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256 GRAYS INN ROAD (PLOT 1) REMEDIATION STRATEGY

RAMBOLL

256 GRAY'S INN ROAD (PLOT 1)
REMEDIATION STRATEGY

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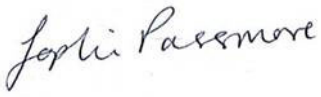

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1. INTRODUCTION

1.1 Background

Ramboll UK Limited ('Ramboll') was commissioned by University College London ('UCL') or (the 'Client') to develop a Remediation Strategy for the proposed redevelopment of the former Royal Free Hospital, located at 256 Gray's Inn Road, London WC1X 8HD. This Remediation Strategy relates specifically to Plot 1 (referred to herein as the 'site' or the 'study area') as shown in Appendix 1, Figure 1.

This Remediation Strategy was compiled based on the findings of previous environmental assessments pertaining to the site, as detailed below:

- Phase I Geotechnical and Geo-environmental Desk Study (Plot 1), prepared by Ramboll UK Ltd, dated 27th March 2018, (ref. BEMP-RAM-P1-XX-RP-CG-0001);
- Site Investigation Report, prepared by Concept, dated 15th July 2019, (ref. 18/3113-FR01).
- UCL Institute of Neurology (IoN)/Dementia Research Institute (DRI) Phase II Contaminated Land Interpretive Report, prepared by Ramboll UK Ltd, dated 5th October 2018, (ref. BEMP-RAM-P1-XX-RP-C-99-0016).

The findings of the above-referenced reports are summarised in Section 2 of this Remediation Strategy.

It is envisaged that this document will be used to support discharge of planning condition 33 and as a summary of the 'Employers Requirements' relating to the remediation works, from which prospective Contractors can develop a remediation design and costed scope of works. This document does not provide an engineering or geotechnical specification for the demolition or remediation works. The appointed Contractor would be responsible for ensuring that the demolition and remediation works meet the specifications set out by the Client and other relevant parties. The Contractor would also be responsible for reporting any discrepancies or conflicts between this Remediation Strategy and other specification documents prepared by, or on behalf of UCL, to UCL as soon as they are identified.

1.2 Site Description

The site forms part of the London Borough of Camden and is situated at National Grid Reference (NGR) TQ 530699 182515. The site is near-rectangular in shape and covers an area of approximately 0.39 hectares (0.96 acres). According to Google Earth™, the site resides at an elevation of +20 m above ordnance datum (AOD), which a slight downward slope to the south-east.

A single building referred to as 'The Former Royal Free Hospital' occupies the majority of the site. The hospital comprises 4 no. wings arranged around a central courtyard. The wings are known as 'Sussex Wing', 'Victoria Wing', 'New Wing', and 'Alexandra Wing', and together form the northern, eastern, southern and western limbs of the hospital respectively. Victoria Wing and New Wing are attached to 'Levy Wing', the latter of which is part of the former Royal Free Hospital but outside the boundary of Plot 1. A large tree and a fountain are present in the courtyard, and a small asphalted car parking area is situated in the north-east of the site.

The site is surrounding by the following land uses:

- To the north, Calthorpe Project Centre (a community garden); beyond which is Ampton Street.
- To the east, New Calthorpe Estate (residential properties); beyond which is Cubitt Street.
- To the south, Eastman Dental Hospital, beyond which is St. Andrew's Gardens.

- To the south-east, the Levy Wing (part of the former Royal Free Hospital situated off-site).
- To the west, Gray's Inn Road.

1.3 Proposed Development

The Plot 1 site has been identified as the potential new hub for the UK Dementia Research Institute (DRI) and the Institute of Neurology (IoN), alongside related neurological NHS outpatient services provided by the UCL Hospital's NHS Foundation Trust. The current proposals assume the retention of the Alexandra Wing which fronts onto Gray's Inn Road, the demolition of the Sussex, Victoria and New Wings, and the construction of a nine-storey development; this comprises a two-storey basement (approximately 9 m below existing Plot 1 basement level and 14 m bgl) and a seven-storey superstructure, inclusive of two storeys for plant. Within the car park area would be a 14 m excavation. An additional development comprises an extension of the Plot 1 basement in the south-east and south-west corners, in order to house a sprinkler tank at B2 level and the London Fire Brigade (LFB) Core at B2 level respectively. The retaining wall at the eastern edge of the site will be replaced with a new contiguous piled retaining wall.

The building will cover the majority of the site, with proposed hardstanding on all external areas. Above ground planters will contain soft landscaping.

1.4 Planning Background

Ramboll understands that the proposed development has been approved in Planning Permission 2019/2879/P, as described below:

- *Partial redevelopment of the site, including to the former Royal Free Hospital (Plot 1); Eastman Dental Clinic (Plot 2); Levy Wing (Plot 3); Frances Gardner House, and the Riddell Memorial Fountain within the courtyard of the former Royal Free Hospital, to create approximately 23,861sqm of medical research, outpatient facility and academic (Use Class D1) floorspace.*
    - *Former Royal Free Hospital: Demolition of the New, Sussex and Victoria Wings (with retention of the Alexandra Wing); single storey extensions and reinstatement of southern pediment on Alexandra Wing; erection of five storey building (plus two storeys of plant and two storeys of basement) to the rear of the Alexandra Wing, including plant, terraces, flues, to provide a dementia and neurology research facility.*
    - *Eastman Dental Clinic: Alterations to the listed building including the part rebuilding of the northern façade and new entrance; replacement windows; new plant; works to the courtyard and associated external and internal alterations associated with its conversion to education use.*
    - *Levy Wing: Substantial demolition of the building and erection of a part 4, part 7 storey building (plus two storey basement, including plant and external amenity spaces), to provide education space.*
    - *Frances Gardner House: Installation of photovoltaic panels on the roof and landscaping works to the courtyard.*
    - *Riddell Memorial Fountain: Relocation of the listed fountain from the courtyard of the former Royal Free Hospital to the courtyard of the Eastman Dental Clinic.*

  Associated landscaping arrangements including the creation of a new public square, other public spaces and routes, and pedestrian connections to Gray's Inn Road, St Andrew's Gardens, Cubitt Street and Langton Close. Associated transport and servicing arrangements including cycle parking, parking and a new servicing ramp.

Condition 33 of planning permission 2019/2879/P, pertains specifically to land contamination at Plot 1, as detailed below:

- *Land Contamination (Plot 1): 'Prior to demolition (excluding demolition to ground slab level) of Plot 1, a Remediation Strategy in accordance with Section 9 of the Ground Contamination Interpretive Report by Ramboll (Ref BEMP-RAM-P1-XX-RPC99-0016) shall be submitted to and approved in writing by the local planning authority. Prior to the occupation of the development, and on completion of the agreed contamination remediation works, a verification report providing details including data collected to demonstrate that the works set out/recommended in the remediation strategy are complete shall be submitted to and agreed in writing by the local planning authority. Each section of the development shall be carried out strictly in accordance with the relevant risk assessment, site investigation, options appraisal, remediation strategy and verification plan so approved, and no change therefrom shall take place without prior written consent from the local planning authority.'*

1.5 Objectives

This Remediation Strategy has been produced in support of the discharge of Planning Condition 33. The objective of this Remediation Strategy is to reduce concentrations of contaminants which pose a risk to human health and controlled waters to acceptable levels, in the context of a Commercial Land Use scenario.

The Strategy is based on the results of risk assessments which have determined what the appropriate level of remediation should be. This is the standard approach to remediating land contamination in the UK.

This Remediation Strategy has also been developed to provide prospective Contractors with an outline of the remediation scope of works for the study area, from which the prospective Contractors can develop a remediation design and a costed scope of works.

This Remediation Strategy sets out the remediation requirements, the standard to which the works should be carried out, and the means by which the completion of the works shall be measured.

1.6 Report Structure

The report is structured as follows:

- Section 2: Summarises previous reports, contamination, and risks present at the Plot 1 site.
- Section 3: Outlines the Conceptual Site Model for the Plot 1 site.
- Section 4: Presents the remediation strategy and the requirements for the Contractor and Environmental Consultant during the works
- Section 5; Presents the general requirements for managing the remediation, including health, safety and environmental considerations; and
- Section 6: Describes the verification process which will be undertaken during the remediation works and outlines the information which will be presented in the Verification Plan

1.7 Limitations

This Remediation Strategy is designed to support the proposed demolition and development process as described in Section 1. Should previously unidentified contamination be encountered during demolition, the remediation strategy should be reviewed accordingly and may need to be updated.

2. GROUND CONDITIONS

2.1 Introduction

The design of this Remediation Strategy has been informed through the findings of a desk study, site investigation and interpretation, as detailed in the following reports:

- Phase I Geotechnical and Geo-environmental Desk Study (Plot 1), prepared by Ramboll UK Ltd, dated 27th March 2018 (ref. BEMP-RAM-P1-XX-RP-CG-0001);
- Site Investigation Report, prepared by Concept, dated 19th September 2018 (ref. 18/3113-FR00).
- UCL Institute of Neurology (IoN)/Dementia Research Institute (DRI). Phase II Contaminated Land Interpretive Report, prepared by Ramboll UK Ltd, dated 5th October 2018 (ref. BEMP-RAM-P1-XX-RP-C-99-0016).

The geo-environmental findings of the site investigation are provided in detail within the Interpretive Report (GIR) and have been summarised for the purpose of this document within the following sections. The full reports should be referred to for further details.

2.2 Phase 1 Geotechnical and Geo-Environmental Desk Study

The objective of the Phase I Geotechnical and Geo-environmental Desk Study was to identify potentially significant geotechnical and geo-environmental risks and constraints to the proposed development. For the purpose of this summary, discussion will be limited to the geo-environmental aspects only. The geo-environmental component included a review of recent and historical ordnance survey maps to identify activities which might have led to contamination of soil and/or groundwater both on the site and in the vicinity; an examination of geological and hydrogeological information to ascertain the sensitivity and vulnerability of ground and surface water resources to contamination, if present; a search of a proprietary environmental database relating to the site and surrounding area; a walkover of the site; and the formulation of a preliminary conceptual site model.

The report identified a number of potential sources of contamination (PSC) on-site associated with current and former uses. Specifically, the following were identified as potential sources of contamination: the presence of Made Ground of unknown thickness and chemical composition beneath the site; the storage of materials and chemicals for use in plant rooms and laboratories; and the unconfirmed presence of a deep borehole used for the storage of radium. The specific location of the radium borehole could not be confirmed, although there is some evidence to suggest it may be located on the site of the current Francis Gardener House, to the east of Plot 1.

A number of potential off-site contamination sources were also identified.

Contaminants of concern associated with the PSC were considered to include heavy metals; Total Petroleum Hydrocarbons (TPH); Polyaromatic Hydrocarbons (PAH); Volatile Organic Compounds (VOCs); Semi-Volatile Organic Compounds (SVOCs); phenols; solvents; chlorides; sulphate; sulphides; Asbestos Containing Material (ACM); Polychlorinated Biphenyls (PCBs); elevated concentrations of CO_2 and CH_4; depleted concentrations of O_2; and residual radioactive material.

The report concluded by stating that an intrusive ground investigation should be undertaken to confirm the underlying ground conditions at the site.

2.3 Site Investigation

The site investigation, which was designed by Ramboll and undertaken by a contractor (Concept), aimed to investigate soil and groundwater conditions at the site for both geotechnical and geo-environmental purposes. The investigation comprised:

- drilling of seven boreholes to depths ranging from 9.0 m to 60 m bgl: 2 No. cable percussive boreholes to a maximum depth of 46.90 m, 2 No. cable percussive boreholes with rotary follow on to a maximum depth of 60.00 m, and 3 No. windowless sample boreholes to a maximum depth of 9.00 m;
- installation of combined groundwater and ground gas monitoring standpipes within five boreholes;
- logging of soil arisings and collection of soil samples;
- in-situ testing for VOCs;
- hand excavation of eight trial pits to a maximum depth of 1.60 m bgl;
- analysis of selected soil and groundwater samples for a suite of contaminants designed to be reflective of the PSC identified on-site; and
- six rounds of ground gas monitoring using a portable gas analyser.

2.4 Ground Conditions

2.4.1 Geology

The ground conditions encountered during the investigation were as follows:

Table 2.1: Summary of Ground Conditions

Strata	Description	Top of Strata (m AOD)	Thickness Range (m)
Made Ground	Encountered across the site. Constituents varied depending on location, but included gravel, sand, clay, brick, tile, concrete, clinker, slate, slag, ceramic and glass. **Potential ACM was identified** within the Made Ground underlying the car parking area in the north-east of the site: asbestos cement tile fragments in four locations, insulation lagging material in one location and suspected fibrous material.	+20.56 to +16.35	0.70 – 4.70
Alluvium	Encountered at three locations: WS02, WS03 in the east of the site, and TP09 off-site of Plot 1 to the south-east. Comprised firm green grey and light brown occasionally mottled grey slightly sandy gravelly CLAY with occasional orange brown discolouration and pockets of firm red brown clay.	+17.94 to +16.87	0.25 - 0.50
River Terrace Deposits	Encountered at two locations in the WS02 in the central east and BH02 in the west of the site, comprising medium dense yellow brown and orange brown sandy clayey to very clayey subangular fine to coarse GRAVEL of flint with occasional pockets of grey silty clay.	+18.06 to +17.54	0.7 – 2.0
Weathered London Clay	Encountered across the site as firm, extremely closely fissured brown occasionally mottled bluish grey slightly micaceous slightly gravelly slightly sandy silty CLAY with rare pockets of orangish brown fine sand.	+18.14 to +15.81	1.9 - 4.8
London Clay	Encountered in 7 locations BH01, BH02C, BH03, BH04, WS01, WS02, WS03, as firm to stiff extremely closely fissured dark grey and brownish grey slightly micaceous slightly sandy silty CLAY.	+14.94 to +12.43	12.7 - 15.7
Lambeth Group	Encountered at four locations BH01, BH02C, BH03, BH04 comprising:	+0.01 to -0.76	18.8 – 20.3

Strata	Description	Top of Strata (m AOD)	Thickness Range (m)
	• Stiff to very stiff brown grey and blue grey silty CLAY (Reading Formation: Upper Mottled Beds); • Stiff to very stiff dark grey and black silty CLAY (Woolwich Formation: Laminated Beds); • Very stiff grey and light bluish grey occasionally mottled yellowish brown and locally purple silty CLAY (Reading Formation: Lower Mottled Beds); • Very stiff dark grey to black sandy silty CLAY with occasional pockets of light grey fine sand (<35mm) and rare shell fragments (Reading Formation: Lower Mottled Beds Kings Cross Unit); • Very stiff dark grey and green grey slight sandy slightly gravelly silty CLAY with pockets of light grey and light brown fine sand (Upnor Formation)		
Thanet Sand	Encountered at three locations BH01, BH02C, BH04 comprising very dense, grey fine sand with rare pockets of dark grey clay.	-19.56 to -20.57	3.0 to 4.9
Chalk	Encountered at four locations BH01, BH02C, BH03, BH04. Chalk.	-22.99 to -24.46	Not proven

2.4.2 Hydrogeology

Groundwater was not encountered during the investigation during the drilling of the boreholes; however, groundwater seepage was observed at the base of two trial pits within the superficial deposits of Alluvium. During subsequent monitoring rounds, wells screened within the Made Ground were found to be dry, with the exception of BH04 where groundwater was encountered at 2.48 m bgl on one occasion. Groundwater was also encountered in wells installed within the London Clay at depths of between 7.89 mAOD and 9.97 mAOD, and within the Lambeth Group at depths of between -16.78 mAOD and -17.66 mAOD. Groundwater is also expected to be in the Thanet Sands and Chalk aquifer.

2.4.3 Ground Gas

Six rounds of ground gas monitoring were undertaken, which found carbon dioxide concentrations to be <5%, with a maximum concentration of 2.2%. Methane, carbon dioxide and Hydrogen sulphide were not detected at any monitoring wells. Based on the data obtained, a worst-case gas screening value of 0.0022 l/hr was calculated, which corresponds to Characteristic Situation 1 (CS1) – Very Low Risk.

2.5 Contamination Findings

Following the ground investigation, an interpretive report was completed by Ramboll. The objective of the Phase II Contaminated Land Interpretive Report was to assess the potential risks and liabilities associated with potential contaminants in soil and groundwater at the site based upon the findings of the Site Investigation Report.

A Generic Quantitative Risk Assessment (GQRA) was undertaken to assess potential risks posed to both Human Health and Controlled Waters receptors from contaminants of concern recorded at the site. The assessment was modelled on a future Commercial Land Use scenario.

2.5.1 Risks to Human Health

The results of the Human Health Assessment recorded concentrations of pH, PAHs, and asbestos in soil above the respective Generic Assessment Criteria (GAC), as presented in Table 2.1 below:

Table 2.2: Summary of Elevated Chemical Concentrations in Soil

Determinand	GAC	Number of Samples	Number of Exceedances	Maximum Concentration
General Inorganics				
pH	<5,>9	21	12	12.1
Polycyclic Aromatic Hydrocarbons				
Benzo(a)pyrene	76 mg/kg	21	1	85.0 mg/kg
Benzo(b)fluoranthene	45 mg/kg	21	1	79.0 mg/kg
Dibenz(ah)anthracene	3.5 mg/kg	21	1	12.0 mg/kg
Asbestos in Soil				
Asbestos (Chrysotile)*	-	21	9	0.30% w/w

*Note that **visual observations** of asbestos fragments were also found and not subject to asbestos quantification, which is a soil test.

The Human Health Assessment concluded that the following impacts may present a risk to human health and building materials, thereby requiring further consideration:

- alkaline pH greater than pH 9 within 12 samples;
- exceedances of benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(ah)anthracene at one location OP01 0.30m east of the car park on the eastern boundary of the site, along the reduced level walkway; and
- asbestos fragments and chrysotile/amosite fibres in nine samples of Made Ground. Following quantification, three samples were below the limit of detection (LOD) of 0.001 w/w, and six samples were above LOD ranging from 0.002% at WS01 (0.50m) to a maximum 0.30% at WS01 (0.20m). Visible fragments of ACM were identified at four locations underlying the car park in the east of Plot 1, at TP01, TP01A, BH03 and WS01.

There were no exceedances of the GAC for metals, ammonium, or TPH. VOCs and BTEX were not detected above the LOD.

2.5.2 Risks to Controlled Waters

The results of the Controlled Waters Assessment were based on a leachate and groundwater screening analysis. Three samples of Made Ground were selected for the leachate analysis. Contaminant concentrations recorded above the recommended GAC in one or more samples are presented in Table 2.3 below:

Table 2.3: Summary of Elevated Chemical Concentrations in Leachate

Determinand	GAC	Number of Samples	Number of Exceedances	Maximum Concentration
General Inorganics				
Ammonium (as NH_4)	500 µg/l	3	1	720 µg/l
Heavy Metals				
Antimony	5 µg/l	3	1	5.70 µg/l

Determinand	GAC	Number of Samples	Number of Exceedances	Maximum Concentration
Arsenic	7.5 µg/l	3	1	9.90 µg/l
Lead	7.5 µg/l	3	3	14.0 µg/l
Mercury	0.01 µg/l	3	3	0.054 µg/l

The groundwater results were only slightly above the GAC and of the same order of magnitude. It was noted that all of the leachate samples were taken from Made Ground soils underlying hardstanding, with no water strikes encountered during drilling, and as such the probability of water infiltration and subsequent leaching and migration of contaminants was considered to be low in these locations.

For the groundwater analysis, two groundwater samples were obtained from BH02C (response zone within the London Clay, 14.0 – 15.1 m bgl) and the results were screened against the recommended GAC. All other wells had been found to either be dry, or to contain a volume of groundwater too small to sample during the two groundwater monitoring rounds. Both samples were analysed for a broad suite of contaminants including metals, PAH, TPH, BTEX and phenols. Contaminant concentrations recorded above the recommended GAC are presented in Table 2.3 below:

Table 2.4: Summary of Elevated Chemical Concentrations in Groundwater

Determinand	GAC	Number of Samples	Number of Exceedances	Maximum Concentration
General Inorganics				
Sulphate (as SO_4)	188 mg/l	2	2	1160 mg/l
Ammonium (as NH_4)	500 µg/l	2	2	860 µg/l
Heavy Metals				
Boron	750 µg/l	2	2	1300 µg/l
Manganese	50 µg/l	2	2	80.0 µg/l
Selenium	7.5 µg/l	2	2	10.0 µg/l

The Controlled Waters Generic Screening Assessments concluded that the following impacts require further consideration, as explained in this report:

- presence of leachable ammonium, arsenic, and lead within Made Ground soils; and
- exceedances of ammonium, sulphate, boron, manganese, and selenium in groundwater.

Whilst mercury was identified at concentrations greater than the LOD for hazardous substances in all three leachate samples, the exceedances were of the same order of magnitude as the LOD, and did not exceed the threshold value for mercury when considering the Water Framework Directive criteria for General Quality of a Groundwater Body. Mercury was therefore not considered further.

However, a significant risk to controlled waters was not identified by the Phase II report.

3. REMEDIATION CONCEPTUAL SITE MODEL

3.1 Introduction

The remediation conceptual site model follows the contaminant-pathway-receptor philosophy that is a main principle of UK guidance and legislation. The remediation conceptual site model presented in this section provides the basis of this Remediation Strategy.

3.2 Contaminant Sources

The Phase I Geotechnical and Geo-environmental Desk Study (Plot 1), the Site Investigation Report, and the Phase II Contaminated Land Interpretive Report have identified the following contaminant sources and pollutant linkages which will require remediation, as summarised in Table 3.1:

Table 3.1: Risk Assessment: Contaminant-Pathway-Receptor (Commercial Land Use)

Pollutant Linkage	Source	Pathways	Receptor(s)	Discussion	Risk Ranking
PL1	Asbestos within Made Ground	Dermal Contact; Ingestion; Inhalation	Site construction workers; Future site users; Adjacent site users	Asbestos was identified in nine samples of Made Ground as visible fragments and fibrous debris. Maximum concentration was 0.30%. On redevelopment, the entire site will be capped by buildings/ hardstanding, thereby preventing exposure to the soil. **Risk management measures will be required for the protection of site workers during development.** Clean imported topsoil from an accredited source should be used within the planters rather than existing Made Ground.	**High** risk to workers during site development. An Asbestos Management Plan should be completed prior to the commencement of site development. **Moderate to Low** risk to adjacent site users during site development. **Low** risk to future site users with typical mitigation/remediation.
PL2	Localised marginal exceedance of PAHs in Made Ground	Dermal Contact; Ingestion; Inhalation	Site construction workers; Future site users; Adjacent site users	Exceedances of PAHs (benzo(a)pyrene, benzo(b)fluoranthene and dibenz(ah)anthracene) were identified in one soil sample from the eastern part of the site. On redevelopment, areas of soft landscaping on-site are likely to be limited to above ground planters, thereby preventing exposure to the underlying soil. Risk management measures will be required for the protection of site workers during construction. Clean imported topsoil from	**Moderate to Low** risk to site construction workers. **Low** risk to adjacent and future site users with typical mitigation/ remediation.

Pollutant Linkage	Source	Pathways	Receptor(s)	Discussion	Risk Ranking
				an accredited source should be used within the planters rather than existing Made Ground.	
PL3	Alkaline pH in Made Ground	Direct Contact	Building materials	Soils across the site were identified as generally alkaline, with a pH ranging from 7.6 to 12.1. Twelve of the 21 soil samples were identified as having a pH greater than 9. Aggressive ground conditions can have negative impacts on building materials. On redevelopment, areas of soft landscaping on-site are likely to be limited to above ground planters, thereby preventing exposure to the soil. Risk management measures will be required for the protection of site workers during construction. Clean imported topsoil from an accredited source should be used within the planters rather than existing Made Ground.	**Moderate**
		Dermal Contact; Ingestion	Site construction workers; Future site users; Adjacent site users		**Moderate** risk to site construction workers. **Low** risk to adjacent and future site users with typical mitigation/ remediation.
PL4	Leachable arsenic and lead in Made Ground	Direct Contact; Ingestion	Site construction workers; Future site users; Adjacent site users	A marginal exceedance of arsenic was recorded in the central-southern part of the site. A marginal exceedance of lead was identified in the central-southern and north-eastern portions. The exceedances were recorded within the Made Ground underlying the site. Given no water strikes were encountered during drilling, the probability of water infiltration and subsequent leaching and migration of contaminants present in shallow soils is considered to be low. On redevelopment, areas of soft landscaping on-site are likely to be limited to above ground planters, thereby preventing exposure to the soil. Risk management measures will be required for the protection of site construction workers. Clean imported topsoil from an accredited source should be used within the planters rather than existing Made Ground.	**Low** risk to site construction workers, future site users and adjacent site users.
		Leaching and migration	Surface waters; Secondary A Aquifer (River Terrace Deposits); Secondary A Aquifer (Lambeth Group); Principal Aquifer (Thanet Sands and Upper Chalk Formation)		**Low** risk to surface waters. **Low** risk to Secondary A Aquifer (River Terrace Deposits). **Low** risk to Secondary A Aquifer (Lambeth Group); Principal Aquifer (Thanet Sands and Upper Chalk Formation).

Pollutant Linkage	Source	Pathways	Receptor(s)	Discussion	Risk Ranking
				Mitigation measures would comprise appropriate watching briefs for possible undiscovered sources of groundwater contamination.	
PL5	Exceedances of ammonium, sulphate, boron, manganese, and selenium in BH02C groundwater	Leaching and migration	Surface waters; Secondary A Aquifer (River Terrace Deposits); Secondary A Aquifer (Lambeth Group); Principal Aquifer (Thanet Sands and Upper Chalk Formation)	Localised, marginal exceedances were recorded in groundwater in the London Clay in the central-western part of the site. Given that the exceedances were within the London Clay, strata of generally low permeability, it is considered unlikely that groundwater will migrate further laterally or vertically into the Secondary A Aquifers or Principal Aquifers underlying the site. Mitigation measures would comprise appropriate watching briefs for possible undiscovered sources of groundwater contamination.	**Low** risk to surface waters. **Low** risk to Secondary A Aquifer (River Terrace Deposits); Secondary A Aquifer (Lambeth Group); Principal Aquifer (Thanet Sands and Upper Chalk Formation).
PL6	Previously unidentified contamination (e.g. between borehole locations)	Direct contact; Ingestion; Inhalation	Site construction workers; Future site users; Adjacent site users	Previously unidentified contamination could be present in investigated areas of the site such as between borehole locations. These have the potential to impact site users and controlled waters. Risk management measures will be required for the protection of site workers during development. Clean imported topsoil from an accredited source should be used within the planters rather than existing Made Ground.	**Moderate** risk to workers during site development. **Low** risk to adjacent and future site users with typical mitigation/ remediation.
		Direct contact	Building materials		**Moderate**
		Leaching and migration	Surface waters; Secondary A Aquifer (River Terrace Deposits); Secondary A Aquifer (Lambeth Group); Principal Aquifer (Thanet Sands and Upper Chalk Formation)		**Low** risk to surface waters and Secondary A Aquifer (Lambeth Group); Principal Aquifer (Thanet Sands and Upper Chalk Formation). **Low** risk to Secondary A Aquifer (River Terrace Deposits).

4. REMEDIATION STRATEGY

4.1 Introduction

This section sets out the various remediation elements and shows how these measures are designed to be protective of the Proposed Development. On completion of the development, Ramboll considers there will not be a complete contaminant-pathway-receptor connection and therefore contamination risks will have been appropriately mitigated. This section demonstrates how this will be accomplished.

Ramboll understands that a contractor (i.e. the Principal Contractor under Construction (Design and Management) Regulations 2015 (CDM 2015), the 'Contractor') will be appointed to undertake the demolition and remediation work. This may require the engagement of a specialist sub-Contractor for some aspects of the work.

It is envisaged that the Contractor would propose a detailed remediation design which would meet the objectives of this Remediation Strategy, and the Contractor would verify that the overall strategy has met its objectives in accordance with the verification process and plan set out in this Remediation Strategy. An independently appointed Environmental Consultant would provide independent oversight during the remediation works, including independent confirmation that the validation sampling and chemical analysis obtained by the Contractor meets the requirements of the Remediation Strategy, and the production of the final Verification Report.

4.2 Remediation Approach

Significant or 'gross' contamination was not encountered during investigation of the site. As such, the remediation will be implemented during and as part of the development of the site. In summary, the remediation approach will comprise excavation and removal off-site of Made Ground as part of the basement development; management of asbestos known to be present within Made Ground as detailed in the Asbestos Management Plan[1]; importation of clean topsoil and capping layer for any soft landscaping areas/above ground planters; and piling works groundwater monitoring. These aspects are detailed below. Groundwater remediation will comprise a watching brief for unexpected contamination sources (see Section 7).

In addition, best practise measures of environmental controls, and requirements for the Contractor and Environmental Consultant as outlined in Sections 6 need to be undertaken as part of the development.

4.3 Proposed Soil Quality Criteria

Soil re-used on site or imported materials must meet the soil quality criteria provided in Appendix 2. Further details are provided in Section 5.

4.4 Gas Protection Measures

Based upon the results of the ground gas risk assessment, the overall gas regime at the site has been assessed as being Characteristic Situation 1 (CS1) – Very Low Risk (see Section 2.3). This indicates that no specific gas protection measures will be required in the new buildings on-site.

4.5 Excavation of Contaminated Soils

The construction of a sub-grade two-storey basement extending to approximately 9-14 m bgl will form part of the redevelopment works (see Section 1.3).

[1] UCL Plot 1 Asbestos Management Plan, November 2020

Large volumes of Made Ground and thus also the identified contaminants, will be excavated and removed from the site to allow for the development of the basement. The removal of Made Ground will therefore remove the identified contamination and thus the risk to site users or controlled waters.

4.6 Asbestos Removal

The Made Ground soils contain significant amounts of asbestos, particularly in the eastern car park area. This is relevant for construction and maintenance works and the **Asbestos Management Plan should be referred to for further details.** On completion of the development the soil will be 'capped' preventing site users being exposed to soil and therefore mitigating potential risks of exposure to asbestos in soil.

4.7 'Hard' Capping Layers

Following redevelopment, the proposed building/hardstanding footprint will cover the majority of the site except for above ground planters. The future buildings and other areas of hardstanding will therefore provide a physical barrier, preventing future site users from being exposed to contamination remaining in on-site soils (which had not already been removed for the basement excavation).

4.8 'Soft' Capping Layers - Landscaping Areas

It is understood that soft landscaping areas are likely to be limited to above ground planters. The planters will therefore provide a barrier between on-site soil and the site user. *Should* soft landscaping layers be included at ground level, not contained within planters, then a clean capping layer of 600 mm depth of clean imported topsoil should be installed.

The planters should be filled with clean, imported topsoil from a reputable and auditable source, and should be clean and uncontaminated and suitable as a growing medium. Analytical certificates for the imported topsoil should be provided, to ensure that the topsoil meets Ramboll's soil import criteria, provided in Appendix 2. Existing Made Ground or other soil at the site **should not** be re-used within planters. The imported soil will need to be sampled in-situ and analysed at an accredited laboratory.

The Contractor will source suitable clean and uncontaminated topsoil and be responsible for importing it onto site in line with appropriate legislation, waste exemption (if applicable) or with the CL: AIRE Definition of Waste Code of Practice (DoW CoP).

Prior to import onto site the Contractor will provide the Environmental Consultant with information on the topsoil, to include:

- the source of origin (be it one site or multiple sites);
- the volume of topsoil required;
- the name and address of the producer;
- any quality information on the sub-soil and topsoil from the producer/vendor, including laboratory testing; and
- analytical sample results to confirm compliance with the characteristics set out in BS882:2015 Specification for topsoil.

Natural topsoil and manufactured topsoil can be considered by the Contractor as potential topsoil sources.

Verification samples will be collected from the topsoil once placed in-situ at the development, to verify that the soil is not contaminated. The verification sampling is defined in Section 7.

5. OUTLINE MATERIAL MANAGEMENT STRATEGY

5.1 Materials Management Plan

It is envisaged that the re-use of excavated soils and demolition materials on site may be undertaken by the Contractor. This should be done under the CL: AIRE Definition of Waste: Development Industry Code of Practice (DoW CoP). **In line with this, the Contractor shall be required to develop and maintain a Material Management Plan (MMP).** The MMP will monitor where materials used on-site originate, through to their final destination, including temporary storage or stockpiling as necessary. The Contractor must confirm how it will manage all re-use of materials.

No Made Ground material is suitable for reuse in open areas of soft landscaping as part of the final development.

The MMP should develop appropriate geotechnical and environmental re-use criteria to be agreed with the Environmental Consultant.

There should be no re-use of materials unless agreed with the Environmental Consultant and an appropriate MMP has been completed.

The Contractor should also refer to the Ramboll Excavation and Filling Specification, reference BEMP-RAM-P1-XX-SP-CG-17-1002, and the Specification for Piling and Embedded Retaining Walls, reference BEMP-RAM-P1-XX-SP-CG-15-1001.

5.2 Breaking Out

The proposed excavation areas will require removal of the current building and hardstanding cover. There is also potential for undiscovered sub-surface structures to be present beneath the hardstanding which may require removal to facilitate the development.

In principal and subject to appropriate approvals, excavated concrete hardstanding and floor slab with no visible contamination could be crushed and re-used on site, provided that the material meets the chemical verification criteria as agreed with the Environmental Consultant in the MMP, and also the geotechnical criteria set out in the Contractor's demolition specification. Other approvals and permissions may be necessary that are not discussed in this document.

The Contractor will be required to find an alternative disposal route for crushed material that does not meet chemical verification criteria.

5.3 Soil Segregation

Soils will be carefully segregated by the Contractor during excavation, based on visible and olfactory evidence of contamination, the results of PID screening and the results of available chemical analysis. The soils will be segregated into the following streams:

- 'Contaminated' soils: Based on investigation results, gross organic or inorganic contamination is not anticipated, but may be present as previously unidentified contamination. **In addition, a proportion of the excavated soils will be contaminated with asbestos.** If encountered, these soils cannot be re-used on site and require off-site disposal as hazardous waste at a licensed waste management facility. The Asbestos Management Plan should be referred to for the appropriate protocol.
- 'Clean' soils: It is envisaged that a proportion of the soils excavated from the site would contain contaminants at concentrations which do not constitute 'gross' contamination. Soils should be tested to determine the appropriate disposal route; further details are provided in Section 5.7.

It is important to segregate soils to maximise sustainability and disposal or re-use options, and provide a cost benefit. The Contractor will need to be able to demonstrate this.

5.4 Perched Groundwater Removal from Excavation

Should perched groundwater be encountered during the excavation, then the water should be observed for signs of obvious contamination such as sheens or free product ('neat' oil on the surface of the water). If contamination is suspected then an investigation of the potentially contaminated material will be required to determine management options.

For example, perched groundwater containing dissolved phase hydrocarbons could be disposed of off-site by tanker or treated on-site using a temporary on-site treatment unit. The Contractor will determine an appropriate disposal solution, taking into account the likely volume of perched groundwater, the dissolved phase concentrations and the ability of the Contractor to obtain appropriate consents for the discharge of treated groundwater (e.g. to foul sewer). The perched water will be sampled and analysed by the Contractor prior to disposal to ensure that the perched water meets relevant requirements (e.g. discharge consent/permit limits for disposal to foul sewer). The Contractor will be responsible for obtaining all necessary permits and consents for water disposal or discharge.

5.5 Stockpiling

Excavated materials may need to be temporarily stockpiled whilst awaiting disposal, or re-use on-site. The materials will be stockpiled in accordance with the following:

- In order to minimise waste disposal costs, soils excavated will be segregated during excavation based on visual and olfactory evidence of contamination, and stockpiled separately, as 'clean', 'grossly contaminated' and 'contaminated' soil streams.
- All stockpiles will be kept to a manageable size and good housekeeping procedures implemented.
- All stockpiles will be placed in an impermeable area of the site (e.g. concrete in good condition with no surface water drains), covered with impermeable sheeting and secured.
- Each stockpile will be labelled by the Contractor with specific identification. If necessary, the Contractor will make arrangements to manage rainwater run-off from the stockpiles.

5.6 Use of Materials for Backfill

It is not anticipated that there will be substantial backfill of excavations using either re-used or imported material. The exception to this is the far eastern strip of the current car park area which lies outside the proposed building and basement extent. This will be excavated to a shallower depth than the basement, the retaining wall at the eastern edge of the site will be replaced with a new retaining wall, and the area backfilled with imported engineering fill. Above this will be a raised planter with imported topsoil.

Should backfilling be required, the following procedures for backfill should be followed.

5.6.1 Imported Backfill Materials (excluding Topsoil – refer to Section 4.8)

If there is a requirement to use imported material on-site, such as the imported engineering fill for the section along the eastern boundary, the Contractor should ensure that the Quality Protocol 'Aggregates from Inert Waste' published by WRAP is followed when importing recycled aggregates. The Contractor will provide the Environmental Consultant with the following documentation on the recycled aggregate:

- date of supply;

- product description to aggregates standard and customer specification;
- the name and contact details of the aggregate producer;
- the quantity imported to site by weight and volume;
- a statement that the aggregate was produced in compliance with the Quality Protocol; and
- the locations on site where the imported aggregate was used, including the depth/thickness of fill (e.g. the depth placed within excavations).

Prior to use on-site, the imported material will be inspected by the Contractor for visible signs of contamination such as asbestos, hydrocarbon staining or odours, and the Contractor will sample and analyse the material in line with the chemical verification requirements in Section 7.

The Contractor shall seek agreement from the Environmental Consultant on the use of the materials as backfill prior to backfilling commencing.

As with site-won material there is a requirement for imported backfill materials to meet geotechnical requirements specified within the demolition specification.

It is understood that the development requires only minimal areas of soft landscaping, limited to above-ground planters. Site-won materials such as existing Made Ground are not considered suitable for reuse in soft landscaping. Should soft landscaping layers be included at ground level, not contained within planters, then requirements for a 600 mm depth clean capping layer should be followed, as described in Section 4.8.

5.6.2 Re-use of Site-won Materials

If required, existing soil can be re-used to backfill remediation excavations, provided that the Contractor can demonstrate to the Environmental Consultant that the soils meet the chemical verification criteria agreed upon within the MMP.

Crushed concrete can also be re-used to backfill remediation excavations provided that the Contractor can demonstrate to the Environmental Consultant that crushed concrete meets the chemical verification criteria agreed upon within the MMP. For use as backfill, the crushed material must be free from asbestos, metal, glass, putrescible materials and other potentially contaminative materials.

The Contractor must obtain agreement from the Environmental Consultant on the re-use of the crushed concrete or soil prior to backfilling commencing.

There is also a requirement for backfill materials to meet geotechnical requirements; these requirements are outside the scope of this remediation strategy, but the Contractor should ensure that these requirements are met.

Re-use of materials is also subject to other approvals and permissions that are not discussed further in this report. The Contractor will need to ensure it has followed appropriate all procedures and obtained all permissions necessary.

5.6.3 Out of Specification Materials

Site-won or imported materials which do not meet the chemical verification criteria (Appendix 2) will be considered as 'out of specification' and generally not be considered suitable for re-use on-site.

However, the Environmental Consultant may use professional judgement, for example in the event that a limited number of contaminants marginally exceed the verification criteria. This will be at the discretion of the Environmental Consultant, and the Contractor must not re-use such material without obtaining prior agreement from the Environmental Consultant.

The Contractor will be responsible for dealing with out of specification material; this may be through off-site disposal (in which case the Contractor would be expected to source the most cost-effective disposal route), or by further on-site treatment until it meets chemical verification criteria.

5.7 Off-Site Waste Disposal

The waste disposal routes of both the material excavated for the basement area as well as any obviously contaminated excavated soils and other materials to landfill, recycling or treatment facilities will be determined by the Contractor and will follow relevant guidance and legislation. The Contractor will provide full details of the disposal route.

The Contractor is responsible for arranging laboratory analysis for waste classification and (if necessary) waste acceptance criteria (WAC) purposes. This should be undertaken at an appropriately accredited laboratory.

The Contractor will provide all relevant documentation on completion of its work to the Environmental Consultant, including:

- methods used to classify the waste and the results of the classification;
- results of WAC analysis (if required);
- the place of disposal;
- waste volumes; and
- waste transfer notes and other Duty of Care information.

A fully auditable waste management procedure will be prepared by the Contractor. Correspondence with the landfill or receiving facility regarding the classification of waste will also be provided to the Environmental Consultant by the Contractor.

The Contractor will be responsible for identifying the appropriate disposal route. The disposal options should consider soil treatment and recycling as well as disposal to landfill.

Groundwater which has been dewatered from the excavations will be required to be disposed of in accordance with legislation.

The Contractor will dispose of 'general' waste arising from the remedial works in accordance with the Duty of Care and other applicable waste regulations. Where possible the disposal options should consider recycling.

The Contractor will provide a valid copy of the waste transfer certificate for each load of material which exits the site for off-site disposal during the works, including proof of receipt of the material at the destination site (e.g. landfill, soil treatment facility, waste water treatment facility, recycling plant etc.).

6. REMEDIATION MANAGEMENT

6.1 Introduction

This section comprises an overview of typical management considerations during a remediation project. It is not intended to be a prescriptive set of instruction or remove the Contractor's responsibility to prepare its own compliant health, safety and environment management plans and procedures.

6.2 Health and Safety

6.2.1 CDM 2015

This remediation strategy considers the roles under CDM 2015 during the remediation work and does not specifically address requirements for the demolition work. Ramboll understands that ISG (Project Managers) on behalf of UCL has appointed the Principal Contractor, Keltbray to undertake the demolition and remediation works. This remediation strategy therefore assumes that Keltbray will be the Principal Contractor for the demolition and remediation work under CDM.

This remediation strategy also assumes that the Client (UCL) will appoint a Principal Designer to plan, manage, monitor and co-ordinate health and safety in the pre-demolition and pre-remediation phase, and to liaise with the principal Contractor to help in the planning, management, monitoring and coordination of the demolition and remediation phase.

The Environmental Consultant will act as a Contractor during the remediation phase.

6.2.2 Risks to Workers during the Remediation Works

Construction workers, workers and visitors on the wider UCL site may be exposed to contaminants in soil and groundwater during the remediation works. This includes (but is not limited to) the contaminants identified to date, contaminated dusts, odours and vapours, and also the likelihood of asbestos fibres to be present in the Made Ground. The Asbestos Management Plan should be referred to before, during and after the works to ensure risks are appropriately managed.

The Contractor will be responsible for undertaking adequate risk assessments and preparing method statements to mitigate risks to remediation workers and other site users from contamination. Potential solutions will include measures to minimise exposure to contaminated materials, and as a last line of defence, the provision of suitable personal protective equipment (PPE) to mitigate potential risks.

This Remediation Strategy report does not constitute a design or method statement for the proposed demolition work, or any form of health and safety advice.

6.3 Environmental Management

In light of the site setting and proposed remediation works, a number of potentially sensitive receptors have been identified (as detailed in Table 3.1).

Environmental management issues throughout the life of the project, including design through to commissioning, are to be governed or guided by a number of 'standards', including:

- those contained in legislation; and
- those established by industry codes of practice.

The remedial work will be undertaken by the Contractor in accordance with relevant construction industry practices, Environment Agency (EA) guidance and industry-accepted standards of 'good working practice'.

The Contractor will need to ensure that the site is managed during demolition, piling and excavation works to prevent pollution or risk to surface and groundwater resources. All site activities would be undertaken in accordance with the requirements of the following legislation:

- Water Resources Act 1991;
- Water Act 2003;
- Control of Pollution (Oil Storage) (England) Regulations 2001 SI 2954;
- Hazardous Waste (England and Wales) (Amendment) Regulations 2009 SI 507;
- Hazardous Waste (England and Wales) Regulations 2005 SI 894 & Amendments;
- Environmental Protection (Duty of Care) Regulations 1991;
- Construction (Design and Management) Regulations 2015;
- Health and Safety at Work Act 1974;
- The Workplace (Health, Safety and Welfare) Regulations 1992;
- Control of Noise at Work Regulations 2005;
- Control of Substances Hazardous to Health Regulations 2002 (CoSHH);
- Management of Health and Safety at Work Regulations 1998;
- Environment Agency: Land Contamination: Risk Management' (LCRM) (2020);
- CIRIA: Guide to Safe Working on Contaminated Sites: R132D (1996);
- CIRIA: Control of Water Pollution from Construction Sites: C532 (2001);
- CIRIA: Waste Minimisation in Construction – Site Guide: SP133 (1997);
- CIRIA: Managing Materials and Components On-Site: SP146;
- CIRIA: Environmental Good Practice on Site Guide (fourth edition) C741 (2015);
- CIRIA: Asbestos in soil and made ground: a guide to understanding and managing risks: C733 (2014);
- Manual of Contract Documents for Highway Works, Series 600, Highways Agency. April 2014;
- The CL:AIRE Definition of Waste: Development Industry Code of Practise (DoW CoP), version 2 March 2011, available at www.claire.co.uk;
- Quality Protocol Aggregates from Inert Waste, WRAP and the Environmental Agency October 2013; and
- The Construction Code of Practise for the Sustainable Use of Soils and Construction Sites, published by Defra and WRAP, 2009.

Specific mitigation measures to be incorporated as part of the remedial works, with respect to dust suppression, noise reduction and vehicle cleanliness are outlined below. These measures are not intended to replace any environmental management measures specified in the planning consent for the demolition and remediation work.

6.3.1 Surface Water Management

Remediation Considerations

Underground services and utilities were traced by RPS – Midland Survey prior to the commencement of the Plot 1 ground investigation; a utilities plan is provided in Appendix 3. This

is provided for information only and cannot be relied on by the Contractor and does not remove the Contractor's responsibility for managing services and utilities during its works.

The site surface/stormwater drainage ultimately discharges to the mains sewer along Gray's Inn Road.

The Contractor will be responsible for confirming the route of the stormwater drainage discharge within the study area, and re-routing/protecting the drainage system, as required (in agreement with UCL).

The Contractor will be responsible for managing all surface water run-off and perched groundwater within the area of the remediation works. It is anticipated that after periods of rainfall, water will likely collect within open excavations, in addition to any perched groundwater which enters the excavations from the surrounding Made Ground.

It is anticipated that the water from within the excavations will be pumped out of the excavations for either treatment and disposal on-site, or tankered off-site for treatment and disposal.

'Contaminated' run-off (for example from stockpiles, if present) will not be allowed to be discharged directly into any surface water drainage system or onto neighbouring properties; the Contractor shall make arrangements to limit 'contaminated' water run-off and to manage water run-off appropriately.

The Contractor will be responsible for liaising with UCL if water treatment requirements or discharge arrangements are proposed during the remediation works. If necessary, the Contractor may be required to apply for a temporary discharge consent. The Contractor will be responsible for ensuring that any discharges from the Site meet agreed standards and will submit copies of verification analysis while the remediation works are ongoing.

Post-Remediation Considerations

The surface water drainage requirements which the Contractor will be required to achieve will be specified by UCL.

6.3.2 Release of Contaminants to Ground

The use of plant equipment on-site during the remediation works could result in the potential for the release of contaminants to ground, such as fuel, oils, coolants and lubricants. To avoid the accidental leakage of fuel, oils and/or lubricants, all plant should be maintained to a safe and efficient working condition at all times and any oils or fuels should be contained in accordance with Control of Pollution (Oil Storage) (England) Regulations 2001 SI 2954.

As a minimum all liquids and solids of a potentially hazardous nature (e.g. diesel fuel, oils, degreasers, stored pumped groundwater and free phase oil etc.) shall be stored with appropriate secondary containment (e.g. bunding). A dedicated area for the refuelling of plant and vehicles away from any surface water drains shall be established and the fuelling area shall be kept clean at all times. No refuelling shall be undertaken outside of the established refuelling area. Spillages or leaks of fuel shall be cleaned up immediately by the Contractor and contingency arrangements for dealing with spillages shall be available at all times, including absorbency granules and dedicated spill response kit.

All equipment containing fuel/oils (e.g. pumps and generators) shall be placed on drip trays and these shall be maintained by the Contractor to remove standing water as appropriate to their correct operation and containment of the plant in question.

6.3.3 Dust Control

Dust control is of importance in respect of any major earthmoving, on-site stockpiling or vehicle loading and movement over unsurfaced areas. The Contractor is required to put in place appropriate measures to deal with dust and the identified contamination during the works. This is particularly important when moving Made Ground soils which are known to be contaminated with asbestos. The Asbestos Management Plan should be referred to for the appropriate protocol.

The Contractor will need to consider appropriate health and safety precautions for site workers during excavating through Made Ground. The pathway by which site workers may come into contact with asbestos in soil is through inhalation. This overarching approach is discussed in industry guidance published in CIRIA C733, 2014: Asbestos in Soil and Made Ground: a Guide to Understanding and Managing Risks. Accordingly, the Contractor will need to undertake a risk assessment in order to determine the best approach in accordance with the Asbestos Management Plan.

The Control of Asbestos Regulations (CAR) 2012 requires actions to ensure the protection of workers and general public from asbestos exposures resulting from work activities. The Principal Contractor is expected to have suitable precautions in place.

6.3.4 Vehicle Cleanliness

The Contractor will take all reasonable measures to prevent, as far as is practically possible, the deposit or tracking of mud or debris arising from the study area onto roadways and the public areas outside of the UCL site (this will include public highways and areas of public access).

The following procedures will be put in place by the Contractor as part of its Method Statement:

- During excavation activities, the loading of vehicles shall be performed in an organised manner so as to prevent the escape of materials. All vehicles will be appropriately designed to hold the waste without release during transit and sheeted prior to leaving the site. All reasonable and applicable measures to prevent the escape of material during loading and transportation shall be taken.
- Soil waste should be maintained in a damp condition.
- All vehicles shall be inspected prior to departure and where necessary loose material removed.
- Drivers will inspect their vehicles prior to leaving the study area and ensure that their loads are secure.
- If deemed necessary, a wheel washing facility should be made available.

6.3.5 Noise

The Contractor shall employ current good practice and guidance in relation to noise control (and, if necessary, meet noise criteria set within the baseline noise assessment), such as:

- proper maintenance of plant and equipment used for the works, which is silenced where appropriate, and operated to prevent excessive noise. Plant should be certified to meet any relevant EC Directives/UK/BS5228 standards;
- enclosing or screening static construction plant (e.g. compressors); and
- shutting down items of plant when not in use.

6.3.6 Environmental Incidents

Environmental incidents can be defined as unexpected events which lead to, or could in different circumstances have led to, adverse effects on people, property or on environmental resources such as habitats or watercourses. Procedures shall be put in place by the Contractor to deal with environmental emergencies and incidents.

As is standard practice for a demolition site, a relevant response plan would be developed by the Contractor in the unlikely event of an incident occurring during the remediation work, such as a fuel spillage or an episode of unexpectedly elevated noise and dust levels.

6.4 General Management

6.4.1 Preparatory Works

Prior to starting the works, the Contractor shall supply the Environmental Consultant with copies of all relevant method statements and associated risk assessments for each activity of the works.

6.4.2 Site Security

The Contractor will need to ensure that the remediation areas, including access routes and entrances, will be made secure during the remedial works, ensuring so far as is reasonably practicable, the health, safety and welfare of all those involved in the works and on-site, and preventing unauthorised access.

All appropriate Health & Safety signage and contact details will be clearly displayed by the Contractor at the entrance to the remediation areas and any other areas where the Contractor is required to work.

6.4.3 Training

All remediation personnel (including the Environmental Consultant) will undergo a site-specific induction by the Principal Contractor before commencing excavation work. This will include:

- health and safety requirements and PPE;
- housekeeping issues such as alarms and emergency procedures on-site;
- materials management plan;
- fuel storage;
- dealing with unforeseen environmental incidents; and
- the roles of the Contractor's staff with respect to environmental issues.

6.4.4 Contractor Reporting during the Remediation Works

During the remediation works the Contractor will provide regular updates to the Environmental Consultant. This will include progress reports and observations of unexpected contamination or unusual ground conditions. Reporting of unexpected contamination to the Environmental Consultant will be immediate.

6.4.5 Permits and Licenses

It is the responsibility of the Contractor to obtain all relevant licenses, exemptions, consents and deployment forms relevant to the remediation works prior to beginning any work. The Contractor will notify UCL of any necessary permits, consents or license applications. The Contractor shall comply with and give all notices required by any regulation or by-law applicable to the works, including in particular treatment and reuse of the material on-site. The Contractor will obtain the

necessary permits for all equipment in terms of potential nuisance (e.g. noise and odour) and agree these with the relevant regulatory authorities.

If UCL hold any existing Environmental Permits, it will be the Contractor's responsibility to ensure their activities do not conflict with any of the conditions stipulated in the Permit.

7. VERIFICATION PROCESS AND PLAN

7.1 Introduction

This section provides a summary of the works that will confirm and verify that the site has been remediated successfully, and the documentation of these works which will form part of the Remediation Verification Report for the site.

7.2 Verification Sampling

As noted within Section 4, verification sampling and analysis of the following soils is envisaged:

- Imported topsoil should be sampled in-situ, with at least three samples per source site. The results should be analysed for the suite of contaminants specified in Appendix 2 and should not exceed the soil import criteria.
- Imported engineering fill for the far eastern boundary and any other areas that are filled, should be sampled at a frequency of one sample for every 250 m^3 of imported material with at least three samples per source site. The samples should comply with the appropriate geotechnical and environmental import criteria developed in the MMP and as agreed with the Environmental Consultant.
- Excavations of unexpected contamination. Should such excavations be required, the remaining sides, wall and base of the excavated area should be sampled at a rate of one sample per 10 m face of an excavation and one sample per 10 m^2 of the base of an excavation. However, validation will be tailored to the unexpected contamination found. The samples should comply with the appropriate geotechnical and environmental re-use criteria developed in the MMP and as agreed with the Environmental Consultant.

All samples to be analysed at a UKAS and MCERTS accredited laboratory.

7.3 Unforeseen Contamination

With the exception of asbestos, the concentration and distribution of the other identified contaminants was found to be marginal and localised, with no areas of gross of significant contamination encountered during the previous investigations.

As with any brownfield site, there remains the possibility of contamination or structures being encountered that were not identified during past assessments. Unexpected contamination could include, for example, unusual discolouration or staining, and hydrocarbon and/or chemical odours.

The Contractor will develop a method statement for dealing with unexpected contamination or ground conditions and **a route to communicate this to the Client, Ramboll and the regulators.** If encountered, further investigation and remediation may be required to deal with the unexpected contamination. This will be agreed with the regulatory authorities and appropriately validated.

Upon identification of potentially contaminated material the appointed Contractor should:

1. Halt works in the area and inform the client that contaminated materials have been encountered.
2. Inform the Environmental Consultant so a site visit and subsequent watching brief can be arranged to oversee the works.
3. Where necessary Ramboll will inform the statutory authorities of any significant contamination of concern.

4. Where required, produce specific detailed risk assessments and method statements for review prior to the undertaken of any work.
5. Implement measures to remove contaminated materials (where feasible) for segregation, storage or stockpiling (of soils) within a bunded and polythene covered area whilst testing is undertaken. Contaminated liquids should be stored in suitable containers.
6. A record should be made of the volume and location of material removed and the extent of any required excavation.
7. The full extent of the contaminated material must be excavated and furthermore validated, with soil samples taken from the base and sides of the excavation, by an Environmental Consultant.
8. Any excavation should be back-filled with uncontaminated (screened and certified uncontaminated site-won material or imported fill) and geotechnically suitable material.
9. Undertake laboratory testing of representative samples of the material for a suitable suite of contaminants and comparison against the screening criteria for material re-use (presented in Appendix 2).
10. If the material fails comparison against the screening criteria this material should be disposed of off-site in accordance with current waste regulations.
11. Records including laboratory analytical certificates, waste transfer notes, consignment notes and volumes requiring removal should be retained by the appointed Contractor.
12. If the material meets the requirements of the screening criteria for material re-use (and is geotechnically suitable), determine and record the location for placement of the material.
13. Should either groundwater or perched water be identified as contaminated from visual/olfactory assessment, waters should be stored in a controlled manner for subsequent testing and characterisation prior to disposal.
14. Advice should be sought from Ramboll where any contaminants identified within the material falls outside the scope of the re-use criteria.

The appointed Contractor will be responsible for maintaining all records relating to testing, quantity, depth and location of the material identified. Off-site disposal will need to follow appropriate Duty of Care; records must be made available at the request of the Environmental Consultant.

7.4 Environmental Consultant Watching Brief

The Environmental Consultant will undertake a watching brief during the remedial work. It is envisaged that this will comprise part time site attendance during the demolition and removal of hardstanding, the piling works, and the basement excavation and removal of soils.

The Contractor shall liaise with the Environmental Consultant with regards to the programme and timing of the works, to ensure that the environmental consultant can attend site at appropriate times.

7.5 Groundwater Monitoring & Remediation

Only limited contamination was encountered during the 2018 site investigation, with the primary contaminant of concern being asbestos, which does not leach to groundwater. As such there is considered limited potential for contamination to impact the deeper aquifers. However, in accordance with best practise, groundwater monitoring and sampling will be undertaken pre-, during – and post- the demolition, piling and excavation works on-site (three rounds in total). The wells to be monitored are BH102C located on the subject site, and two deep wells located on Plot 3. No other wells are suitable for groundwater monitoring on the subject site.

Groundwater monitoring well BH02C located in the current building's central courtyard will need to be protected by the contractor during the demolition, piling, and excavation works, to ensure that it is undamaged and available for groundwater monitoring and sampling.

Following the demolition, piling and basement excavation, the existing deep monitoring wells (BH102C and BH04) and any shallow monitoring wells remaining on site will need to be decommissioned by the Contractor to prevent the wells acting as a preferential pathway into the underlying aquifers during the construction. The Contractor will be responsible for decommissioning these wells in line with current guidance and best practise, including the EA document 'Good practice for decommissioning redundant boreholes and wells'.

The Contractor shall provide the environmental consultant with method statements for the well decommissioning prior to the works commencing.

The environmental consultant will submit groundwater samples from the three monitoring wells for analysis at a UKAS and MCERTS accredited laboratory for the same suite of analytes as in the 2018 investigation. The results of pre-demolition monitoring round will initially be screened by the environmental consultant against the Ramboll GAC, and against available results obtained from BH02C during the 2018 investigation. The pre-demolition groundwater monitoring results will be used as a baseline for subsequent monitoring rounds; and that the environmental consultant will review the trends in groundwater concentrations compared against the baseline monitoring results and taking into consideration the conceptual site model.

Should the subsequent groundwater monitoring phases identify a deterioration in baseline groundwater concentrations, the environmental consultant will inform the Client and the Contractor; after which additional assessment may be required (such as increased groundwater monitoring frequencies, detailed quantitative risk assessment etc.).

7.5.1 Groundwater Remediation

No specific groundwater remediation is considered necessary. However, the watching brief will also have the aim of identifying and mitigating potential sources of groundwater contamination should they be encountered during the ground or other works. This may include, for example, unknown underground tanks, oily soil or obviously leachable substances.

7.6 Contractor Documentation

The Contractor will provide the Environmental Consultant with the following information, for use by the Environmental Consultant within the verification report:

- a report on any environmental controls required during excavation works (e.g. dust monitoring and noise monitoring);
- plans showing the location and depth of excavations and verification samples, sub-surface voids and obstructions (if encountered), location and description of unexpected contamination (if encountered);
- 'as-dug' plans of where backfill materials have been placed at the site, including the thicknesses and types of backfill and the final site levels;
- results of laboratory analysis (laboratory analytical certificates in PDF format and compiled laboratory results in Excel format);
- details of consents, exemptions and permits for the works;
- waste duty of care information (including the types and amounts of waste disposed of, waste classification and WAC analysis, waste transfer and consignment notes and applicable site and carriers' licenses;

- documentation obtained from the producer of any imported recycled aggregate and topsoil;
- delivery notes for imported materials (where applicable); and
- the completed MMP for the works.

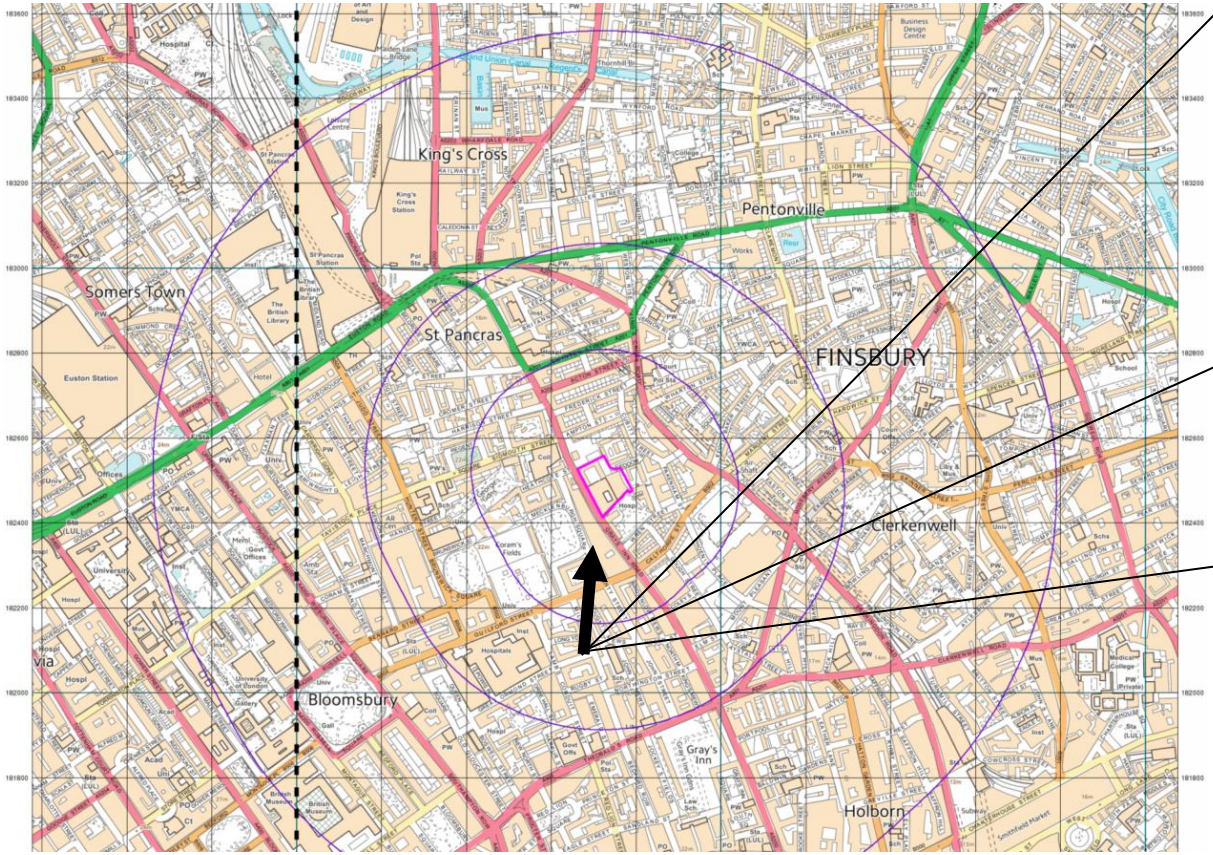
7.7 Verification Report

On completion of the remediation, the Environmental Consultant will prepare a remediation Verification Report, which will include the following information, in accordance with current guidance on verification:

- the details and roles of Contractor/sub-contractors involved in the remediation work;
- a summary of the original site conditions, with reference to the original site investigations and assessments;
- the remediation objectives and criteria, together with the basis on which the criteria were to be achieved (i.e. by reference to the remediation strategy);
- the Conceptual Site Model for the remediation and reference to the lines of evidence which demonstrate that the pollutant linkages have been broken;
- a description of the remedial activities with reference to relevant design reports including the remediation method statement, detailed designs, permits, phasing etc.;
- a photographic record of the remediation works, together with plans indicating the dates and locations of remediation activities;
- a clear description of the verification plan, including the methods used for data collection and interpretation;
- a summary of progress data such as excavation records and groundwater monitoring data, waste consignment notes, imported fill records, any variations;
- details of communications held with regulators during the remediation works;
- reference to the Health and Safety file;
- a clear statement that the remedial objectives have been completed; and
- supporting documents, to include where appropriate analytical results, monitoring data, health and safety documentation and quality management documentation.

APPENDIX 1
FIGURES

Site Location Plan
Site Overview



Key

- Royal Free Hospital c. 1855-1895
- Eastman Dental Hospital c. 1931
- Later Additions c. 1950's

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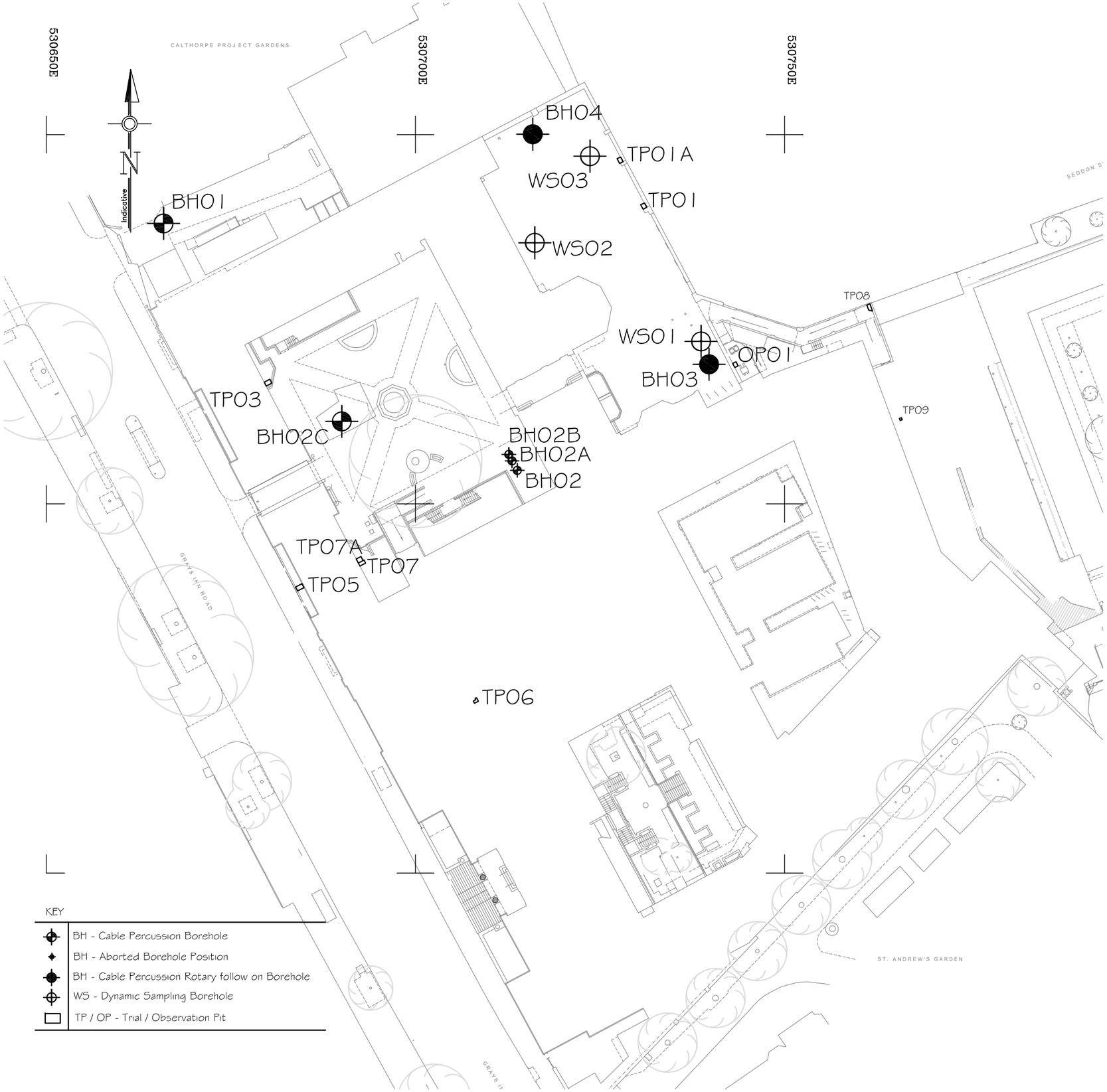
UCL

Project N° 1620004664

SITE LOCATION PLAN

Sketch N°
BEMP-RAM-P1-XX-SK-G-0002

Scale	**Engineer**	**Checked**
NTS	MT	MG
Date	**Rev.**	**Suitability**
23/10/2018	P01	S2



KEY

- BH - Cable Percussion Borehole
- BH - Aborted Borehole Position
- BH - Cable Percussion Rotary follow on Borehole
- WS - Dynamic Sampling Borehole
- TP / OP - Trial / Observation Pit

Hole ID	Easting	Northing	Level (mOD)
BH01	530665.82	182537.93	20.14
BH02	530713.76	182504.51	20.69
BH02A	530713.11	182505.78	20.64
BH02B	530712.66	182506.65	20.62
BH02C	530689.92	182511.26	20.56
BH03	530739.75	182518.84	20.51
BH04	530715.98	182550.00	20.43
WS01	530738.66	182521.99	20.44
WS02	530716.12	182535.35	20.44
WS03	530723.64	182546.98	20.45
TP01	530731.02	182540.75	20.55
	530730.50	182540.51	20.54
	530730.85	182539.90	20.53
	530731.35	182540.19	20.53
TP01A	530727.65	182546.09	20.52
	530727.31	182546.75	20.50
	530727.80	182546.97	20.52
	530728.12	182546.33	20.52
TP03	530679.80	182515.95	17.27
	530679.52	182516.48	17.27
	530680.56	182516.35	17.27
	530680.28	182516.88	17.27
TP05	530684.04	182488.21	16.60
	530683.76	182488.74	16.60
	530684.63	182489.19	16.60
	530684.91	182488.66	16.60
TP06	530707.99	182473.00	16.35
	530707.84	182473.30	16.35
	530708.17	182473.47	16.35
	530708.08	182473.65	16.35
	530708.27	182473.75	16.35
	530708.52	182473.28	16.35
TP07	530693.04	182492.40	16.72
	530692.27	182491.99	16.72
	530693.25	182491.99	16.72
	530692.48	182491.58	16.72
TP07A	530692.27	182491.99	16.72
	530691.98	182492.53	16.72
	530692.62	182492.87	16.72
	530692.91	182492.33	16.72
TP08	530761.55	182527.09	18.65
	530761.13	182526.93	18.65
	530761.39	182526.24	18.65
	530761.90	182526.11	18.65
TP09	530765.93	182511.39	17.97
	530765.65	182511.29	17.97
	530765.54	182511.57	17.97
	530765.83	182511.67	17.97
OP01	530743.41	182519.25	18.24
	530743.70	182518.70	18.24
	530743.24	182518.46	18.24
	530742.96	182519.01	18.24

NOTES

1. This drawing should not be scaled.
2. OP01, TP03, TP05, TP06, TP07, TP08 & TP09 are located at basement level.

No	Revision	Drawn	Checked	Passed	Date

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Client:	University College London
Project:	UCL ION / DRI
Title:	Exploratory Hole Location Plan
Dwg. No:	183113/01
Status:	Issue
Scale:	NTS

Drawn	Checked	Passed	Date
OS	IP	IP	September 18

APPENDIX 2
SOIL IMPORT CRITERIA

Soil Import Criteria

The Contractor shall submit the verification samples of topsoil to an independent laboratory certified to UKAS and MCERTS standards.

Table 7.1: Topsoil Verification Criteria

Analytical Determinand	Verification Target (mg/kg)
Inorganics (risk based GAC)	
Asbestos identification and quantification (analytical methods accredited to ISO17025)	<0.001% by weight within the quantification
Arsenic	40
Beryllium	1.7
Boron	11000
Cadmium	150
Hexavalent chromium	21
Total chromium	1500
Copper[1]	100 at <pH6.0 / 135 at pH6.0 to 7.0 / 200 at pH>7.0
Lead	310
Mercury (inorganic)	56
Nickel[1]	60 at <pH6.0 / 75 at pH6.0 to 7.0 / 110 at pH>7.0
Selenium	430
Zinc[1]	200 at <pH6.0 / 300 pH >7.0
pH[2]	5.5 to 8.5
BTEX suite	
Benzene	0.37
Toluene	Sum <6 mg/kg
Ethylbenzene	
Xylenes (sum)	
Speciated Total Petroleum Hydrocarbons (TPH CWG Suite)	
Aliphatic C5-6	24
Aliphatic C6-8	53
Aliphatic C8-C10	13
Aliphatic C10-C12	62
Aliphatic C12-C16	100[3]
Aliphatic C16-C21	100[3]
Aliphatic C21-C35	100[3]
Aromatic C8-C10	22
Aromatic C10-C12	100[3]
Aromatic C12-C16	100[3]
Aromatic C16-C21	100[3]
Aromatic C21-C35	100[3]

Analytical Determinand	Verification Target (mg/kg)
Sum of all individual aliphatic and aromatic TPH C5-35 fractions	500
Polycyclic Aromatic Hydrocarbons	
Acenaphthene	<100[3]
Acenaphthylene	<100[3]
Anthracene	<100[3]
Benzo(b)fluoranthene	4
Benzo(k)fluoranthene	<100[3]
Benzo(a)pyrene	5.3
Benzo(g,h,i)perylene	<100[3]
Benzo(a)anthracene	12
Chrysene	30
Dibenzo(a,h)anthracene	0.31
Fluorene	<100[3]
Fluoranthene	<100[3]
Indeno(1,2,3-cd)pyrene	45
Naphthalene	0.99
Phenanthrene	<100[3]
Pyrene	<100[3]
Sum of all PAHs (in addition to meeting the speciated PAH criteria listed above)	<100

Notes:

Except where stated, the topsoil verification targets are based on Ramboll Environ's risk based Generic Assessment Criteria (GAC) for residential use without plant (i.e. vegetable) uptake. This is considered to be protective of both human health and vegetation (for compounds where BS 3882:2015 does not provide targets).

1 - The verification targets for nickel, zinc and copper are based on the BS 3882:2015 Specification for Topsoil, which is below the risk based GAC for human health.

2 - The soil pH remedial target is based on the pH range for multipurpose topsoil as presented in BS 3882:2015 Specification for Topsoil.

3 - The risk-based GAC for these hydrocarbon fractions and PAHs are generally in excess of 1,000 mg/kg Although the GAC concentrations do not present a risk to human health it is considered that a lower verification target is required to minimise the potential effects on vegetation growth when the topsoil is seeded. As such, a remedial target of 100 mg/kg has been selected based on Ramboll's professional judgement. In addition, the sum of all TPH fractions should not exceed 500 mg/kg and the sum of all PAH compounds should not exceed 100 mg/kg.

Although validation samples will be collected for analysis, verification criteria will also be based on visual / olfactory observations. Soils with gross hydrocarbon contamination (e.g. visible free phase oils) will not be considered acceptable.

APPENDIX 3
UTILITIES AND TOPOGRAPHIC PLAN

Notes

1. This drawing has been prepared in accordance with the scope of RPS's appointment with its client and is subject to the terms and conditions of that appointment. RPS accepts no liability for any use of this document other than by its client and only for the purposes for which it was prepared and provided.
2. If received electronically it is the recipients responsibility to print to correct scale. Only written dimensions should be used.
3. This drawing should be read in conjunction with all other relevant drawings and specifications.

TOPOGRAPHICAL SURVEY/UTILITY KEY :-

(ht) - height
ø - diameter
● - pea trap
a/g - above ground
a/r - assumed route
av - air valve
bb - belisha beacon
bd - back drop
bl - bed level
boll - bollard
bos - bottom of shaft
bt - telecom
c/b fence - closeboard fence
c/box - control box
catv - cable television
cl - cover level
con - conifer
cr - cable riser
cws - combined water sewer
d/chan - drainage channel
ejb - electric junction box
elec - electric
eot - end of trace
ep - electric pole
er - earth rod
f/bed - flower bed
fh - fire hydrant
fl - floor level
fs - fire switch
fws - foul water sewer
g - gully
g/run - gully run
gr - gas riser
h/chestnut - horse chestnut
h/thorn - hawthorn
ic - inspection cover
il - invert level
ill - illuminated
int - interceptor
lp - lamp post
mh - manhole cover
mkr - marker
o/h - over head
ol - off let
osa - off survey area
OSBM - ordnance survey bench mark
p & r fence - post & rail fence
pd - pit depth
pr - pipe riser
ptg - pipe to ground
pts - pipe to surface
re - rodding eye
ret wall - retaining wall
rs - road sign
rwp - rain water pipe
s/birch - silver birch
s/p - safety paving
sap - sapling
sec fence - security fence
sfc - soil filled chamber
sl - spot light
sp - soil pipe
st - stop tap
sv - stop valve
svp - soil vent pipe
sws - storm water sewer
TBM - temporary bench mark
tfr - taken from records
tl - threshold level
toc - top of cap
top - top of pipe
tot - top of tank
tp - telecom pole
ts - traffic signal
t/s - trench scar
u/s - underside
utl - unable to lift
utr - unable to rod
uts - unable to survey
utt - unable to trace
vp - vent pipe
wfc - water filled chamber
wl - water level
wm - water meter
wp - waste pipe
wr - water riser

UTILITY SURVEY KEY :-

HATCHED AREA
BOREHOLE
CPT
TRIAL PIT
HAND PIT
WINDOW SAMPLE

ELECTRIC CABLE
W — W WATER PIPE
FOUL SEWER
STORM SEWER
COMBINED SEWER
D — D DUCTS
TV — TV CABLE TELEVISION
COM — COM DATA CABLE
TELECOM CABLE
G — G GAS PIPE
U — U UNIDENTIFIED SERVICE
OTHER
CCTV — CCTV CCTV
TL — TL TRAFFIC LIGHT
O — O OFFSET FILL
V — V VENT
F — F FUEL PIPE
GL — GL GAUGE LINES
P — P PIPE
AR — AR ASSUMED ROUTE
TFR — TFR TAKEN FROM RECORDS

DISCLAIMER :-

Electromagnetic techniques have been used in the location of underground services. The results are not infallible and trial excavations should be carried out to confirm service identification, positions and particularly depths, where these are critical. The completeness of the underground services information cannot be guaranteed.

This method of survey does not differentiate between live and dead services, and as such all services should be treated as live. This drawing may not include the location of all public services that may cross the site, therefore the relevant service drawings should be obtained from the appropriate utility company and used in conjunction with this drawing.

Private service pipes and cables in highways are not shown, but there presence should be anticipated.

Additional below ground structures or obstructions not shown on this drawing may be present. Reference should be made to historical plans and as-built drawings. Excavations in the vicinity of services should be carried out with due diligence ref: HSG47 document avoiding dangers from underground services

Please note that factors such as ground conditions, proximity of other utilities, material and method of construction have an influence on the quality of the data collected on site.

TSA Standards - "Even an appropriate and professionally executed survey may not be able to achieve a 100% detection rate."

UTILITY NOTES

UNABLE TO SURVEY DRAINAGE IN PLACES DUE TO CLOSED SEWER PIPES/SILTED CHAMBERS. ROUTES HAVE BEEN ASSUMED WHERE POSSIBLE. ALL DRAINAGE IN MAIN COURTYARD FLOWS TO BASEMENT DRAINAGE SYSTEM. RECORD INFORMATION SUGGESTS A 300ø SEWER LEAVING SITE AT MAIN RECEPTION. LOCATION HAS BEEN ADDED USING RECORD INFORMATION ONLY.

ASSUMED HEATING DUCT LOCATED WITHIN COURTYARD TO THE SOUTH. POOR SIGNAL USING EML METHODS. ROUTE UNKNOWN.

ALL MAINS UTILITIES ARE STRAPPED TO CEILING WITHIN WALKWAY IN MAIN COURTYARD (NORTH-WEST).

ALL UNDERGROUND BASEMENTS HAVE BEEN ADDED USING FLOOR PLANS SURVEYED BY OTHERS.

SURVEY BOUNDARY HIGHLIGHTED IN YELLOW.

125mm PE GAS IN ROAD OUT OF SURVEY AREA.

125mm PE WATER IN ROAD OUT OF SURVEY AREA.

Rev	Description	By	Ckd	Date
A	UTILITIES ADDED TO EXISTING SURVEY	MSL	AHP	04.06.18

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Client UCL

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Title UTILITIES SURVEY ADDED TO EXISTING TOPOGRAPHICAL SURVEY

Status	Scale	Date Created
FINAL	1:200 @A0	04.06.18
Project Leader	**Drawn By**	**Checked by**
NB	MSL	AHP

Document Number	Revision	Suitability
JKK9984 - 1	A	
Project Number / Originator - Zone - Level - Type - Role - Drawing Number		