on our understanding of the proposed plans for the site in the future. If, however, the site is developed for a varying use, then a different interpretation might be appropriate.

The report has been prepared following the guidelines and principles established in the British Standards. It necessarily relies on the co-operation of other organisations and the free availability of information and total access. Where data supplied by the Client, including that from previous site investigations, have been used, it has been assumed that the information is correct. No responsibility can be accepted by PGE for inaccuracies within the data supplied.

No responsibility can, therefore, be accepted for conditions arising from information that was not available to the investigating team because of information being withheld or access being denied.

The scope of this Ground Investigation was discussed and agreed with the Client. No responsibility is accepted for conditions not encountered, which are outside of the agreed scope of work.

This report may suggest an opinion on a possible configuration of strata or conditions between exploratory points and below the maximum depth of investigation. However, this is for guidance only and no liability can be accepted for its accuracy. Comments on the groundwater conditions are based on observations made at the time of the investigation unless otherwise stated. It should be noted, however, that groundwater levels might vary due to seasonal or other effects.

It should be noted that this report is based solely on the samples collected in the borehole locations investigated. During the works and following general site clearance, should the sub-soil conditions in other areas of the site appear to be inconsistent with those found in the areas sampled then this geotechnical appraisal and site contamination assessment may need to be reviewed.

This report is prepared and written in the context of the proposals stated in the introduction to this report and it should not be used in a differing context. Furthermore, new information, improved practices and changes in legislation may require an alteration to the report in whole or in part after its submission. Therefore, with any changes in circumstances, or after one year from the date of the report, the report should be referred to Paddock Geo Engineering Limited for re-assessment (and, if necessary, for an estimate for the cost of such).

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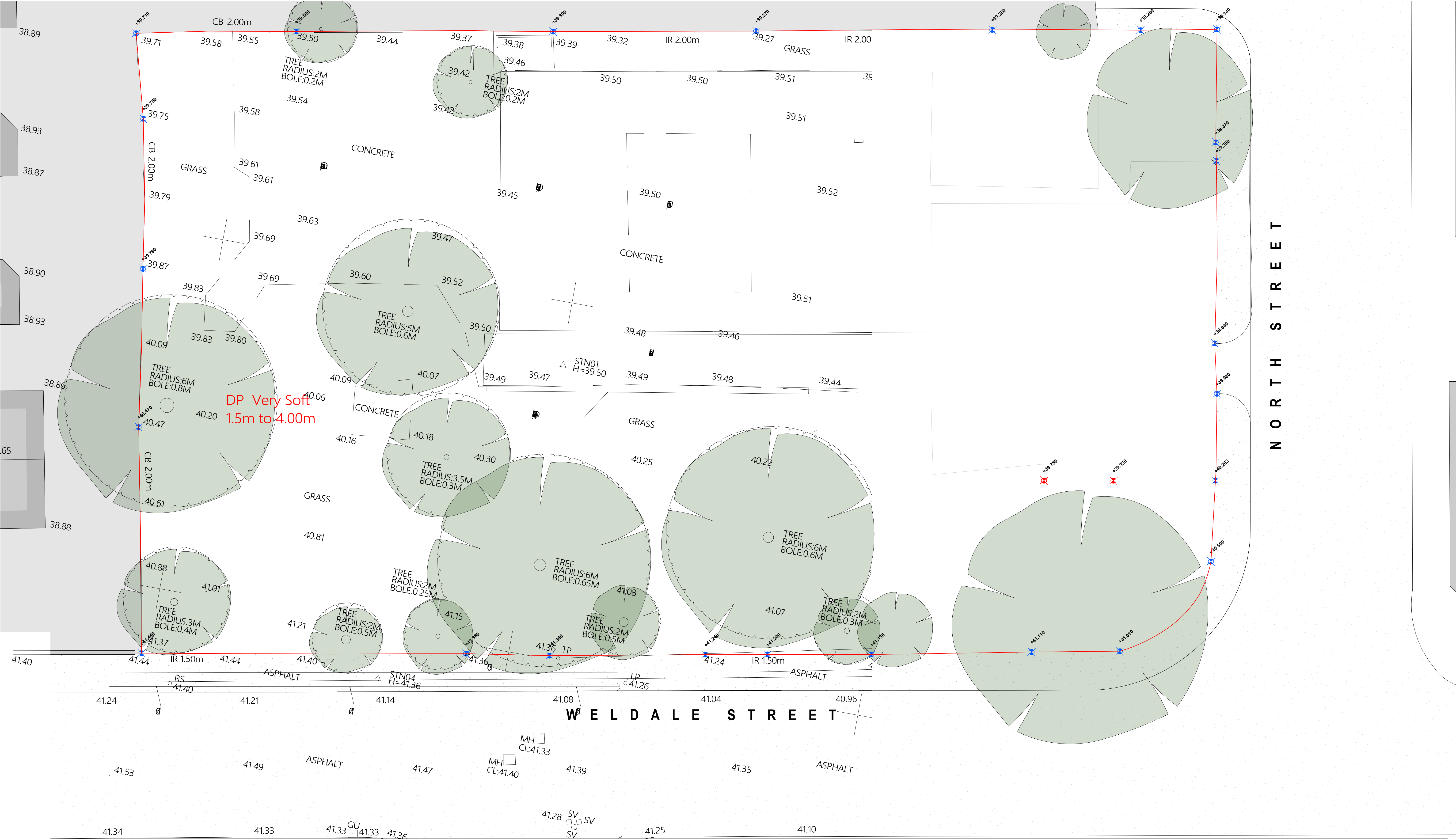
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APPENDIX A

Site Location Plan

Proposed Development Plan

BUILDING	Area m2
SITE AREA	2,119.12



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☒ Preliminary

☐ Feasibility

☐ Planning

☐ Building Regulations

☐ Tender

☐ Construction issue

☐ As Built

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2. Do not scale drawing - all dimensions to be checked on site prior to construction and any discrepancies reported to contract administrator

RIBA
Chartered Practice

PRELIMINARY ISSUE FOR INFORMATION 16/01/2021

Drawing title: EXISTING SITE PLAN

Client: READING BOROUGH COUNCIL

Drawn by: **RG** Checked: **TC**

Job number: 20.20.022

Project: READING AFFORDABLE HOUSING SITE NORTH STREET, Reading, RG1 7DA.

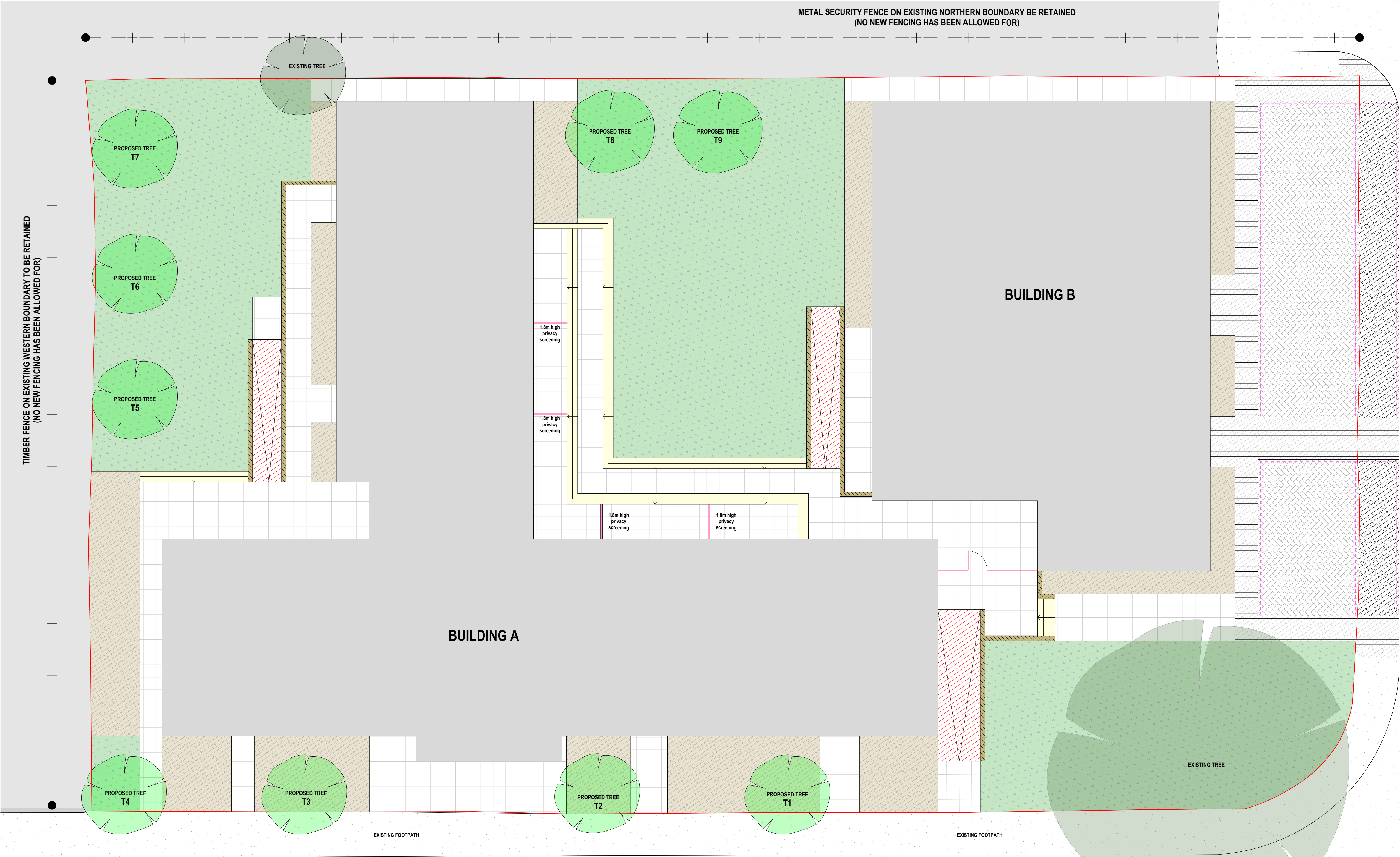
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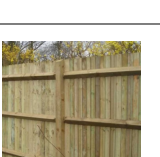
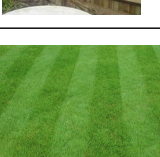
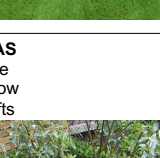
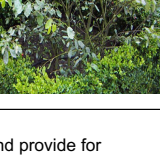
Date: **NOVEMBER 2020**

Drawing no: W100

coombes : everitt architects

READING AFFORDABLE HOUSING SITE NORTH STREET, Reading, RG1 7DA.
W103 - BEARD TENDER - PROPOSED SITE PLAN



Materials Schedule		
External Hard & Soft Landscape Material Finishes:		
(A)	MACADAM SURFACES Macadam vehicle cross over to be constructed to an adoptable standard. New kerbs to be installed with transition junctions joining into existing paving and road finishes.	
(B)	BLOCK PAVINGS - CAR PARKING BAYS Permeable block paved carparking bays to be constructed to an adoptable standard. Bays to be formed using Marshalls Driveline Prior Permeable Brindle Block Paving (Paving size - 200 x 100 x 60mm).	
(C)	MACADAM SURFACES Macadam pedestrian footway to be constructed to an adoptable standard. New kerbs to be installed with transition junctions joining into existing paving and road finishes.	
(D)	PAVING 600x600mm Marshalls, or similar buff coloured concrete slabs	
(E)	RAMPS Macadam pedestrian ramp formed between external retaining / landscape walls built in facing brickwork to structural Engineers designs. Facing to comprise 215mm thick walls finished 450mm high above adjacent paving's / high ground levels.	
(F)	PAVING TO STEPS 450x450mm Marshalls, or similar buff coloured concrete slabs	
(G)	RETAINING AND EXTERNAL LANDSCAPE WALLS External retaining and landscape walls are to be built in facing brickwork to structural Engineers designs. Facing to comprise 215mm thick walls finished 450mm high above adjacent paving's / high ground levels.	
(H)	TIMBER SCREEN WALLS External screen walls are to be 1500 to 1800mm high Kertoryn Scots Pine character grade unfinished timber fin panels comprising 50x200mm sections at 125mm centres cast into concrete foundation block	
(J)	TRADITIONAL TIMBER FENCING New full height (height stated on the drawing), or 1.50m high treated softwood feather edge close board timber fence with 400mm deep trellis top section between concrete or timber posts and complete with timber gate, where applicable.	
(K)	SOFT LANDSCAPING - GRASS LAWN New areas of soft landscape lawn areas to be imported high quality laid turf on min. 150mm imported topsoil. Area to be well feed with a good quality compound fertiliser in the spring and/or autumn to produce the best root growth.	
(L)	SOFT LANDSCAPING AND PROPOSED PLANTING AREAS Areas are to be planted in groups of in a random mix at a rate of 2L shrubs consisting of 4 plants per sq. m. Shrubs to be low maintenance and provide all year round colour planted in drifts comprising : - Berberis thunbergii - Cornus mas - Potentilla fruticosa Tangerine - Skimmia confusa Kew Garden - Eucynthus fortunei Emerald Gaiety - Lavandula x intermedia grosso	
(M)	SOFT LANDSCAPING - TREES New native species tree planting to enhance development and provide for biodiversity and habitat. New species referenced T1-T9 to consist : - 2no. upright Birch (Betula pendula 'Fastigiata') 8-10cm girth - 2no. Japanese Hornbeam (Carpinus japonica) 6-10cm girth - 3no. Beech (Fagus sylvatica 'Glauca') 8-10cm girth - 2no. Pencil cedar (Scopressus sempervirens) 8-10cm girth Trees on Weldale Street to be fitted with proprietary tree guard protection	

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- ☐ Preliminary
☐ Feasibility
☐ Planning
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☐ Construction issue
☐ As Built

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Drawing title: BEARD TENDER - PROPOSED SITE PLAN

Client: READING BOROUGH COUNCIL

Drawn by: RG Checked: TC

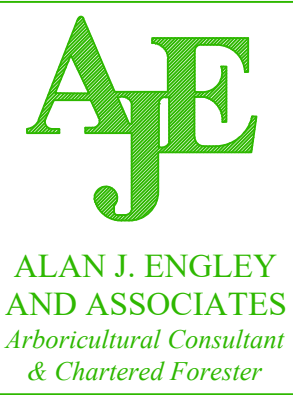
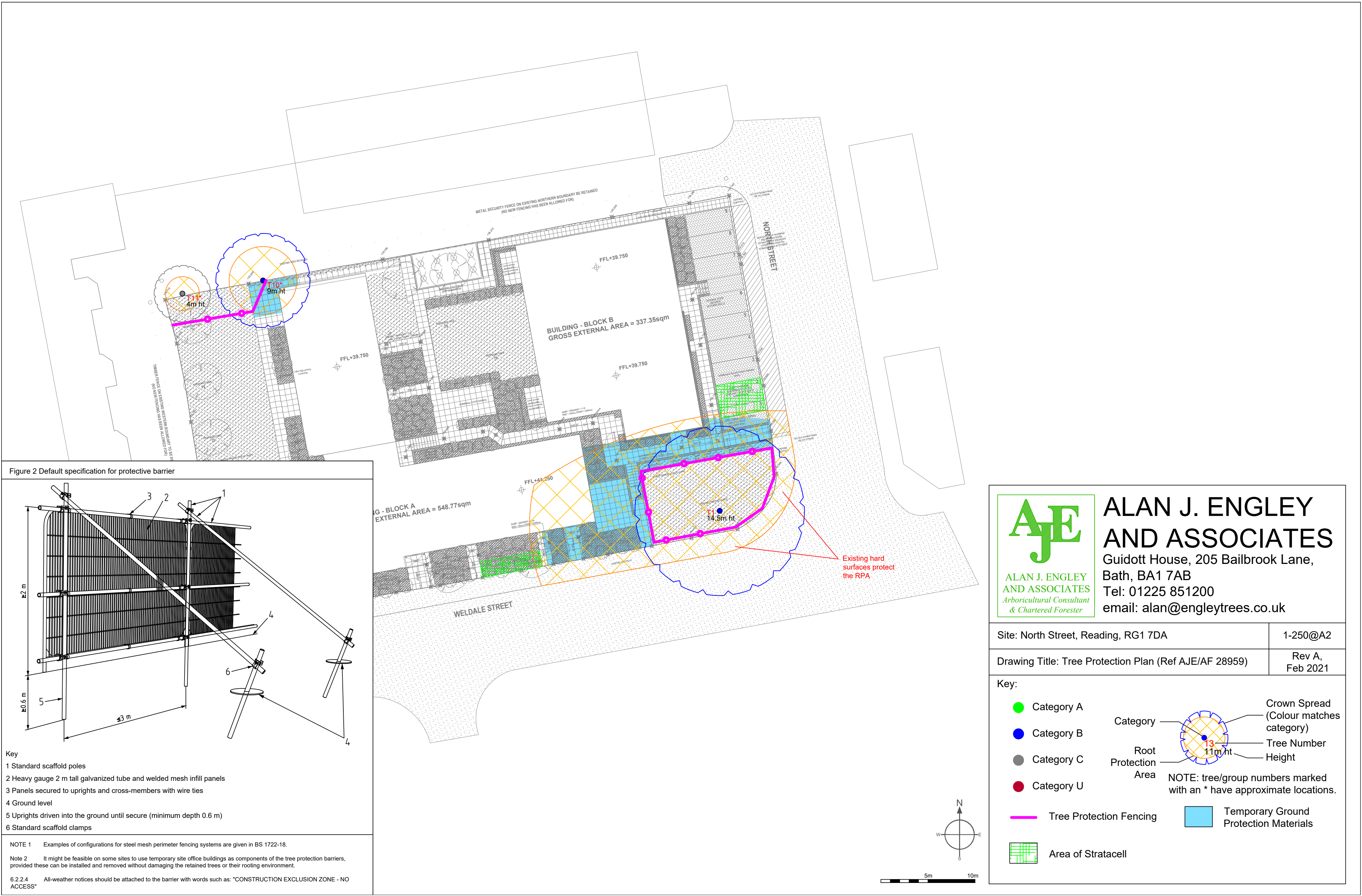
Job number: 20.20.022

Project:
READING AFFORDABLE HOUSING SITE
NORTH STREET, Reading, RG1 7DA.

Scale: 1:100 at A1 (1:200 at A3)

Date: NOVEMBER 2020

Drawing no: W103



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Site: North Street, Reading, RG1 7DA

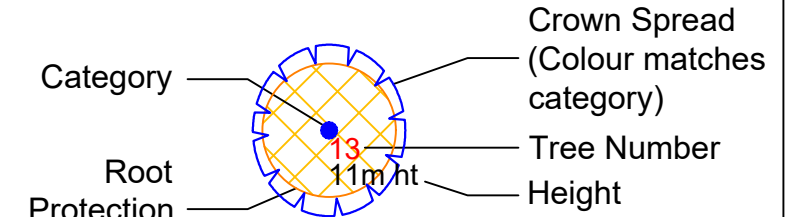
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Drawing Title: Tree Protection Plan (Ref AJE/AF 28959)

Rev A,
Feb 2021

Key:

- Category A
- Category B
- Category C
- Category U

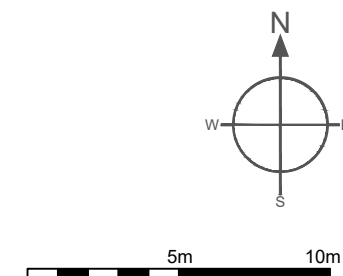


NOTE: tree/group numbers marked with an * have approximate locations.

Tree Protection Fencing

Temporary Ground Protection Materials

Area of Stratacell



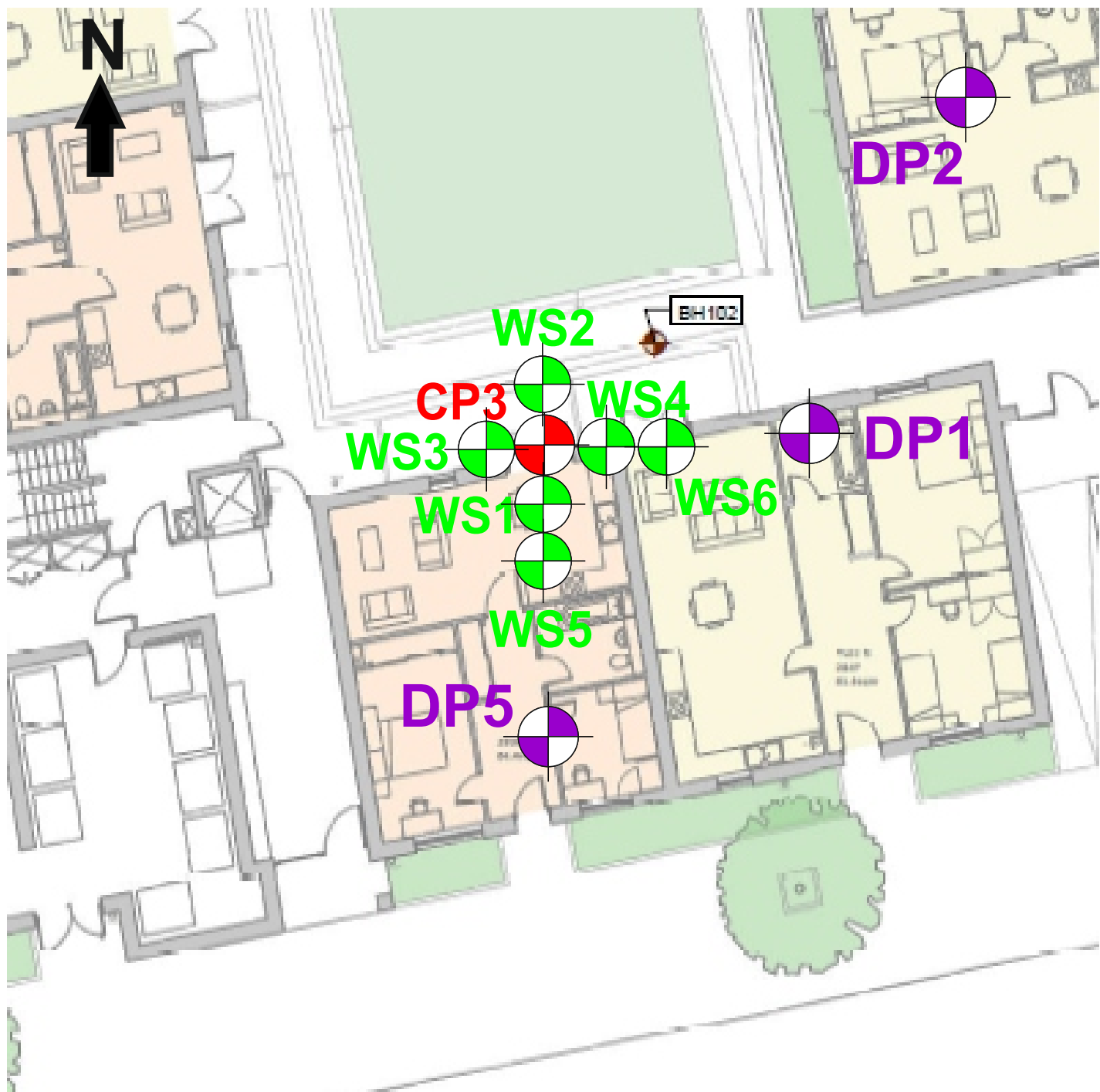
APPENDIX B

Supplementary Investigation Data

Borehole Location Plan

Boreholes Logs

Laboratory Testing Results



Borehole Location Plan

Land at North Street,
Reading,
RG1 7DA

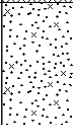
Beard Construction Limited

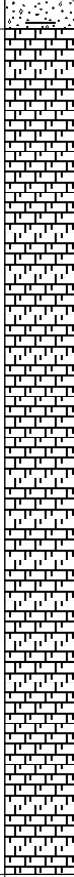
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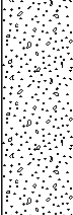
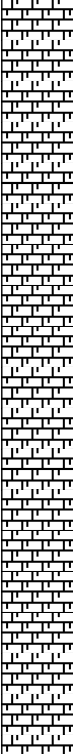
-  Dynamic Sampling Locations
-  Percussion Liner Sampler Borehole Locations
-  Cable Percussion Borehole Locations

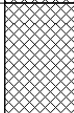
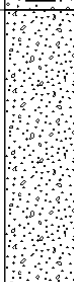
Not to scale.
All positions are approximate.
Based on plan provided by
the client.

PADDOCK GEO ENGINEERING						Site Land at North Street, Reading, RG1 7DA		Number WS1	
Excavation Method Drive-in Windowless Sampler		Dimensions 87mm to 1.00m 57mm to 4.00m 77mm to 2.00m 47mm to 5.00m 67mm to 3.00m 47mm to 6.00m		Ground Level (mOD)		Client Beard Construction Limited		Job Number P21-009	
		Location		Dates 17/02/2021		Project Contractor PGE		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
3.40	ES				(0.35) 0.35	Soft dark grey brown slightly sandy gravelly CLAY with occasional roots and rootlets. Gravel is very angular to sub-rounded fine to coarse flint, brick and concrete. (MADE GROUND)			
					(1.90)	Yellow brown clayey very gravelly SAND. Gravel is very angular to angular fine to coarse flint. (TAPLOW GRAVEL MEMBER)			
					2.25	Structureless CHALK composed of cream slightly sandy slightly gravelly SILT. Gravel is extremely weak to very weak low to medium density angular to sub-angular chalk and frequent fine to coarse flint. (SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED))			
					(3.75)	... blue staining and hydrocarbon odour noted between 3.35-3.45m depth.			
					6.00	Complete at 6.00m			
Remarks PID reading at 3.40m = 59.2 Boreholes sides rained upright and stable. No groundwater encountered.							Scale (approx) 1:40	Logged By TN	
							Figure No. P21-009.WS1		

						Site Land at North Street, Reading, RG1 7DA		Number WS2
Excavation Method Drive-in Windowless Sampler		Dimensions 87mm to 1.00m 57mm to 4.00m 77mm to 2.00m 47mm to 5.00m 67mm to 3.00m 47mm to 6.00m		Ground Level (mOD)		Client Beard Construction Limited		Job Number P21-009
		Location		Dates 17/02/2021		Project Contractor PGE		Sheet 1/1
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Soft dark brown mottled black, red and yellow brown sandy slightly gravelly CLAY with occasional roots and rootlets. Gravel is very angular to sub-rounded fine to coarse flint, brick and concrete. (MADE GROUND)		
					0.30			
					(0.70)	Dark orange brown silty fine to coarse SAND. (ALLUVIUM)		
					1.00			
					(1.60)	Yellow brown clayey very gravelly SAND. Gravel is very angular to angular fine to coarse flint. (TAPLOW GRAVEL MEMBER)		
					2.60			
					(3.40)	Structureless CHALK composed of cream slightly sandy slightly gravelly SILT. Gravel is extremely weak to very weak low to medium density angular to sub-angular chalk and frequent fine to coarse flint. (SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED))		
4.90	ES					... slight hydrocarbon odour at 4.90-5.00m depth.		
5.80	ES					... slight hydrocarbon odour at 5.60-5.95m depth.		
					6.00	Complete at 6.00m		
Remarks No groundwater encountered. Boreholes sides rained upright and stable. PID reading at 4.90m = 1.4 PID reading at 5.80m = 0.0							Scale (approx) 1:40	Logged By TN
							Figure No. P21-009.WS2	

PADDOCK GEO ENGINEERING						Site Land at North Street, Reading, RG1 7DA		Number WS3	
Excavation Method Drive-in Windowless Sampler		Dimensions 87mm to 1.00m 57mm to 4.00m 77mm to 2.00m 47mm to 5.00m 67mm to 3.00m 47mm to 6.00m		Ground Level (mOD)		Client Beard Construction Limited		Job Number P21-009	
		Location		Dates 17/02/2021		Project Contractor PGE		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
4.25	ES				(0.35) 0.35	Soft dark brown mottled black, red and yellow brown sandy slightly gravelly CLAY with occasional roots and rootlets. Gravel is very angular to sub-rounded fine to coarse flint, brick and concrete. (MADE GROUND)			
					(0.55) 0.90	Stiff to firm dark orange brown slightly gravelly slightly sandy SILT. Gravel is angular fine to coarse flint. (TAPLOW GRAVEL MEMBER)			
					(0.65) 1.55	Yellow brown clayey very gravelly SAND. Gravel is very angular to angular fine to coarse flint. (TAPLOW GRAVEL MEMBER)			
					(4.45)	Structureless CHALK composed of cream slightly sandy slightly gravelly SILT. Gravel is extremely weak to very weak low to medium density angular to sub-angular chalk and frequent fine to coarse flint. (SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED))			
					6.00	Complete at 6.00m			
Remarks PID reading at 4.25m = 1.5 Boreholes sides rained upright and stable. No groundwater encountered.							Scale (approx) 1:40	Logged By TN	
							Figure No. P21-009.WS3		

						Site Land at North Street, Reading, RG1 7DA		Number WS4	
Excavation Method Drive-in Windowless Sampler		Dimensions 87mm to 1.00m 57mm to 4.00m 77mm to 2.00m 47mm to 5.00m 67mm to 3.00m 47mm to 6.00m		Ground Level (mOD)		Client Beard Construction Limited		Job Number P21-009	
		Location		Dates 17/02/2021		Project Contractor PGE		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
					(0.45)	Orange brown mottled black, pink red gravelly clayey SAND. Gravel is angular fine to coarse clinker and brick. (MADE GROUND)			
					0.45 (0.35)	Firm brown mottled orange brown slightly gravelly sandy CLAY with roots and rootlets. Gravel is angular to rounded fine to coarse flint. (ALLUVIUM)			
					0.80 (1.20)	Orange brown SAND and GRAVEL. Gravel is angular fine to coarse flint. (TAPLOW GRAVEL MEMBER)			
					2.00	Structureless CHALK composed of cream slightly sandy slightly gravelly SILT. Gravel is extremely weak to very weak low to medium density angular to sub-angular chalk and frequent fine to coarse flint. (SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED))			
3.40	ES					... mottled dark blue grey with hydrocarbon odour at 3.35-3.65m depth.			
3.90	ES				(4.00)	... mottled light grey white to blue white with hydrocarbon odour at 3.80-4.00m depth.			
					6.00	Complete at 6.00m			
Remarks PID reading at 3.40m = 4.5 PID reading at 3.90m = 0.0 Boreholes sides rained upright and stable. No groundwater encountered.							Scale (approx) 1:40	Logged By TN	
							Figure No. P21-009.WS4		

PADDOCK GEO ENGINEERING						Site Land at North Street, Reading, RG1 7DA		Number WS5	
Excavation Method Drive-in Windowless Sampler		Dimensions 87mm to 1.00m 57mm to 4.00m 77mm to 2.00m 47mm to 5.00m 67mm to 3.00m 47mm to 6.00m		Ground Level (mOD)		Client Beard Construction Limited		Job Number P21-009	
		Location		Dates 17/02/2021		Project Contractor PGE		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
4.50	ES				(0.35) 0.35	Black clayey slightly gravelly SAND with frequent roots and rootlets. Gravel is angular fine to coarse brick, flint and concrete. (MADE GROUND)			
					(0.65) 1.00	Multicoloured red, cream, dark blue grey very sandy very angular to angular fine to coarse GRAVEL of brick, flint and concrete. (MADE GROUND)			
					(0.45) 1.45	Firm dark orange brown slightly sandy gravelly CLAY. Gravel is sub-angular to well rounded fine to coarse flint. (TAPLOW GRAVEL MEMBER)			
					(1.45) 2.90	Yellow brown very gravelly fine to coarse SAND. Gravel is angular fine to coarse flint. (TAPLOW GRAVEL MEMBER)			
					(3.10) 6.00	Structureless CHALK composed of cream slightly sandy slightly gravelly SILT. Gravel is extremely weak to very weak low to medium density angular to sub-angular chalk and frequent fine to coarse flint. (SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED))			
						... mottled grey blue with hydrocarbon odour at 4.45-4.65m depth.			
						Complete at 6.00m			
Remarks No groundwater encountered. Boreholes sides rained upright and stable. PID reading at 4.50m = 0.6							Scale (approx) 1:40	Logged By TN	
							Figure No. P21-009.WS5		

PADDOCK GEO ENGINEERING						Site Land at North Street, Reading, RG1 7DA		Number WS6	
Excavation Method Drive-in Windowless Sampler		Dimensions 87mm to 1.00m 57mm to 4.00m 77mm to 2.00m 47mm to 5.00m 67mm to 3.00m 47mm to 6.00m		Ground Level (mOD)		Client Beard Construction Limited		Job Number P21-009	
		Location		Dates 17/02/2021		Project Contractor PGE		Sheet 1/1	
Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	
3.70	ES				(0.50)	Black silty gravelly SAND with frequent roots and rootlets. Gravel is angular fine to coarse flint, brick and metal. (MADE GROUND)			
					0.50 (0.30)	Firm dark orange brown slightly sandy gravelly CLAY. Gravel is angular fine to coarse flint and brick. (MADE GROUND)			
					0.80 (1.00)	Firm dark orange brown slightly sandy gravelly CLAY. Gravel is sub-angular to well rounded fine to coarse flint. (TAPLOW GRAVEL MEMBER)			
					1.80	Structureless CHALK composed of cream slightly sandy slightly gravelly SILT. Gravel is extremely weak to very weak low to medium density angular to sub-angular chalk and frequent fine to coarse flint. (SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION (UNDIFFERENTIATED))			
					(4.20)	... mottled blue grey with hydrocarbon odour at 3.50-4.00m depth.			
					6.00	Complete at 6.00m			
Remarks PID reading at 3.70m = 50.0 Boreholes sides rained upright and stable. No groundwater encountered.							Scale (approx) 1:40	Logged By TN	
							Figure No. P21-009.WS6		

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Analytical Report Number : 21-57909

Project / Site name:	Land at North Road, Reading, RG1 7DA	Samples received on:	19/02/2021
Your job number:	P21-009 C2	Samples instructed on/ Analysis started on:	19/02/2021
Your order number:	P21-009	Analysis completed by:	02/03/2021
Report Issue Number:	1	Report issued on:	02/03/2021
Samples Analysed:	6 soil samples		

Signed:



Zina Abdul Razzak
Senior Quality Specialist
For & on behalf of i2 Analytical Ltd.

Standard Geotechnical, Asbestos and Chemical Testing Laboratory located at: ul. Pionierów 39, 41 -711 Ruda Śląska, Poland.

Accredited tests are defined within the report, opinions and interpretations expressed herein are outside the scope of accreditation.

Standard sample disposal times, unless otherwise agreed with the laboratory, are :

soils - 4 weeks from reporting
leachates - 2 weeks from reporting
waters - 2 weeks from reporting
asbestos - 6 months from reporting

Excel copies of reports are only valid when accompanied by this PDF certificate.

Any assessments of compliance with specifications are based on actual analytical results with no contribution from uncertainty of measurement.
Application of uncertainty of measurement would provide a range within which the true result lies.
An estimate of measurement uncertainty can be provided on request.

Analytical Report Number: 21-57909

Project / Site name: Land at North Road, Reading, RG1 7DA

Your Order No: P21-009

Lab Sample Number				1776538	1776539	1776540	1776541	1776542
Sample Reference				WS1	WS2	WS3	WS4	WS5
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				3.40	4.90	4.25	3.40	4.50
Date Sampled				17/02/2021	17/02/2021	17/02/2021	17/02/2021	17/02/2021
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	0.01	NONE	22	16	7.9	18	17
Total mass of sample received	kg	0.001	NONE	0.4	0.4	0.4	0.4	0.4

Monoaromatics & Oxygenates

Benzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	2.1	4.7	< 1.0	3.3	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	62	16	< 2.0	13	33
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	310	26	< 8.0	20	120
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	92	< 8.0	< 8.0	28	46
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	460	47	< 10	65	200

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	1.3	< 1.0	< 1.0	< 1.0	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	77	12	< 2.0	< 2.0	31
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	250	< 10	< 10	< 10	62
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	76	< 10	< 10	< 10	19
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	400	30	< 10	< 10	110

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number: 21-57909

Project / Site name: Land at North Road, Reading, RG1 7DA

Your Order No: P21-009

Lab Sample Number				1776543
Sample Reference				WS6
Sample Number				None Supplied
Depth (m)				3.70
Date Sampled				17/02/2021
Time Taken				None Supplied
Analytical Parameter (Soil Analysis)	Units	Limit of detection	Accreditation Status	
Stone Content	%	0.1	NONE	< 0.1
Moisture Content	%	0.01	NONE	18
Total mass of sample received	kg	0.001	NONE	0.4

Monoaromatics & Oxygenates

Benzene	µg/kg	1	MCERTS	< 1.0
Toluene	µg/kg	1	MCERTS	< 1.0
Ethylbenzene	µg/kg	1	MCERTS	< 1.0
p & m-xylene	µg/kg	1	MCERTS	< 1.0
o-xylene	µg/kg	1	MCERTS	< 1.0
MTBE (Methyl Tertiary Butyl Ether)	µg/kg	1	MCERTS	< 1.0

Petroleum Hydrocarbons

TPH-CWG - Aliphatic >EC5 - EC6	mg/kg	0.001	MCERTS	< 0.001
TPH-CWG - Aliphatic >EC6 - EC8	mg/kg	0.001	MCERTS	< 0.001
TPH-CWG - Aliphatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001
TPH-CWG - Aliphatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0
TPH-CWG - Aliphatic >EC12 - EC16	mg/kg	2	MCERTS	18
TPH-CWG - Aliphatic >EC16 - EC21	mg/kg	8	MCERTS	50
TPH-CWG - Aliphatic >EC21 - EC35	mg/kg	8	MCERTS	18
TPH-CWG - Aliphatic (EC5 - EC35)	mg/kg	10	MCERTS	85

TPH-CWG - Aromatic >EC5 - EC7	mg/kg	0.001	MCERTS	< 0.001
TPH-CWG - Aromatic >EC7 - EC8	mg/kg	0.001	MCERTS	< 0.001
TPH-CWG - Aromatic >EC8 - EC10	mg/kg	0.001	MCERTS	< 0.001
TPH-CWG - Aromatic >EC10 - EC12	mg/kg	1	MCERTS	< 1.0
TPH-CWG - Aromatic >EC12 - EC16	mg/kg	2	MCERTS	17
TPH-CWG - Aromatic >EC16 - EC21	mg/kg	10	MCERTS	33
TPH-CWG - Aromatic >EC21 - EC35	mg/kg	10	MCERTS	16
TPH-CWG - Aromatic (EC5 - EC35)	mg/kg	10	MCERTS	67

U/S = Unsuitable Sample I/S = Insufficient Sample

Analytical Report Number : 21-57909

Project / Site name: Land at North Road, Reading, RG1 7DA

* These descriptions are only intended to act as a cross check if sample identities are questioned. The major constituent of the sample is intended to act with respect to MCERTS validation. The laboratory is accredited for sand, clay and loam (MCERTS) soil types. Data for unaccredited types of solid should be interpreted with care.

Stone content of a sample is calculated as the % weight of the stones not passing a 10 mm sieve. Results are not corrected for stone content.

Lab Sample Number	Sample Reference	Sample Number	Depth (m)	Sample Description *
1776538	WS1	None Supplied	3.4	White chalk with gravel.**
1776539	WS2	None Supplied	4.9	White clay and sand with gravel and chalk.
1776540	WS3	None Supplied	4.25	White clay and sand with gravel and chalk.
1776541	WS4	None Supplied	3.4	White clay and sand with gravel and chalk.
1776542	WS5	None Supplied	4.5	White clay and sand with gravel and chalk.
1776543	WS6	None Supplied	3.7	White clay and sand with gravel and chalk.

** NON MCERTS MATRIX

Analytical Report Number : 21-57909

Project / Site name: Land at North Road, Reading, RG1 7DA

Water matrix abbreviations: Surface Water (SW) Potable Water (PW) Ground Water (GW)

Analytical Test Name	Analytical Method Description	Analytical Method Reference	Method number	Wet / Dry Analysis	Accreditation Status
Moisture Content	Moisture content, determined gravimetrically. (30 oC)	In house method.	L019-UK/PL	W	NONE
Stones content of soil	Standard preparation for all samples unless otherwise detailed. Gravimetric determination of stone > 10 mm as % dry weight.	In-house method based on British Standard Methods and MCERTS requirements.	L019-UK/PL	D	NONE
BTEX and MTBE in soil (Monoaromatics)	Determination of BTEX in soil by headspace GC-MS.	In-house method based on USEPA8260	L073B-PL	W	MCERTS
TPHCWG (Soil)	Determination of hexane extractable hydrocarbons in soil by GC-MS/GC-FID.	In-house method with silica gel split/clean up.	L088/76-PL	W	MCERTS

For method numbers ending in 'UK' analysis have been carried out in our laboratory in the United Kingdom.

For method numbers ending in 'PL' analysis have been carried out in our laboratory in Poland.

Soil analytical results are expressed on a dry weight basis. Where analysis is carried out on as-received the results obtained are multiplied by a moisture correction factor that is determined gravimetrically using the moisture content which is carried out at a maximum of 30oC.

APPENDIX C

Remediation Options Matrix

Remediation Option Applicability Matrix: Organic Substances

Remediation Option	Applicable Media	Applicable Substances						
		VOCs	Halogenated hydrocarbons	Non-halogenated hydrocarbons	PAHs	PCBs	Dioxins + Furans	Pesticides + herbicides
Civil Engineering Methods								
Containment - Cover systems	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Containment - Hydraulic barriers	W	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Containment - In-ground barriers	S, W	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Excavation and Disposal	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Biological Methods								
Natural Attenuation	W	Yes	Yes	Yes	Yes	No	No	Yes
Biopiles	S	Yes	No	Yes	Yes	No	No	Yes
Bioventing	S	Yes	Yes	Yes	Yes	No	No	No
Biosparging	S, W	Yes	Yes	Yes	Yes	No	No	Yes
Landfarming	S	Yes	No	Yes	Yes	No	No	Yes
Slurry phase biotreatment	S	Yes	Yes	Yes	Yes	No	?	Yes
Windrow turning	S	Yes	No	Yes	Yes	No	No	Yes
Chemical Methods								
Chemical oxidation	S, W	Yes	Yes	Yes	Yes	No	No	Yes
Chemical dehalogenation	S	Yes	Yes	Yes	No	No	Yes	No
Soil flushing	S	Yes	Yes	Yes	Yes	No	No	No
Solvent extraction	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Surface amendments	S	No	No	No	No	No	No	No
Physical Methods								
Dual Phase SVE	S, W	Yes	Yes	Yes	No	No	No	No
Air sparging	W	Yes	Yes	Yes	No	No	No	No
Soil vapour extraction (SVE)	S	Yes	Yes	Yes	No	No	No	No
Permeable reactive barriers (PRBs)	W	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Soil washing	S	No	Yes	Yes	Yes	Yes	No	Yes
Stabilisation and Solidification Methods								
Hydraulic binders (e.g., cement)	S	No	No	?	Yes	Yes	Yes	?
Vitrification	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Thermal Methods								
Incineration	S	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Thermal desorption	S	Yes	Yes	Yes	Yes	Yes	No	Yes

Yes	Most Suitable Method
Yes	Potentially applicable
No	Not applicable
?	A pre-treatment step may be necessary prior to the method being suitable
S	Soils, made ground and sediments
W	Groundwater and surface water

Remediation Option Applicability Matrix: Inorganic Substances

Remediation Option	Applicable Media	Applicable Substances				
		Heavy metals	Non-metals	Asbestos	Cyanides	Explosives
Civil Engineering Methods						
Containment - Cover systems	S	Yes	Yes	Yes	Yes	Yes
Containment - Hydraulic barriers	W	Yes	Yes	Yes	Yes	Yes
Containment - In-ground barriers	S, W	Yes	Yes	Yes	Yes	Yes
Excavation and Disposal	S	Yes	Yes	Yes	Yes	Yes
Biological Methods						
Natural Attenuation	W	Yes	Yes	No	No	Yes
Biopiles	S	No	No	No	No	Yes
Bioventing	S	No	No	No	No	No
Biosparging	S, W	No	No	No	No	No
Landfarming	S	No	No	No	No	Yes
Slurry phase biotreatment	S	No	No	No	Yes	Yes
Windrow turning	S	No	No	No	No	Yes
Chemical Methods						
Chemical oxidation	S, W	No	Yes	No	No	No
Chemical dehalogenation	S	No	No	No	No	No
Soil flushing	S	Yes	No	No	No	No
Solvent extraction	S	No	No	No	No	Yes
Surface amendments	S	Yes	Yes	No	No	No
Physical Methods						
Dual Phase SVE	S, W	No	Yes	No	No	No
Air sparging	W	No	No	No	No	No
Soil vapour extraction (SVE)	S	Yes	No	No	No	No
Permeable reactive barriers (PRBs)	W	No	No	No	No	Yes
Soil washing	S	Yes	Yes	No	No	No
Stabilisation and Solidification Methods						
Hydraulic binders (e.g., cement)	S	Yes	Yes	Yes	?	No
Vitrification	S	Yes	Yes	Yes	Yes	Yes
Thermal Methods						
Incineration	S	Yes	Yes	Yes	Yes	Yes
Thermal desorption	S	Yes	No	No	Yes	No

Yes	Most Suitable Method
Yes	Potentially applicable
No	Not applicable
?	A pre-treatment step may be necessary prior to the method being suitable
S	Soils, made ground and sediments
W	Groundwater and surface water

APPENDIX D
Remediation Plan



Remediation Plan

Land at North Street,
Reading,
RG1 7DA

Beard Construction Limited

February 2021

 Areas requiring
600mm Clean
Cover System

 Areas within
Tree Root
Protection Zone
where only surface
Topsoil Dressing of
150mm Clean
Cover is required

Not to scale.
All positions are approximate.
Based on plan provided by
the client.

APPENDIX E

PGE In-House GACs

GENERIC HUMAN HEALTH SCREENING TOTAL SOIL CONCENTRATION ASSESSMENT CRITERIA (GAC)

DETERMINAND		RESIDENTIAL (mg/kg)		COMMERCIAL (mg/kg)
Chemical	GAC Sources and units	With Home Grown produce	Without Home Grown produce	
Asbestos Screen & ID*	-	Detected	Detected	Detected
Cyanide - Total	SNIFFER	53.25	53.25	53.25
Cyanide - Free	SNIFFER	53.25	53.25	53.25
Loss on Ignition @ 450°C	-	-	-	-
Sulphate (as SO ₄) - Total	BRE****	2400	2400	2400
Sulphide	ICRCL	2500	2500	2500
Sulphur - Total	ICRCL	2500	2500	2500
Phenol (Total Monohydric)	CLEA	420	420	3200
pH	ICRCL	<5,>12	<5,>12	-
Metals and Metalloids (CLEA Metals)				
Arsenic	LQM S4UL	37	40	640
Beryllium	LQM S4UL	1.7	1.7	12
Cadmium	LQM S4UL	11	85	190
Chromium III	LQM S4UL	910	910	8600
Lead	DEFRA C4SL	190	310	2300
Mercury (Total)	LQM S4UL (Inorganic)	40	56	1100
Selenium	LQM S4UL	250	430	12000
Copper (phytotoxicity)	LQM S4UL	2400 (111)	7100	68000
Nickel	LQM S4UL	180	180	980
Zinc (phytotoxicity)	LQM S4UL	3700 (330)	40000	730000
Vanadium	LQM S4UL	410	1200	9000
Boron - Water Soluble	LQM S4UL	290	11000	240000
Total Petroleum Hydrocarbons**				
TPH (EC6-EC10) - PRO	LQM S4UL (2.5% SOM)	65	100	4800
TPH (EC10-EC21) - DRO	LQM S4UL (2.5% SOM)	300	600	23000
TPH (EC21-EC40) - Min. Oil	LQM S4UL (2.5% SOM)	1500	1900	28000
Total TPH (EC10-EC40)	LQM S4UL (2.5% SOM)	600	900	23000
Polycyclic Aromatic Hydrocarbons***				
Naphthalene	LQM S4UL (2.5% SOM)	5.6	5.6	460
Flourene	LQM S4UL (2.5% SOM)	400	3800	68000
Benzo[a]pyrene	LQM S4UL (2.5% SOM)	2.7	3.2	35
Dibenzo[a,h]anthracene	LQM S4UL (2.5% SOM)	0.28	0.32	3.6

Notes

The Generic Assessment Criteria (GAC) are based on CLEA Soil Guidance Values published values and CIEH/LQM S4CLs where available or ICRCL, DoE, BRE and HSE levels where necessary. Where gaps remain GACs were calculated using the latest CLEA spreadsheet using DEFRA C4SL toxicology and physiochemical parameters from DEFRA SP1010.

* Guidance level set at any fibre identification.

** TPH 3 band is employed as a screening tool to instigate detailed speciated analysis to the TPHCWG methodology. Based on mean of fractions included

*** Testing based on USEPA Priority 16 compounds. GACs for four compounds and total PAH with published GACs only, used as a screening tool.

**** BRE SD1 - DS-1 Concrete Sulphate Design Class limit. Sulphate is not considered to pose a significant risk to human health under normal circumstances.

GENERIC HUMAN HEALTH HYDROCARBON TOTAL SOIL CONCENTRATION ASSESSMENT CRITERIA (GAC)

DETERMINAND		RESIDENTIAL (mg/kg)		COMMERCIAL (mg/kg)
Chemical	GAC Sources and units	With Home Grown produce	Without Home Grown produce	
TPH CWG				
Aliphatic EC 5-6	LQM S4UL (2.5% SOM)	78	78	5900
Aliphatic EC >6-8	LQM S4UL (2.5% SOM)	230	230	17000
Aliphatic EC >8-10	LQM S4UL (2.5% SOM)	65	65	4800
Aliphatic EC >10-12	LQM S4UL (2.5% SOM)	330	330	23000
Aliphatic EC >12-16	LQM S4UL (2.5% SOM)	2400	2400	82000
Aliphatic EC >16-35	LQM S4UL (2.5% SOM)	92000	92000	1700000
Aliphatic EC >35-44	LQM S4UL (2.5% SOM)	92000	92000	1700000
Aromatic EC 5-7 (Benzene)	LQM S4UL (2.5% SOM)	140	690	46000
Aromatic EC >7-8 (Toluene)	LQM S4UL (2.5% SOM)	290	1800	110000
Aromatic EC >8-10	LQM S4UL (2.5% SOM)	83	110	8100
Aromatic EC >10-12	LQM S4UL (2.5% SOM)	180	590	28000
Aromatic EC >12-16	LQM S4UL (2.5% SOM)	330	2300	37000
Aromatic EC >16-21	LQM S4UL (2.5% SOM)	540	1900	28000
Aromatic EC >21-35	LQM S4UL (2.5% SOM)	1500	1900	28000
Aromatic EC >35-44	LQM S4UL (2.5% SOM)	1500	1900	28000
Aliphatic and Aromatic EC >44	LQM S4UL (2.5% SOM)	1500	1900	28000
Polycyclic Aromatic Hydrocarbons				
Acenaphthene	LQM S4UL (2.5% SOM)	510	4700	97000
Acenaphthylene	LQM S4UL (2.5% SOM)	420	4600	97000
Anthracene	LQM S4UL (2.5% SOM)	5400	35000	540000
Benzo[a]anthracene	LQM S4UL (2.5% SOM)	11	14	170
Benzo[a]pyrene	LQM S4UL (2.5% SOM)	2.7	3.2	35
Benzo[b]fluoranthene	LQM S4UL (2.5% SOM)	3.3	4	44
Benzo[ghi]perylene	LQM S4UL (2.5% SOM)	340	360	4000
Benzo[k]fluoranthene	LQM S4UL (2.5% SOM)	93	110	1200
Chrysene	LQM S4UL (2.5% SOM)	22	31	350
Dibenzo[ah]anthracene	LQM S4UL (2.5% SOM)	0.28	0.32	3.6
Fluoranthene	LQM S4UL (2.5% SOM)	560	1600	23000
Fluorene	LQM S4UL (2.5% SOM)	400	3800	68000
Indeno[123-cd]pyrene	LQM S4UL (2.5% SOM)	36	46	510
Naphthalene	LQM S4UL (2.5% SOM)	5.6	5.6	460
Phenanthrene	LQM S4UL (2.5% SOM)	220	1500	22000
Pyrene	LQM S4UL (2.5% SOM)	1200	3800	54000
Coal Tar (BaP as marker)	LQM S4UL (2.5% SOM)	0.98	1.2	15

Notes

The Generic Assessment Criteria (GAC) are based on CIEH/LQM S4ULs.