British Museum – Energy Centre Programme

Discharge of Contamination Planning Condition

Prepared for The British Museum

December 2024

Alan Baxter
50 YEARS IN PRACTICE

British Museum – Energy Centre Programme

Discharge of Contamination Planning Condition

The British Museum is progressing with its strategy for transitioning to sustainable, low-carbon infrastructure. This project focuses on the design of key infrastructure upgrades needed to deliver this strategy. Planning permission for the development was granted in October 2024.

This note has been prepared to discharge the following planning condition:

No.	Condition	Reason
20a	*A) Excluding external demolition down to ground level, no demolition or development shall commence until the following components of a scheme to deal with the risks associated with contamination of the site have been submitted to and approved in writing by the local planning authority:* *i) A site investigation scheme, based on previous findings to provide information for a detailed assessment of the risk to all receptors that may be affected, including those off-site;* *ii) The site investigation results and the detailed risk assessment resulting from i);* *iii) An options appraisal and remediation strategy giving full details of the remediation measures required and how they are to be undertaken;* *iv) A verification plan providing details of the data that will be collected in order to demonstrate that the works set out in iii) are complete and* *identifying any requirements for longer-term monitoring of pollutant linkages, maintenance and arrangements for contingency action.* *The development shall thereafter be implemented in accordance with the details and measures approved*	*To ensure the risks form land contamination to the future users of the land and neighbouring land are minimised, together with those to controlled waters, property and ecological systems, and to ensure that the development can be carried out safely without unacceptable risks to workers, neighbours and other offsite receptors, in accordance with policies G1, D1, A1 and DM1 of the London Borough of Camden Local Plan 2017.*

A detailed series of ground investigations were undertaken by Harrison Group in 2023. As part of the investigation a contamination assessment was undertaken of the ground on the proposed development site. Their report (appended) identified there were no issues of contamination which required further investigations or works to remediate.

Document: Ground Investigation Report

Project: The British Museum (Proposed SWEC)

Reference No: GL25243_GI

Date: September 2024

Prepared for: Steadberry Restoration Limited

harrisongeotechnical
ENGINEERING

A division of Harrison Group Environmental Limited

HARRISON GROUP ENVIRONMENTAL LIMITED

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CONTENTS

FOREWORD

General Conditions Relating to Site Investigation

This investigation has been devised to generally comply with the relevant principles and requirements of B.S.10175:2011+A2:2017 'Investigation of potentially contaminated sites - Code of practice', 'Land contamination: technical guidance' collection (Environment Agency, 2016), 'Land contamination: risk management' (Environment Agency, 2019) and BS EN 1997 (Eurocode 7). The recommendations made and opinions expressed in this report are based on the information obtained from the sources described using a methodology intended to provide reasonable consistency and robustness.

The opinions expressed in this report are based on the ground conditions revealed by the site works, together with an assessment of the site and of laboratory test results. Whilst opinions may be expressed relating to sub-soil conditions in parts of the site not investigated, for example between exploratory positions, these are only for guidance and no liability can be accepted for their accuracy.

Boring and sampling procedures are undertaken in accordance with B.S.5930:2015+A1:2020 'Code of Practice for Ground Investigations'. Likewise, in-situ and laboratory testing comply with B.S.1377:1990 'Methods of Tests for Soils for Civil Engineering Purposes' and B.S.22475:2011, unless stated otherwise in the text. Chemical Testing has been undertaken by a UKAS accredited laboratory.

The groundwater conditions entered on the boring records are those observed at the time of investigation. The normal rate of boring usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions.

Some items of the investigation have been provided by third parties and whilst Harrison Group have no reason to doubt the accuracy, the items relied on have not been verified. No responsibility can be accepted for errors within third party items presented in this report.

This report is produced in accordance with the scope of Harrison Group's appointment and is subject to the terms of appointment. Harrison Group accepts no liability for any use of this document other than by its client and only for the purposes, for which it was designed and produced. No responsibility can be accepted for any consequences of this information being passed to a third party who may act upon its contents/recommendations.

Any advice, opinions, or recommendations within this document should be read and relied upon only in the context of the document as a whole. The contents of this document are not to be construed as providing legal, business or tax advice or opinion.

EXECUTIVE SUMMARY

Location	The site was located within the grounds of the British Museum in central London. The site can be accessed from Great Russell Street, London, WC1B 3DG centred at approximate National Grid Reference (NGR) 530008, 181621.
Previous & Current Site Use	The site under consideration is located in the southwestern corner of the British Museum grounds and bounded by the main Grade I listed British Museum buildings to the northwest, northeast and southeast. Notably the building immediately to the northwest of the site is the current South West Energy Centre (SWEC), containing a substation, switch room, boiler house, generator room and chiller enclosure. To the southwest, the site is bounded by an approximately 3m high boundary wall, separating the museum from residential and commercial townhouses and associated gardens along Bloomsbury Street. A London plane tree, approximately 18m high is located close to the boundary wall. The main access into the site was located to the southeast and consisted of an asphalt service road which led from the South West Gate on Great Russell Street. At the time of the walkover the site was in active use as a service road and partially occupied by a two storey modular building, used for office space, kitchens, and welfare facilities. The site surface was primarily covered by asphalt hardstanding. During a long history, the site is shown to have been part of the gardens of the terraced townhouses lining present day Bloomsbury Street, from the late 19th century until the 1950s. The British Museum expanded their site boundary at this time to incorporate much of these gardens, including the proposed site. A new building, part of the Museum, was shown to have been present on-site until the early 1980s, at which point the building was demolished and the site remained empty once again. It is assumed the present day structure was constructed during the early 2000s.
Proposed Site Use	The proposed development is detailed on ABA drawings ref: 1910-41-100 to 1910-41-130. It is proposed to construct a new 5-storey energy centre to supply the British Museum, with the existing temporary 3-storey modular building demolished to facilitate the redevelopment. It is understood that no soft landscaping will be associated with the proposed development and that the subject site area will be completely covered by the proposed structures footprint. Due to the nature of the development detailed, this report and associated geoenvironmental assessment has assumed a proposed commercial end use for geoenvironmental assessment.
Background Information	HGE have undertaken a Stage 1 Tier 1 Preliminary Risk Assessment (Desk Study Report) for the subject site, ref: GL23964 dated December 2022. Although the findings of the desk study report have been considered within this report it is recommended the Desk Study should be read in conjunction with this report and is presented in Appendix C. This report concluded that an intrusive geo-environmental and geotechnical site investigation should be undertaken at the site in accordance with relevant guidance. The purpose of the work associated with this interpretative report was to undertake a ground investigation, focusing on a geotechnical assessment and a geoenvironmental Tier 2 generic quantitative risk assessment for the site and the proposed development.
Ground Conditions and Geology	Soil containing anthropogenic material (made ground) was encountered to a maximum depth of 0.75mbgl. The disturbed soil comprised granular horizons over more cohesive strata with anthropogenic material such as brick, concrete, asphalt and slate throughout. The underlying natural superficial soils consisted of both cohesive and granular horizons. The cohesive deposits were described as firm brown slightly sandy slightly gravelly CLAY, with gravel comprising subangular to subrounded, fine to coarse flint. This stratum was encountered between 0.75m and 1.60mbgl. These soils are representative of the Lynch Hill Gravel Member. The shallow granular soils were described as very dense brown fine to coarse SAND and subangular to subrounded, fine to coarse flint GRAVEL, becoming dense gravelly fine to coarse SAND from 3.50mbgl. This stratum was encountered between 1.60m and 4.75mbgl. This material is representative of the Lynch Hill Gravel Member. Cohesive bedrock deposits were found to underlie the superficial deposits, comprising of stiff becoming very stiff, grey, CLAY, with occasional lenses of fine grey sand, and occasional fine selenite crystals. This stratum was encountered at between 4.75m and the base of the borehole (20mbgl). This is representative of the London Clay Formation. Depth to groundwater was recorded to range between 4.03m to 4.10m (20.08 to 20.01maOD) within the exploratory holes during drilling and subsequent monitoring of the wells installed. Long-term groundwater monitoring is being undertaken over the course of 12 months, the results of which will be appended to this report upon completion. Olfactory and visual evidence of potential contamination was limited to granular and cohesive fill within BH01 containing gravel of concrete, brick, asphalt, slate and occasional clay pipe fragments.

Foundations, Floor Slabs	We would not advise placing any significantly loaded structures or those sensitive to settlement at ground level, or within the near surface made ground proven to depths of 0.75mbgl, principally due to its variable nature, limited thickness and generally poor geotechnical properties. Although made ground was only encountered to a maximum depth of 0.75mbgl, more extensive areas of made ground could be present locally across the site. It is therefore recommended that an initial foundation depth of 1.60mbgl be adopted but localised deepening of foundations may to be required. Outline assessment has been undertaken for pad foundations in accordance with BS EN 1997-1:2004 +A1:2013 (Eurocode 7), Design Approach 1, Combinations 1 and 2. The assessment has been undertaken using the software package GEO5 2022 Spread Footing (Fine Software). Given the results of the investigation, pad or raft foundations cast on the granular deposits of the Lynch Hill Gravel Member at 2.00mbgl would be placed upon very dense brown fine to coarse SAND and subangular to subrounded fine to coarse GRAVEL of flint, associated with safe bearing capacities in the order of 250kN/m^2 to 300kN/m^2 for foundations up to 1.0m wide. Settlements of the proposed structure will be dependent upon loading intensity as well as size, configuration and stiffness of foundations, but would generally be expected to be less than 25mm for the type of foundations envisaged. Where possible and in order to reduce any possible differential settlement, new foundations should be placed within the same geological horizon. The above has been modelled for a new independent foundation and does not consider any potential effects (loadings or settlements) on existing adjacent foundations/structures and potential basements. Based on the current monitoring data, groundwater should not be encountered in shallow excavations, although surface water/rainfall may pond in excavations. The strength of the sub-soils will be moisture dependent both on drying and wetting and excavations should not be left open for any longer than required for construction and wet weather working should be avoided where possible.
Concrete Design	A design sulphate class of DS-1 and an ACEC class of AC-1s is suitable.
Geoenvironmental Contamination Summary and Recommendations	Due to the nature of the development detailed, this report and associated geoenvironmental assessment has assumed a proposed commercial end use. No elevated contamination concentrations were identified above any of the relevant commercial end use criteria within the 3 No. soil samples analysed. Based on the above, the levels of soil contaminants recorded in the soils are not considered to represent a significant risk to human health end users associated with the proposed development. However, consideration should be given that the ground investigation was limited to a single accessible area (no locations currently undertaken in existing building) and that potential sources and extent of soil contamination across the site may not have been fully assessed. Considering the results and that the proposed structures footprint will cover the whole site area, further investigation or remedial action is not considered to be warranted at this stage. The proposed development will break all potential pollutant linkages to human health end users with the exception of inhalation of soil gas/vapours. However, should indications of additional contamination be discovered during development, this should be further assessed, and appropriate action taken, as necessary. The potential risk to construction workers should be mitigated through a contractor's risk assessment prior to development. If any obviously contaminated soil is encountered the advice of a suitably qualified person should be sought regarding the appropriate course of action. The result of the asbestos analysis indicates that there were no asbestos fibres detected in any of the samples tested, however, based on the anthropogenic impacts observed as well as the potential contaminant sources identified in the HGE Stage 1 Tier 1 Preliminary Risk Assessment (Desk Study), there is potential that some ACM could be locally present within made ground across the area. Should further areas of made ground containing potential asbestos-containing materials (ACMs), or other forms of contamination be discovered during development, this should be further assessed. An asbestos survey is recommended prior to demolition of any structures. Any subsequent removal to be undertaken by controlled methods by appropriately qualified operators. Groundwater from the superficial Lynch Hill Gravel Member (Secondary A Aquifer) has been analysed from the cable percussive borehole. Compared to stringent WHO DWQG water standards, no elevated concentrations of TPH speciation's were detected in the groundwater sample analysed. It is considered the metal concentrations (copper) currently identified within the groundwater analysis would unlikely be significantly detrimental to the identified controlled waters. The appropriate ground gas protection measures for the proposed buildings on the site are based on the GSV and building type. Based on the worst case GSVs for CO2 and CH4 in accordance with BS8485:2015, the site falls within CS1 'Very low hazard potential'. Based on the limited gas monitoring undertaken, a viable source of ground gases has not been found and an assessment of the levels recorded during monitoring suggests that remedial action is not required. However, data should be provided to contractors involved in development to allow them to undertake their own specific risk assessments.

	Volatile Organic Compounds (VOCs) were recorded during the ground gas monitoring rounds at concentrations of <10ppm, recorded at a maximum of 4.7ppm and as such do not give cause for concern. The potential risk to construction workers should be mitigated through a contractor's risk assessment prior to development. If any obviously contaminated soil is encountered the advice of a suitably qualified person should be sought with regard to the appropriate course of action. The basic requirement for development standards in the UK is that land should be 'suitable for use' or 'fit for purpose'. It is important to consider the limited nature of the sampling for this investigation, and the possibility of higher concentrations of contaminants and differing ground conditions existing between sample positions. However, providing the recommendations are adhered to, we believe that the site can be suitable for the intended use. **We recommend that this report is submitted to Regulators as part of the planning process. It is recommended that correspondence with the regulators is undertaken before any additional ground investigation and associated assessments are undertaken.**

GROUND INVESTIGATION REPORT
FOR
THE BRITISH MUSEUM (PROPOSED SWEC)

1 TERMS OF REFERENCE & INTRODUCTION

1.1 Introduction

The work covered by this report was undertaken on behalf of Steadberry Restoration Ltd (Client), in accordance with Harrison Geotechnical Engineering (HGE) quotation GL25243 - The British Museum - Quote 1 BoQ Rev 2 dated July 2022. The work was undertaken in accordance with the relevant specification Ref. 1910/40/LK/lk and drawing (Ref. 1910/40/02) issued by Alan Baxter Ltd (ABA) who acted as the engineer.

HGE have undertaken a Stage 1 Tier 1 Preliminary Risk Assessment (Desk Study Report) for the subject site, ref: GL25243 dated December 2022. Although the findings of the desk study report have been considered within this report it is recommended the Desk Study should be read in conjunction with this report and is presented in Appendix C.

The purpose of the work associated with this interpretative report was to undertake a ground investigation, focusing on a geotechnical assessment and a geoenvironmental Tier 2 generic quantitative risk assessment for the site and the proposed development. The subject site and proposed development is referred to as The British Museum (Proposed SWEC). It is understood that the subject site area will be completely covered by the proposed structures footprint.

The site was located within the grounds of the British Museum in central London. The site can be accessed from Great Russell Street, London, WC1B 3DG centred at approximate National Grid Reference (NGR) 530008, 181621. The site boundary is indicated on drawing GL25243-DR001 presented in the appendix.

We understand it is proposed to construct a new energy centre to supply the British Museum, as set out in the plans provided by ABA.

At the time of our assessment the site was partially occupied by a temporary 3-storey modular building, providing office, welfare and kitchen facilities. The building appears to have been constructed in the early 2000s according to the historical maps available. The site also covers a portion of the west service road to the Museum, comprising of tarmac hardstanding and a waste storage area.

Due to the nature of the development detailed, this report and associated geoenvironmental assessment has assumed that the end use will comprise of commercial end use. It is understood that no soft landscaping will be associated with the proposed development.

A Topographical Survey for the subject site was provided by ABA, undertaken by John Robinson Associates Survey Specialists Ltd (Ref: UM21-669-JRA dated 04/01/21).

2 BACKGROUND INFORMATION

2.1 Site Description

The site under consideration is located in the southwestern corner of the British Museum grounds. The site covers an area of approximately 0.02ha and can be identified by National Grid Reference 530008, 181621. Examination of the supplied topographical survey shows elevation of the site as approximately 24 – 24.5 metres above Ordnance Datum (maOD).

The site is bounded by the main Grade I listed British Museum buildings to the northwest, northeast and southeast. Notably the building immediately to the northwest of the site is the current South West Energy Centre (SWEC), containing a substation, switch room, boiler house, generator room and chiller enclosure. To the southwest, the site is bounded by an approximately 3m high boundary wall, separating the museum from residential and commercial townhouses and associated gardens along Bloomsbury Street. A London plane tree, approximately 18m high is located close to the boundary wall.

The main access into the site was located to the southeast and consisted of an asphalt service road which led from the South West Gate on Great Russell Street. At the time of the walkover the site was in active use as a service road and partially occupied by a two storey modular building, used for office space, kitchens, and welfare facilities. The site surface was primarily covered by asphalt hardstanding.

The site had a secondary pedestrian access point located to the northeast of the site, leading into the main British Museum buildings.

A site walkover was undertaken on 5th August 2022 and the findings are presented in the HGE Stage 1 Tier 1 Preliminary Risk Assessment (Desk Study Report) appended in Appendix C.

2.2 HGE Phase 1 Desk Study Report GL25243

HGE have undertaken a Stage 1 Tier 1 Preliminary Risk Assessment (Desk Study Report) for the subject site, ref: GL23964 dated December 2022. Although the findings of the desk study report have been considered within this report it is recommended the Desk Study should be read in conjunction with this report and is presented in Appendix C.

A summary of the findings in the report and the conclusions are detailed below:

The geology underlying the site is detailed to comprise superficial Lynch Hill Gravel Member overlying London Clay Formation.

The site area is detailed as having a Secondary A aquifer designation (Lynch Hill Gravel Member). The underlying solid geology (London Clay Formation) is identified as unproductive. The site does not lie within a source protection zone.

No surface water features are recorded within 250m of the site. It should be noted that the River Thames is located approximately 1.2km to the southeast of the site.

A negligible risk of flooding from either rivers or the sea was identified on site. However, a moderate risk is considered from groundwater flooding.

The site is located within a SSSI Impact Risk Zone and a conservation zone.

The closest active groundwater abstraction is located some 277m northwest of the site and is detailed as a heat pump. The closest abstraction associated with a Potable Water Supply is located some 923m west, detailed as drinking, cooking, sanitary and washing.

The closest historical tank was located 389m northwest of the site, an obsolete petrol station was recorded 291m northwest of the site and the closest historical garage was recorded 260m southeast of the site.

4 No. electrical substations were recorded within 250m of the site. The closest was situated 19m southeast of the site.

2 No. historical industrial land uses were recorded within 250m of the site. These relate to a brewery recorded 115m to the southwest and an unspecified tank 181m to the west of the site.

31 No. recent industrial land uses are recorded within 250m of the site. Examples of these include electronic stores, electrical substations, publishers, house clearance companies, machinery and photographic stores.

During a long history, the site is shown to have been part of the gardens of the terraced townhouses lining present day Bloomsbury Street, from the late 19th century until the 1950s. The British Museum expanded their site boundary at this time to incorporate much of these gardens, including the proposed site. A new building, part of the Museum, was shown to have been present on-site until the early 1980s, at which point the building was demolished and the site remained empty once again. It is assumed the present day structure was constructed during the early 2000s.

The potential for uncontrolled backfill and relict structures have been identified as potential geotechnical hazards.

The potential presence of a considerable thickness of dense granular Lynch Hill Gravel Member and the anticipated loads associated with the proposed structures are likely to make shallow foundations (including rafts) a suitable foundation solution although the proximity of nearby structures, the unknown foundational detailing of these structures and their ability to tolerate additional settlement needs to be considered when making a foundation choice.

Consideration of the sulphate content of the soils should be given with respect to the grade of concrete suitable for use at this location. The density and permeability of shallow soils should be assessed in order to consider pavement and drainage design. The likely granular nature of the superficial deposits covering the site, suggest that conventional soakaways maybe suitable in the absence of significant made ground deposits. Although groundwater levels will need to be confirmed.

Examination of available historic map data shows since the 1950s a portion of the site has been occupied by buildings intermittently. Unless they and all existing underground structures are thoroughly ‘grubbed out’, demolition of the existing buildings may lead to the presence of relict substructures. There is also the possibility for underground services to cross the site.

Given the recent construction of the building on-site it is assumed that no asbestos is present, and no external structural issues were identified during the site walkover.

Localised areas of waste storage were observed on-site which could be a potential source for contamination.

Of the identified potential contamination sources, made ground associated with the historic nature of the site, and possible asbestos (buried and within existing buildings) are believed to be the most significant sources of potential contamination and will be considered further in the assessment process.

Potential contaminants identified based on the current and previous use could include but not inclusive to metals/metalloids and their compounds, inorganic compounds, total petroleum hydrocarbons (TPH), and polycyclic aromatic hydrocarbons (PAH). An asbestos fibre screen should be included as part of the recommended suite to rule out its’ presence within the near surface soils where physical contact is anticipated with future site users.

It is recommended that a Detailed UXO Risk Assessment is undertaken for the site.

An initial assessment of the risk posed by each pollutant linkage was carried out and is presented in the table below. Refer to the full report presented in Appendix C for a complete Conceptual Site Model (CSM) and Phase 1 risk assessment.

Hazard Identification				Hazard Assessment			
Link No.	**Source/ Hazard**	**Pathway**	**Receptor**	**Probability**	**Consequence**	**Hazard Ranking**	**Hazard Assessment:** - **Action required (AR)** - **Site Investigation (GI)** - **No Action (NA)**
1	Hazardous vapours / soil gas from made ground, volatile hydrocarbons/free product or migrating to site from backfill material	Ingress into excavations, structures and confined spaces, and subsequent inhalation.	People on the site during development construction.	Low Likelihood	Minor	Very Low Risk	**GI** - Ground gas monitoring/assessment with ground worker risk assessment required.
2		Ingress into structures and confined spaces, and subsequent inhalation.	People using the site post development construction.	Low Likelihood	Mild to Medium	Moderate / Low Risk	
3	Contaminated soil from previous and present contamination sources both on and off site	Ingestion of soil through direct contact, eating with dirty hands and dust inhalation.	People on the site during development construction.	Low Likelihood	Minor	Low Risk	**GI** - Possibility of contamination across the site. Requires quantification through investigation and chemical testing followed by ground worker risk assessment.
4			People using the site post development construction.	Low Likelihood	Minor	Low Risk	**GI** - Possibility of contamination across the site. Requires quantification through investigation and chemical testing followed by ground worker risk assessment.
5			Human end users and neighbours post development construction.				
6		Leaching.	Groundwater – Secondary A aquifer superficial deposits. Surface Waters - The River Thames Off-site human receptors and infrastructure.	Low Likelihood	Mild to Medium	Moderate / Low Risk	**GI -** Possibility of contamination across the site which could be affecting groundwater and surface waters. Groundwater chemical analysis and leachate soil analysis should be undertaken as part of intrusive investigation with subsequent assessment. There could be a requirement for DQRA depending on the conditions encountered and the results of the proposed chemical analysis.
7		Infiltration					
8		Via service pipes.	People using site after development completion.	Low Likelihood	Medium	Moderate / Low Risk	**GI** - Chemical testing and assessment of risk required only if significantly deleterious conditions encountered during invasive investigation works and/or in proposed landscape and garden areas.
9		Plant uptake.	Local flora and fauna.	Low Likelihood	Minor	Very Low Risk	NA - Chemical testing and assessment of risk required only if significantly deleterious

							conditions encountered during invasive investigation works.
10		Direct Contact	Building structures	Low Likelihood	Minor	Very Low Risk	**GI** - Chemical testing and assessment of risk required only if significantly deleterious conditions encountered during invasive investigation works and/or in proposed structure areas.
11	Potential asbestos containing materials within Made Ground soils	Inhalation of dust.	Humans on and in the vicinity of the site during demolition/ development construction.	Low Likelihood	Severe	Moderate Risk	**GI -** Possibility of asbestos in existing Made Ground and so it is recommended that the potential for ACMs is assessed through an appropriate survey, with removal and disposal undertaken in accordance with the 'Duty of Care' and applicable legislation.

Table 2.2.1: HGE Phase 1 Desk Study Initial Hazard Identification and Hazard Assessment (Table of Pollutant Links)

3 INTRUSIVE INVESTIGATION

3.1 Introduction

The intrusive investigation was designed to target the ground conditions at the site concentrating on the proposed building footprint. This was undertaken by a single cable percussive borehole and following ground gas and groundwater monitoring of the borehole installation.

The sampling strategy and locations were designed and provided by ABA, considering local site constraints including reference to topography of the site, the geology encountered and the development proposals.

During and immediately following completion of the fieldwork, soil samples were transported to Harrison Group's Laboratory in Norwich via in house transportation where, upon arrival, they were logged into our sample management system. Following receipt of the geotechnical schedules, certain geotechnical samples were subsequently dispatched to laboratory subcontractors via courier.

3.2 Fieldwork, Monitoring and In-Situ Testing Program

Details of the site investigation methods employed have been presented on the appended data sheet and a summary of the fieldwork has been presented below with the exploratory locations indicated on appended drawing GL25243-DR002Q presented in Appendix B. All fieldwork records are provided within Appendix D.

3.2.1 Service Clearance and Surveying

Exploratory locations were surveyed whilst undertaking a utility clearance survey on 1st August 2022 to establish co-ordinates and levels. The service clearance was conducted by a specialist subcontractor, Midland Survey Ltd. In addition to examining plans, covers were lifted, and services traced using variety of electromagnetic means. Where possible ground probing radar was also utilised with known services marked up on the ground.

Any changes to proposed exploratory positions, as a result of the above, were discussed and confirmed with ABA via email and telephone.

The location is presented on the exploratory location plan GL25243-DR002Q presented in Appendix B. Co-ordinates and levels are detailed, both below, and on the relevant logs presented in Appendix D.

3.2.2 Cable Percussive Boreholes

1 No. cable percussive borehole (BH01) was drilled between 31st August and 1st September 2022 to a maximum depth of 20.00m to identify, sample and test the sub-soils underlying the site. Upon completion the boreholes was installed with a monitoring well as detailed in section 3.2.3. A summary of the borehole is provided below.

Location ID	Easting	Northing	Ground Level (maOD)	Depth (m)	Installed?	Purpose	Termination Reason	Fieldwork Date(s)
BH01	530003.03	181621.38	24.11	20.00	Y	General site coverage	Target depth achieved	31/08/2022 – 1/09/2022

Table 3.2.2 Summary of Cable Percussive Boreholes

A detailed description of all the strata encountered, in-situ testing undertaken, position and types of samples taken along, with any groundwater observations made at the time of drilling are included on the cable percussive borehole records presented in the appendix.

3.2.3 Monitoring Wells

The cable percussive borehole was installed with a standpipe for monitoring ground gas flow rate and concentrations within the soils encountered. The table below provides a summary of the installation.

Monitoring Point ID	Diameter of Installation (mm)	Base Depth of Installation (m)	Response Zone (m depth)		Target Strata
			Top	Base	
BH01	50	4.50	0.90	4.50	Lynch Hill Gravel Member

Table 3.2.3 Summary of Monitoring Installations

Detailed descriptions of the installation and their corresponding backfill materials are included on the relevant exploratory hole log presented in Appendix D.

3.2.4 Ground Gas & Ground Water Monitoring

Three rounds of monitoring have currently been undertaken on the borehole installation on the following dates:

- Round 1 – 21st September 2022
- Round 2 – 29th September 2022 (groundwater sampling)
- Round 3 – 6th October 2022

The gas monitoring utilised a GA5000 infrared gas analyser to record concentrations of gases including methane, carbon dioxide, oxygen and the related pressure and flow. Volatile Organic Compounds (VOCs) were monitored utilising a PID meter. The results are presented on the gas monitoring result sheets contained in Appendix D.

The results are presented next to the environmental samples (ES) on each exploratory log presented in Appendix D.

Groundwater levels and any free phase NAPL (DNAPL and LNAPL) were also monitored on the above dates utilising a dual phase interface meter.

Groundwater samples from the installations were collected as part of the monitoring round on 29th September 2022. The groundwater results are presented in Appendix D.

Long-term groundwater monitoring is being undertaken over the course of 12 months, the results of which will be appended to this report upon completion.

3.3 Fieldwork Observations

3.3.1 Ground Conditions

Soil containing anthropogenic material (*made ground*) was encountered to a maximum depth of 0.75mbgl. The disturbed soil comprised granular horizons over more cohesive strata with anthropogenic material such as brick, concrete, asphalt and slate throughout.

The underlying natural superficial soils consisted of both cohesive and granular horizons.

The cohesive deposits were described as firm brown slightly sandy slightly gravelly CLAY, with gravel comprising subangular to subrounded, fine to coarse flint. This stratum was encountered between 0.75m and 1.60mbgl. These soils are representative of the *Lynch Hill Gravel Member.*

The shallow granular soils were described as very dense brown fine to coarse SAND and subangular to subrounded, fine to coarse flint GRAVEL, becoming dense gravelly fine to coarse SAND from 3.50mbgl. This stratum was encountered between 1.60m and 4.75mbgl. This material is representative of the *Lynch Hill Gravel Member .*

Cohesive bedrock deposits were found to underlie the superficial deposits, comprising of stiff becoming very stiff, grey, CLAY, with occasional lenses of fine grey sand, and occasional fine selenite crystals. This stratum was encountered at between 4.75m and the base of the borehole (20mbgl). This is representative of the *London Clay Formation.*

3.3.2 Groundwater

Depth to groundwater was currently recorded to range between 4.03m to 4.10m (20.08 to 20.01maOD) within the exploratory holes during drilling and subsequent monitoring of the wells installed, the results are presented in Appendix D and summarised in Table 3.3.2 below.

Exploratory Hole Location	Groundwater depth during drilling (mbgl)	Response Zone Depth (m)	Groundwater Depth (m) / Level (maOD) encountered during monitoring		
			Round 1 (21/09/22)	Round 2 (29/09/22)	Round 3 (06/10/22)
BH01	4.10	0.90 – 4.50	4.03 / 20.08	4.04 / 20.07	4.05 / 20.06

Table 3.3.2 Summary of Groundwater Levels During Drilling/Excavation & Monitoring

Due to limited information available, it is not possible to infer the groundwater flow direction within the Lynch Hill Gravel Member (Secondary A aquifer). It should be noted that groundwater flow direction may be locally influenced by the presence of underground structures (e.g., building foundations and utility corridors), the influence of which may vary seasonally.

Long-term groundwater monitoring is being undertaken over the course of 12 months, the results of which will be appended to this report upon completion.

3.3.3 Ground Gas

The gas monitoring regime comprised of 3 No. rounds carried out over a one-month period following completion of the fieldwork, the results of which are presented in Appendix D and summarised in Table 3.3.3 below.

Monitoring Point ID	Barometric Pressure (mB)	Gas Concentration Ranges						Max Flow Rate (l/hr)
		CH_4 (%)	CO_2 (%)	O_2 (%)	CO (ppm)	H_2S (ppm)	Peak PID (ppm)	
BH01	1002 - 1029	<0.1	<0.1 - 0.1	20.3 - 21.0	<1	<1	0.0	1002 - 1029

Table 3.3.3 Summary of Ground Gas Concentrations and Flow Rates

3.3.4 Contamination Observations

Olfactory and visual evidence of potential contamination was limited to granular and cohesive fill within BH01 containing gravel of concrete, brick, asphalt, slate and occasional clay pipe fragments.

3.4 In-Situ Testing

In-situ testing was undertaken for geotechnical purposes and is summarised in Table 3.4 below with subsequent sections providing details regarding the tests results.

Test Type and Reference (BS 1377: 1990 unless stated)	Stratum	Number of Results	Results (Range)	Comments / Limitations
Standard Penetration Test (BS EN ISO 22476-3:2005)	Lynch Hill Gravel Member (Granular)	4	N = 24 - 50 N_{60} = 24 - 60	Indicative medium dense to very dense granular soils.
	London Clay Formation	6	N = 19 - 33 N_{60} = 23 - 40	Indicative of still to very stiff cohesive soils.
In-situ Hand Penetrometer Test	Lynch Hill Gravel Member (Cohesive)	1	150kPa	Indicative of stiff cohesive soils.
	London Clay Formation	8	150 – 220kPa	Indicative of stiff to very stiff cohesive soils.

Table 3.4 Summary of In-Situ Geotechnical Testing

3.4.1 Standard Penetration Testing

The N values reported directly from the blow counts of the equipment in the field standard penetration tests are presented on the appended borehole records. To adjust the field test results for potential energy loss to and by the drive rods, these have been converted to standardised N_{60} values by using the following equation provided in BS EN ISO 22476-3:2005+A1:2011.

$$N_{60} = \frac{E_r}{60} N\boldsymbol{\lambda}$$

where:

N = N values from field tests.

E_r = Energy ratio of the hammers (76% (SI08) and 57% (SI07) for the cable percussive hammers and 70% (DART312) for the dynamic sampling rig hammer utilised on this site).

λ = Correction value for the rod length below the anvil (where in granular soils).

Figure below provides the relationship between depth and N_{60}.

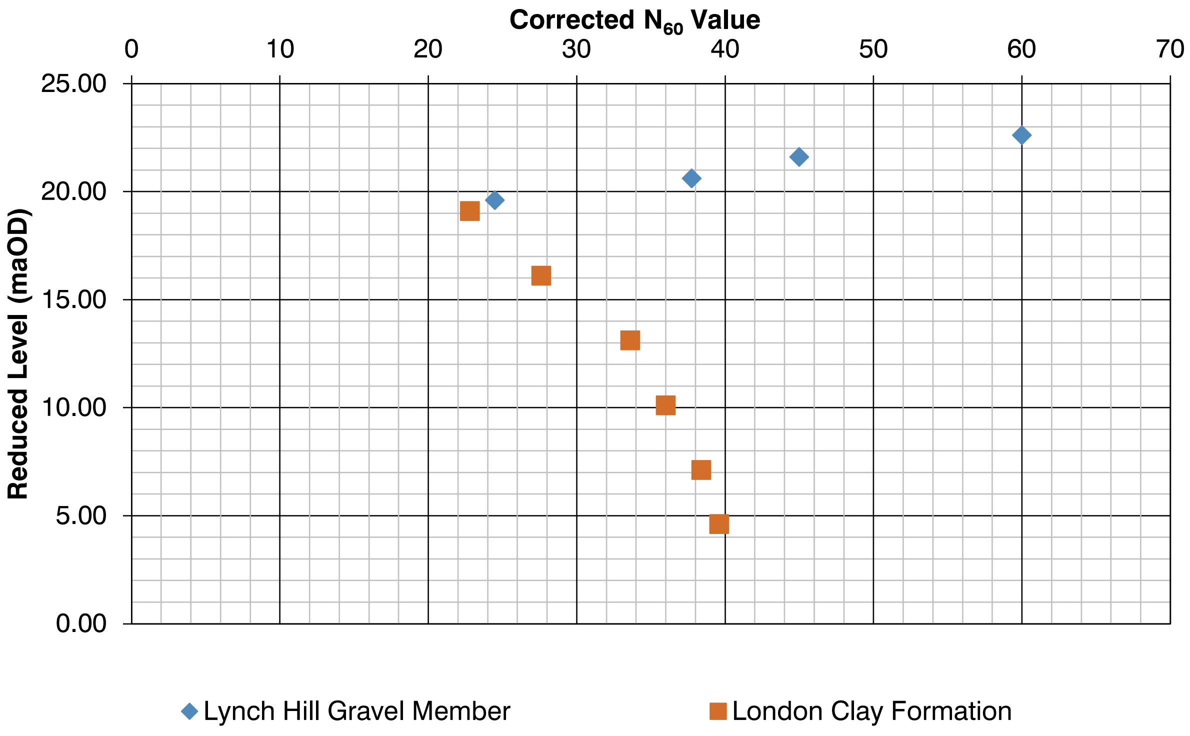

Figure 3.4.1 Corrected N_{60} Values vs. Depth

The above graph shows that all of the SPT N_{60} values were above 20. Using these values, the majority of the Lynch Hill Gravel Member can be interpreted as being medium dense or better.

The SPT results, in conjunction with engineers' descriptions can be also used as a guide to estimate the strength of cohesive material. The figure above indicates that most of the tests conducted in the cohesive London Clay material have determined a higher resistance, which can be interpreted as a stiff increasing in strength with depth.

Adjustment can also be made to N-values to consider the effect of the overburden pressure in granular material, as described in BS EN ISO 22476-3:2005+A1:2011. This correction has not been applied to the data for this project.

3.4.2 In-situ Hand Penetrometer Test

In-situ Hand Penetrometer testing was undertaken in the deposits of the Lynch Hill Gravel Member (cohesive) and the London Clay Formation. The single result from the Lynch Hill Gravel Member determined a shear strength of 150kPa at a depth of 1.00m bgl. Results from the London Clay Formation have determined shear strengths of between 150kPa and 220kPa at depths of between 4.75m and 17.00m bgl.

In general, the in-situ hand penetrometer testing has determined that cohesive soils of the Lynch Hill Gravel Member to be stiff, and the London Clay Formation to be stiff to very stiff.

3.5 Geotechnical Laboratory Testing

The following laboratory tests have been scheduled by Harrison Geotechnical Engineering and conducted on samples obtained from the exploratory holes. Unless otherwise stated the tests were performed in accordance with BS1377 Methods of Test for Soils for Civil Engineering Purposes. The laboratory test results presented in the appendix and are summarised in Table below.

Test Type and Reference (BS 1377: 1990 unless stated)	Strata	Depth (m)	Number of Results	Results (Range)	Comments / Limitations
Water Content (BS EN ISO 17892-1:2014)	Made Ground	0.50	1	25%	-
	Lynch Hill Gravel Member	1.00 - 1.80	3	11 - 18%	
	London Clay Formation	5.75 - 8.00	2	24 - 29%	
Atterberg Limits (Part 2)	Lynch Hill Gravel Member	1.00 - 1.20	1	PL 18% LL 59% PI 41 Modified PI 29	British Standard classification – High to Very High plasticity (CH to CV).
	London Clay Formation	5.75	1	PL 26% LL 73% PI 47 Modified PI 47	
Particle Size Distribution - Wet Sieving (Part 2, clause 9.2) & Sedimentation by pipette (Part 2, clause 9.4)	Lynch Hill Gravel Member	2.50 - 3.95	2	Cobbles 0.0% Gravel 26.5 - 65.5% Sand 34.3 - 73.3% Fines 0.3%	The recovery of an adequate mass of coarse grained soils for particle distribution analysis can be difficult in boreholes. In obtaining such samples from cable tool boreholes it should also be noted that some loss of fine material generally occurs due to the nature of the sampling process. For health and safety precautions unable to undertake test if suspected asbestos or gross contamination is identified on sample preparation.
Single Stage 100mm UU Triaxial Compression Test (Part 7, clause 8)	London Clay Formation	6.50 - 18.95	5	117 - 162 kPa	The London Clay Formation samples tested were representative of stiff (high strength) to very stiff (very high strength) cohesive soils.
Soil pH – Geochemical Testing (BRE SD1 2005)	Made Ground	0.50	1	8.6	-
	Lynch Hill Gravel Member	1.00 – 4.00	4	7.9 – 9.0	
	London Clay Formation	5.00 – 16.00	4	7.4 – 8.7	

Test Type and Reference (BS 1377: 1990 unless stated)	Strata	Depth (m)	Number of Results	Results (Range)	Comments / Limitations
Water Soluble Sulphate Content 2:1 Aqueous Extract (BRE SD1 2005)	Made Ground	0.50	1	78mg/l	-
	Lynch Hill Gravel Member	1.00 – 4.00	4	15 – 64mg/l	
	London Clay Formation	5.00 – 16.00	4	434 – 1050mg/l	
Acid soluble sulphate content (Total BS1377 HCl extract)	London Clay Formation	5.00 – 16.00	4	0.073 – 0.18 %	-
Sulphur (Total) (L038-PL - I2 in house)	London Clay Formation	5.00 – 16.00	4	0.909 – 1.84 %	-

Table 3.5 Summary of Geotechnical Laboratory Test Results

3.6 Chemical Laboratory Testing

2 No. samples of the near surface made ground and 1 No. of the near surface natural deposits (depth ranging 0.30m to 1.00m) were submitted to a UKAS/MCERTS accredited laboratory for a general suite of analytes as detailed in Table below.

1 No. groundwater sample was collected from monitoring round 2 at a depth of 4.04mbgl from the monitoring well installed in borehole BH01. It was submitted to a UKAS/MCERTS accredited laboratory for a suite of analytes (Suite HW1.1) as detailed in Table 3.6 below.

Analysis Type	Number of Tests
SOILS	
Suite HS1.0: (As, B, Cd, Cr (total & VI), Cu, Ni, Pb, Hg, Se, Zn, V, Be, pH, TOC, TPH CWG, PAH USEPA 16, phenols (total), asbestos screen (with ID where found)).	3
PCBs (total - 7 congeners).	1
Full WAC Suite (inert solid suite, LoI, pH, ANC and single stage leachate).	1
GROUNDWATER	
Suite HW1.1: As, B, Cd, Cr (total and VI), Cu, Pb, Hg, Ni, Se, Zn, cyanide (total and free), sulphate, sulphide, sulphur (free), chloride, NH4 as N, pH, nitrate, nitrite, conductivity, hardness, COD, DOC, DO, PAH (speciated 16), TPH CWG (C10-C40), phenols (speciated)	1

Table 3.6 Summary of Chemical Laboratory Testing

3.7 Comparison with the Ground Model

The soils encountered during the investigation appear to be comparable to that of the ground model and the background research.

Groundwater was encountered at 4.00mbgl during drilling, and between 4.03m and 4.05mbgl during the current monitoring rounds within the Lynch Hill Gravel Member (Secondary A aquifer).

4 GEOTECHNICAL ASSESSMENT

4.1 General

It is understood that the current site, consisting of a temporary 3-storey modular building is proposed to be replaced by a new energy centre to supply the British Museum, as set out in the plans provided by ABA.

The ground conditions were found to comprise made ground to a maximum recorded depth of 0.75m overlying variable cohesive and granular natural Lynch Hill Gravel Member, underlain by London Clay Formation bedrock, which was encountered at a depth of 4.75m and proven to a maximum depth of 20.00m.

Potential geotechnical hazards identified at this location include sulphate bearing soils, uncontrolled backfill, relict structures, high groundwater level, unexploded ordnance, shrink/swell potential, and variable natural soils.

It should be noted that the current work has only investigated the site at discrete locations. Ground conditions may vary between areas of investigation.

4.2 Geotechnical Considerations

For the proposed development, the primary geotechnical considerations will be the strength and compressibility of the founding soils and following on from this the foundation requirements of the proposed structures. This section of the report presents comments on the ground conditions in relation to design and construction of the geotechnical elements of the proposed structures.

Recommended characteristic values of parameters for geotechnical design as determined from consideration of the results of geotechnical testing conducted on samples of the soils recovered during the ground investigation, and consideration of published data and correlations with index properties, are discussed below and are summarised in Table 4.2 below.

Stratum	Bulk Unit Weight, ɣ' (kN/m^3)	Undrained Shear Strength, c_u (kPa)	Effective Cohesion, c' (kPa)	Angle of Internal Friction, ø' (degrees)	Elastic Modulus, E' (MPa)
Made Ground	18.0	-	0	33	20
Lynch Hill Gravel Member - Cohesive	19.0	75	8	29	~0.5
Lynch Hill Gravel Member - Granular	21.0	-	0	41.5	70
London Clay Formation	20.5	125	5	15	40

Table 4.2 Summary of Geotechnical Properties

4.3 Desiccation/Heave Assessment

Based on the laboratory test results, the shallow cohesive Lynch Hill Gravel Member deposits in this area (0.75-1.60mbgl) are associated with medium volume change potential according to the National House Building Council (NHBC) Chapter 4.2 'Building near trees'. A soil sample tested for at Atterberg limits at 1.00mbgl within the unit was not identified as significantly desiccated at the time of analysis (utilising Driscoll method).

4.4 Foundation Recommendations

4.4.1 Traditional Shallow Foundations

Given the above and the results of the investigation, shallow foundations should be taken though the surface layer of made ground and cohesive superficial deposits and extended into the underlying natural granular deposits.

We would not advise placing any significantly loaded structures within the made ground deposits or natural cohesive deposits due to their variable nature, limited thickness and generally poor geotechnical properties. Made ground was only encountered to 0.75mbgl with the natural cohesive deposits to 1.60mbgl, but more extensive areas could be present locally across the site. It is therefore recommended that an initial foundation depth of 2.00mbgl should be adopted founding within the granular deposits, but localised deepening may also be required.

Outline assessment has been undertaken for pad foundations in accordance with BS EN 1997-1:2004 +A1:2013 (Eurocode 7), Design Approach 1, Combinations 1 and 2. The assessment has been undertaken using the software package GEO5 2022 Spread Footing (Fine Software). The analysis has been undertaken based on a 1.00m wide pad foundation constructed at a depth of 2.00m founding in very dense fine to coarse SAND and subangular to subrounded fine to coarse GRAVEL. Calculations indicate that a maximum allowable bearing capacity in the order of 250kN/m^2 to 300kN/m^2 could be adopted for design purposes. The actual settlement of foundations will be dependent upon their size and configuration but would generally not be expected to exceed 25mm at the recommended maximum allowable bearing capacity.

Whilst an initial minimum foundation depth of 2.00m should be adopted, it is recommended that all excavations are inspected by suitably experienced personnel before construction of the foundations. If any soft/loose material is identified, foundations be increased in depth to found upon competent soils. Should unsuitable material be encountered at founding depths, and deepening the foundations is not considered a viable option, alternative foundations options or ground improvement should be considered.

Where possible and in order to reduce any possible differential settlement, new foundations should be placed within the same geological horizon.

The above has been modelled for a new independent foundation and does not consider any potential affects (loadings or settlements) on existing adjacent foundations/structures and potential basements.

Groundwater should not be encountered in shallow excavations, although surface water/rainfall may pond in excavations. The strength of the sub-soils will be moisture dependent both on drying and wetting and excavations should not be left open for any longer than required for construction and wet weather working should be avoided where possible.

4.4.2 Floor Slabs

A ground bearing floor slab could be considered for the proposed structure, depending on loadings and founding level, although the thickness and nature of the made ground and nature of the near surface soils (presence of clay soils with their inherent shrink/swell potential) means a suspended floor slab with sub floor void may be more appropriate.

Suitable compaction of the sub-grade should be carried out in any case in order provide a consistent founding layer and minimise potential deflections. It is important that the sub-grade is protected from exposure during construction to limit the potential detrimental effects of wetting or drying of cohesive sub-soils.

4.5 Stability of Excavations

The underlying made ground and natural deposits comprised cohesive and granular deposits. Shallow excavations within underlying cohesive deposits are likely to be generally relatively stable in the short term, although support will likely be required where the excavations extend within granular deposits (made ground and natural), where they are to be left open for any significant period of time, or where man entry is required. No materials should be stockpiled adjacent to open excavations.

Attention is drawn to the provisions of the Health and Safety at Work regulations, which state that any excavations should be inspected by a competent person, particularly where personnel entry is required. Where necessary excavation sides should be fully supported or battered back to a safe angle.

The inflow of groundwater into shallow excavations should be expected within the granular deposits and at the base of the made ground units. Groundwater was encountered at circa 4.0mbgl during the intrusive works, subsequent monitoring has identified the standing water levels within the natural granular deposits between 4.03 and 4.05mbgl. Groundwater conditions can vary dependent on the time of year and the amount of rainfall that has occurred and therefore levels may differ from the observations currently recorded. Therefore, sump pumping of groundwater within shallow excavations could potentially be required.

If significant quantities of water begin to form in excavations, this should be pumped out. Cohesive materials should be protected from the softening effects of moisture ingress.

4.6 Foundation Concrete (Aggressive Chemical Environment)

Chemical laboratory testing of the shallow soils down to 4mbgl (Made Ground and Lynch Hill Gravel Member) found soluble sulphates in concentrations of up to 0.078g/l, associated with pH values varying between 7.9 and 9.0. The results indicate that a design sulphate class of DS-1 and an ACEC class of AC-1s should be used for buried concrete in contact with these materials in accordance with BRE Special Digest 1, "Concrete in aggressive ground". However, the underlying London Clay Formation recorded soluble sulphates in concentrations of up to 1.05g/l, total potential sulphate of 5.52 and pH values varying between 7.4 and 8.7. If concrete is anticipated to encounter the underlying London Clay Formation a design sulphate class of DCS-5 and an ACEC class of AC4s could be required depending on the applications.

The digest described should be consulted prior to scheduling the permanent works as the specification must be applicable to the application.

4.7 Geotechnical Hazard Evaluation

6 No. geotechnical hazards have been carried forward in the assessment and are detailed in Table 4.7 below. Based on the findings of the intrusive investigation, laboratory testing and monitoring each risk has been evaluated to assess whether a positive risk remains. Where a positive risk is still identified the recommended action(s) have been provided.

Hazard	Requires further consideration?	Comment
Sulphate Bearing Soils	No/**Yes**	Shallow soils down to 4mbgl (Made Ground and Lynch Hill Gravel Member) indicate that a design sulphate class of DS-1 and an ACEC class of AC-1s. If concrete is anticipated to encounter the underlying London Clay Formation a design sulphate class of DCS-5 and an ACEC class of AC4s could be required depending on the applications.
Uncontrolled Backfill	**Yes**	No significant uncontrolled fill and limited made ground has been recorded. However, given the limited coverage during this investigation, the possibility remains for areas of significant uncontrolled backfill and should be monitored during excavation works.
Relict Structures	**Yes**	Assessment of the history of the site area has identified that historical structures have been present in the proposed development area. Currently only a borehole has been undertaken which did not encounter any relict structures. However, given the limited coverage during this investigation, the possibility remains for relict structures to be present and should be monitored during excavation works.
Shrink/Swell Potential	**Yes**	The shallow superficial cohesive soils were shown to have medium volume change potential. A soil sample tested for at Atterberg limits at 1.00mbgl within the unit was not identified as significantly desiccated at the time of analysis (utilising Driscoll method). A minimum foundation depth of 2.00mbgl should be adopted founding on the underlying superficial granular deposits. Further consideration is required if ground bearing floor slabs are to be utilised for the proposed development.
High Groundwater Level	No	Depth to groundwater was recorded to range between 4.03m to 4.10m (20.08 to 20.01maOD) within the exploratory holes during drilling and subsequent monitoring of the wells installed. As such, groundwater is not considered to be at levels of concern for shallow excavations above these levels. However additional monitoring is being undertaken for a complete 12 month period to confirm seasonal groundwater levels at the site.
Variable Deposits	**Yes**	Only 1 No. location was investigated, therefore the extent of any variable deposits across the site could not be confirmed. Foundation excavations should be deepened where necessary to ensure they found in the dense granular deposits and suitably reinforced were required.

Table 4.7 Geotechnical Hazard Evaluation

It is considered that the development of the site will not be limited based on the geotechnical findings of the investigation, assuming the recommendations from this report are followed and approved construction methods are adhered too.

5 CONTAMINATION ASSESSMENT

5.1 General

The risks posed to the potential sensitive receptors associated with the site are assessed at this stage. An initial assessment of the risk posed by each pollutant linkage was carried out and is presented in the HGE Stage 1 Tier 1 Preliminary Risk Assessment (Desk Study Report), summarised in Table 2.2.1 in Section 2.2. Refer to the full report presented in Appendix C for a complete Conceptual Site Model (CSM) and preliminary risk assessment.

Specific assessment of the short-term exposure to ground workers was not part of the scope of this investigation. Therefore, regarding these pollutant links (links 1, 3 and 11 of Table 2.2-1), soil chemical analysis and ground gas/vapour data should be made available for contractor's own risk assessment.

The risk to future site users from ground gases (link 2) is assessed by considering ground gas and vapour data recorded from monitoring and from the volatile concentrations recorded in the analysed soils and groundwater analysis.

The risks associated with long-term human exposure to soil (link 4) can be addressed by comparing the laboratory test results with soil generic assessment criteria (GAC) derived using the CLEA model. This specifically applies to dermal exposure and inhalation of contaminated dust but can be used as a preliminary indication to consider the effects on controlled water (link 6,7), drinking water supply pipes (link 8), natural flora and fauna (link 9) and building structures (link 10) from soil contamination on the site. Screening values have been published for standard land uses, including commercial and residential (with and without gardens) and the CLEA software initially allows for GAC to be amended for site specific exposure scenarios. The potential for asbestos to be present in soil (links 11) will also be considered by reviewing laboratory test results in accordance with CAR:SOILTM (CL:AIRE, 2016) guidance for the application of the Control of Asbestos Regulations (2012) Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials.

The risk to controlled water (link 6,7) has been assessed by considering soil concentrations initially and considered further by comparing concentrations detected in groundwater to environmental quality standards (EQS) and drinking water standards (DWS) researched in Defra (2015) directions to English and Welsh authorities to improve water quality in respect of the EU Water Framework Directive (WFD).

The proposed development is detailed on ABA drawings ref: 1910-41-100 to 1910-41-130. It is proposed to construct a new 5-storey energy centre to supply the British Museum, with the existing temporary 3-storey modular building demolished to facilitate the redevelopment. It is understood that no soft landscaping will be associated with the proposed development and that the subject site area will be completely covered by the proposed structures footprint.

5.2 Soil Assessment

2 No. samples of the near surface made ground and 1 No. of the near surface natural deposits were submitted to a UKAS/MCERTS accredited laboratory for a general suite of analytes as detailed in section 3.6.

For an initial screening of soil chemical test results with regard to long-term human health risks, the results have been compared to GAC. Land Quality Management Limited and the Chartered Institute for Environmental Health published 'Suitable 4 Use Levels' (S4UL) as GAC for a range of substances, for a range of generic land uses. DEFRA published category four screening levels (C4SL) for six contaminants in March 2014 to assist practitioners in assessing land contamination under part IIA of the Environmental Protection Act 1990. These have also been identified as suitable for use within the planning system, although it should be noted that they assume a higher level of acceptable risk than S4UL and earlier published GAC. Rather than universally adopting a higher level of risk, the S4UL are applied initially, with C4SL considered where the maximum concentrations exceed the S4UL.

For each land use category, a single value is provided for metals, with three values specified for organic contaminants based on the proportion of soil organic matter (%SOM) or the total organic carbon (%TOC) content of the soil. Unless otherwise stated, the GAC (S4UL and C4SL) for the most conservative SOM (1%) has been used for the assessment.

Records of the soil chemical testing have been appended to this report and are summarised in the following tables.

Based on the proposed end use of the proposed development the soil analysis results have been screened against 'Commercial' end use criteria.

Compared to Commercial end use criteria

Determinant	Maximum recorded concentration (mg/kg)	LQM/CIEH S4UL 2014 and C4SL* for commercial (mg/kg)	Maximum Exceeds Screening Value?	Samples Exceeding (Fieldwork ID Sample ID Depth)	Exceedance Values (Relative to Sample IDs)
Arsenic	13	640	No	-	-
Beryllium	1	12	No	-	-
Boron	1.9	240000	No	-	-
Cadmium	< 0.2	190	No	-	-
Chromium	33	8600	No	-	-
Chromium - Hexavalent	< 1.8	33	No	-	-
Copper	76	68000	No	-	-
Lead	190	2300	No	-	-
Mercury	1.4	58	No	-	-
Nickel	29	980	No	-	-
Selenium	< 1	12000	No	-	-
Vanadium	52	9000	No	-	-
Zinc	69	730000	No	-	-
Acenaphthene	< 0.05	84000	No	-	-
Acenaphthylene	< 0.05	83000	No	-	-
Anthracene	< 0.05	520000	No	-	-
Benzo(a)anthracene	0.56	170	No	-	-
Benzo(a)pyrene	0.42	35	No	-	-
Benzo(b)fluoranthene	0.53	44	No	-	-
Benzo(ghi)perylene	0.23	3900	No	-	-
Benzo(k)fluoranthene	0.23	1200	No	-	-
Chrysene	0.51	350	No	-	-
Coronene	< 0.05	-		-	-
Di-benzo(a,h)anthracene	< 0.05	3.5	No	-	-
Fluoranthene	1	23000	No	-	-
Fluorene	< 0.05	63000	No	-	-
Indeno(1,2,3-cd)pyrene	0.22	500	No	-	-
Naphthalene	< 0.05	190	No	-	-
Phenanthrene	0.64	22000	No	-	-
Pyrene	0.89	54000	No	-	-
Speciated Total EPA-16 PAHs	4.73	-		-	-
Total PCBs	< 0.007	-		-	-

Determinant	Maximum recorded concentration (mg/kg)	LQM/CIEH S4UL 2014 and C4SL* for commercial (mg/kg)	Maximum Exceeds Screening Value?	Samples Exceeding (Fieldwork ID Sample ID Depth)	Exceedance Values (Relative to Sample IDs)
Total Phenols - Monohydric	< 1	-		-	-
Aliphatic >C5 - C6	< 0.001	3200	No	-	-
Aliphatic >C6 - C8	< 0.001	7800	No	-	-
Aliphatic >C8 - C10	< 0.001	2000	No	-	-
Aliphatic >C10 - C12	< 1	9700	No	-	-
Aliphatic >C12 - C16	7.3	59000	No	-	-
Aliphatic >C16 - C21	16	1600000	No	-	-
Aliphatic >C21 - C35	69	1600000	No	-	-
Aliphatic (C5 - C35)	92	-		-	-
Aromatic >C5 - C7	< 0.001	26000	No	-	-
Aromatic >C7 - C8	< 0.001	56000	No	-	-
Aromatic >C8 - C10	< 0.001	3500	No	-	-
Aromatic >C10 - C12	< 1	16000	No	-	-
Aromatic >C12 - C16	< 2	36000	No	-	-
Aromatic >C16 - C21	< 10	28000	No	-	-
Aromatic >C21 - C35	100	28000	No	-	-
Aromatic (C5 - C35)	100	-		-	-
Benzene	< 0.001	27	No	-	-
Ethylbenzene	< 0.001	56000	No	-	-
MTBE (Methyl Tertiary Butyl Ether)	< 0.001	-		-	-
o-Xylene	< 0.001	6600	No	-	-
p & m-Xylene	< 0.001	5900	No	-	-
Toluene	< 0.001	56000	No	-	-
pH	8.0 – 11.5	-		-	-
Total Organic Carbon (TOC)	2.3%	-		-	-
Asbestos in Soil	Not detected	-		-	-

Table 5.2 Exceedances compared to Commercial end use criteria.

No elevated concentrations were identified above any of the commercial end use criteria within the 3 No. soil samples analysed.

It should be noted that when the sample results were compared against the most stringent land use criteria ‘Residential with Homegrown Produce’, only one determinant marginally exceeded. From the sample taken at 0.50mbgl within the made ground, Mercury recorded a maximum recorded concentration of 1.4mg/kg, exceeding the criteria of 1.2mg/kg.

Based on the above, the levels of soil contaminants recorded in the soils are not considered to represent a significant risk to human health end users associated with the proposed development.

However, consideration should be given that the ground investigation was limited to a single accessible area (no locations currently undertaken in existing building) and that potential sources and extent of soil contamination across the site may not have been fully assessed.

Considering the results and that the proposed structures footprint will cover the whole site area, further investigation or remedial action is not considered to be warranted at this stage. The proposed development will break all potential pollutant linkages to human health end users with the exception of inhalation of soil gas/vapours. However, should indications of additional contamination be discovered during development, this should be further assessed, and appropriate action taken, as necessary.

The potential risk to construction workers should be mitigated through a contractor's risk assessment prior to development. If any obviously contaminated soil is encountered the advice of a suitably qualified person should be sought regarding the appropriate course of action

The result of the asbestos analysis indicates that there were no asbestos fibres detected in any of the samples tested, however, based on the anthropogenic impacts observed as well as the potential contaminant sources identified in the HGE Stage 1 Tier 1 Preliminary Risk Assessment (Desk Study), there is potential that some ACM could be locally present within made ground across the area.

Should further areas of made ground containing potential asbestos-containing materials (ACMs), or other forms of contamination be discovered during development, this should be further assessed.

5.3 Water Supply Pipework

UKWIR has published the 'Guidance for the selection of water supply pipes to be used in brownfield sites (10/WM/03/21)' to advise developers of contaminants in soil which have the potential to leach through drinking water supply pipework and includes a list of threshold concentrations specific to several commonly used types of pipework.

It should be noted that the scope of testing presented in this report is limited to assessing contaminated land based on the previous site use and does not include analysis of all the parameters specified in the UKWIR guidance.

This investigation includes a preliminary assessment of the risk to drinking water supply pipes that would be installed as part of any proposed development. Shallow soil samples of made ground and natural soils have been analysed for a range of potential contaminants, including organic substances listed by UKWIR 'Guidance for the selection of water supply pipes to be used in Brownfield sites'. The details of the compounds currently analysed, and results obtained are detailed in section 5.2 'Soil Assessment'.

The currently recorded TPH concentrations within the soils do not exceed UKWIR TPH criteria. At this stage VOC and SVOC testing has not been undertaken.

Depending on the design, location and depth of the proposed potable water supply pipes, and the extent of any proposed remediation mitigation measures, it may be plausible to adopt standard potable water supply pipes based on the limited analysis to date.

It is recommended that this report is provided to the appointed water company to advise on appropriate materials to be used for construction of potable water supplies.

5.4 Phytotoxic Contamination

It is understood that no soft landscaping will be associated with the proposed redevelopment with the subject site completely covered by the footprint of the proposed building structure. However, should areas of soft landscaping be considered we would recommend BS3882:2015 testing for topsoil to be utilized.

5.5 Groundwater Assessment

The site is not recorded to lie within a source protection zone. The superficial soils (Lynch Hill Gravel Member) are defined as a Secondary A aquifer with the underlying solid geology (London Clay Formation) defined as an unproductive aquifer.

The closest active groundwater abstraction is located some 277m northwest of the site and is detailed as a heat pump. The closest abstraction associated with a Potable Water Supply is located some 923m west, detailed as drinking, cooking, sanitary and washing.

No surface water features are recorded within 250m of the site, the River Thames is located approximately 1.2km to the southeast of the site.

A negligible risk of flooding from either rivers or the sea was identified on site. However, a moderate risk is considered from groundwater flooding.

Groundwater was encountered within the superficial deposits during the investigation at 4.10mbgl and subsequently between 4.03mbgl and 4.05mbgl during the three monitoring rounds currently undertaken. Due to only having one monitoring well location at the time of this report it is not possible to infer the groundwater flow direction. It should be noted that groundwater flow direction could be locally influenced by the presence of underground structures (e.g., building foundations, basements and utility corridors), the influence of which may vary seasonally.

The risk to controlled waters is addressed by comparing the laboratory test data to adopted screening values. At this stage the risk to controlled water is evaluated from groundwater sampled on completion of the intrusive works. Environment Agency (EA) publication "Groundwater Protection: Principles and Practice (GP3)" describes the method for assessing the risk to controlled waters.

Currently 1 No. groundwater sample has been sampled and analysed for a suite of analytes (Suite HW1.1) as detailed below. The groundwater sample was taken from the superficial deposits (secondary A aquifer) in borehole BH01:

- **Suite HW1.1:** As, B, Cd, Cr (total and VI), Cu, Pb, Hg, Ni, Se, Zn, cyanide (total and free), sulphate, sulphide, sulphur (free), chloride, NH4 as N, pH, nitrate, nitrite, conductivity, hardness, COD, DOC, DO, PAH (speciated 16), TPH CWG (C10-C40), phenols (speciated)

The results of the groundwater sample analyses are summarised in Table 5.5.1 below, and are compared against the appropriate groundwater screening values, which are described in the appended Groundwater Screening Values Datasheet (collectively referred to as the 'applicable standards'). These include the UK Drinking Water Standards, WHO Drinking Water Quality Guidelines (WHO DWQG), Environmental Quality Standards (EQS) annual averages (EQS-AA) and maximum allowable concentrations (EQS-MAC), and the Society of Brownfield Risk Assessment (SoBRA) GACgwvap.

The table below only details determinants from the 1 No. Suite HW1.1 analysis.

Determinant **(Hardness band - mgCaCO$_3$/l)**	**Max. Recorded (µg/l) – Range provided where exceeding**	**U.K. Drinking Water Standard / [WHO DWQG] (µg/l)**	**EQS-AA (freshwater)/ [EQS-MAC (freshwater)] (µg/l)**	**SoBRA – Commercial (µg/l)**	**Sample Exceeding (Borehole ID_Sample ID)**	**Exceedance Values**
Ammoniacal Nitrogen as N	< 15	500	-	-		
Chemical Oxygen Demand	< 2,000	-	-	-		
Chloride	77,000	250,000	250,000	-		
Cyanide - Free	< 10	50	1 [5]	-		
Cyanide - Total	< 10	50	1 [5]	-		
Dissolved Organic Carbon	1,240	-	-	-		
Dissolved Oxygen	8,000	-	-	-		
Electrical Conductivity	660uS/cm	2,500	-	-		
Elemental Sulphur	< 20	-	-	-		
Nitrate as N	6,530	50,000	-	-		
Nitrite as N	3	3,000	-	-		
pH	7.9	6.5 - 9.5	[6 – 9]	-		
Sulphate as SO4	95,500	250,000	400,000	-		
Sulphide	< 5	-	-	-		
Total Hardness	285mg CaCO3/l	-	-	-		

Determinant (Hardness band - $mgCaCO_3/l$)		Max. Recorded (µg/l) – Range provided where exceeding	U.K. Drinking Water Standard / [WHO DWQG] (µg/l)	EQS-AA (freshwater)/ [EQS-MAC (freshwater)] (µg/l)	SoBRA – Commercial (µg/l)	Sample Exceeding (Borehole ID_Sample ID)	Exceedance Values
Arsenic		0.41	10	50	-		
Boron		100	2,400	2,000	-		
Cadmium	**(>200)**	3	0.25	-	No		
Calcium		100,000	-	[1.5]	-		
Chromium (II)		0.3	50 (total)	4.7 [32]	-		
Chromium (VI)		< 5		3.4	-		
Copper		1.9	2,000	1 (bioavailable)	-	BH01_EW1-SP1_4.04	1.9
Lead		< 0.2	10	1.2 (bioavailable) [14]	-		
Magnesium		5,900	-	-	-		
Mercury		< 0.05	6	[0.07]	95		
Nickel		0.7	70	4 (bioavailable) [34]	-		
Selenium		3.4	40	-	-		
Zinc		1.4	-	10.9 (bioavailable)	-		
Acenaphthene		< 0.01	-	[0.1]	15,000,000		
Acenaphthylene		< 0.01	-	-	20,000,000		
Anthracene		< 0.01	-	0.1 [0.1]	-		
Benzo(a)anthracene		< 0.01	-	-	-		
Benzo(a)pyrene		< 0.01	0.7	0.00017 [0.27]	-		
Benzo(b)fluoranthene		< 0.01	-	[0.017]	-		
Benzo(g,h,i)perylene		< 0.01	-	[0.0082]	-		
Benzo(k)fluoranthene		< 0.01	-	[0.017]	-		
Chrysene		< 0.01	-	-	-		
Dibenz(a,h)anthracene		< 0.01	-	-	-		
Fluoranthene		< 0.01	-	0.0063 [0.12]	-		
Fluorene		< 0.01	-	-	18000000		
Indeno(1,2,3-cd)pyrene		< 0.01	-	-	-		
Naphthalene		< 0.01	-	2 [130]	23000		
Phenanthrene		< 0.01	-	-	-		
Pyrene		< 0.01	-	-	-		
Total EPA-16 PAHs		< 0.16	-	-	-		
Catechol		< 0.5	-	-	-		
Cresols		< 0.5	-	-	-		
Ethylphenol & Dimethylphenol		< 0.5	-	-	-		
Isopropylphenol		< 0.5	-	-	-		
Naphthols		< 0.5	-	-	-		
Phenol		< 0.5	-	7.7 [46]	-		

Determinant (Hardness band - mgCaCO$_3$/l)	Max. Recorded (µg/l) – Range provided where exceeding	U.K. Drinking Water Standard / [WHO DWQG] (µg/l)	EQS-AA (freshwater)/ [EQS-MAC (freshwater)] (µg/l)	SoBRA – Commercial (µg/l)	Sample Exceeding (Borehole ID_Sample ID)	Exceedance Values
Resorcinol	< 0.5	-	-	-		
Total Phenols (HPLC)	< 3.5	-	-	-		
Trimethylphenol	< 0.5	-	-	-		

Table 5.5 Summary of Groundwater Test Results for determinants >MDL

The contaminants listed above which do not exceed the applicable standards are not considered to pose a risk to the sensitive receptors identified and are therefore not considered further.

Implications of the contaminants exceeding threshold values as summarised in Table 5.5 above are considered in more detail below.

5.5.1 Heavy Metals

Copper marginally exceeded its initial EQS criteria of 1ug/l with 1.9ug/l. The concentration does not exceed relevant drinking water criteria (2000ug/l).

It is considered the concentration of copper is at a level which would be unlikely to be significantly detrimental to the identified controlled waters and likely at background concentrations for the surrounding area.

5.6 Ground Gas/Vapour Assessment

3 No. rounds of gas monitoring have currently been undertaken between 21st September and 6th October 2022. All the monitoring rounds to date have been undertaken on a high atmospheric pressure.

C665 2007 recommends that for a site with a low generation potential of source gas, 6 No. monitoring visits should be undertaken for commercial end use over 2 months.

Given the gas concentrations and flows from the first three monitoring rounds and that no potential source of soil gas generation was identified (only 0.75m of made ground) it is considered that additional gas monitoring is not required.

Currently the maximum recorded carbon dioxide reading was 0.1%. Methane levels were recorded at <0.1%, whilst oxygen levels were recorded down to a minimum of 20.3%.

Flow levels were generally recorded at 0.0 l/hr, however some negative flow (-0.1 l/hr) was recorded during monitoring round 1.

Carbon monoxide and hydrogen sulphide were recorded to be <1ppm. No residential screening thresholds are published for carbon monoxide or hydrogen sulphide. However, the levels recorded are well below the long-term exposure limits (30ppm and 5ppm respectively published in table 1 of HSE EH40/2005 'workplace exposure limits').

Requirement C2 of Schedule 1 of the Building Regulations 2004 for England & Wales covers the potential for methane and carbon dioxide ingress into buildings. This publication indicates that a risk-based approach to consideration of ground gas hazard potential should be undertaken.

Further reference is made to BS8485:2015+A12919 which provides a mechanism to initially quantify the risk from methane (CH_4) and carbon dioxide (CO_2) by calculating a maximum gas flow rate or gas screening value (GSV) as part of a conservative semi-quantitative approach. The worst case GSV is calculated by multiplying the highest flow rate with the maximum recorded concentration of each gas across the site. We have also calculated the GSV for each borehole based on maximum concentrations and flows from the three monitoring rounds.

Table 5.6 summarises the pertinent ground gas concentrations and flow readings taken during the investigation and presents the GSVs for methane and carbon dioxide.

Zone	Max Reported (%)					Flow (l/h)	Peak PID (ppm)	GSV - CH_4 (l/h)	CS - CH_4	GSV – CO_2 (l/h)	CS - CO_2
	CH_4	CO_2	O_2 (min)	H_2S (ppm)	CO (ppm)	Max					
BH01	<0.1	0.1	20.3 - 21.0	<1	<1	-0.1	4.7	0.0001	CS1	0.0001	CS1

Table 5.6 Ground Gas Assessment

Based on the worst case GSVs for CO_2 and CH_4 in accordance with BS8485:2015, the site falls within CS1 'Very low hazard potential'.

Volatile Organic Compounds (VOCs) were recorded during the ground gas monitoring rounds at concentrations of <10ppm, recorded at a maximum of 4.7ppm and as such do not give cause for concern.

The appropriate ground gas protection measures for the proposed buildings on the site are based on the GSV and building type. From the information provided, we understand that the buildings planned at the site can be described as industrial style, with well ventilated areas. The building will be civil engineer designed and any ground protection measures will be appropriately maintained. This comprises building 'type D' in BS8485:2015.

Table 4 in BS8485:2015 provides a scoring matrix whereby a minimum score should be achieved for certain building types under certain CS situations. For this site, type D buildings in a gas regime of CS1, no gas protection measures should be required.

If during construction, evidence is uncovered which may suggest gas protection measures may be appropriate, reference to BS8485:2015 should be made by the design engineer to select appropriate gas protection measures.

Reference to BRE Report 211 "Radon: guidance on protective measures for new buildings" indicates that the site is located in an area where <1% of homes are above action level. On this basis it is considered that special protection measures are not necessary within the proposed development with regard to natural radon hazards. However, it has been stated that in accordance with building regulation, until a building had been constructed and occupied, it is not possible to accurately assess the severity of a radon problem on a particular site.

5.7 Waste Disposal

All waste related activities must be undertaken in accordance with The Waste (England and Wales) Regulations (2011) and The Landfill (England and Wales) Regulations (2002). Any proposed disposal or reuse of materials must be in accordance with the Waste (England and Wales) Regulations 2011 (as amended). According to the regulations waste soil and construction waste must be classified and assessed prior to disposal. The process is described in the Environment Agency Technical Guidance WM3 (2021), with the following steps identified:

Steps to *classify* the waste

i. Check if the waste needs to be classified (is it a waste).
ii. Identify the code or codes that may apply to the waste, as classified in the List of Waste (LoW).
iii. Identify the assessment needed to select the correct code.

Steps to *assess* the waste

iv. Determine the chemical composition of the waste.
v. Identify if the substances in the waste are 'hazardous substances' or 'persistent organic pollutants.'
vi. Assess the hazardous properties of the waste.
vii. Assign the classification code and describe the classification code.

Once classified, the waste can be removed to the appropriately licensed facilities with some waste requiring pre-treatments prior to disposal. The results contained in this report should be submitted to allow suitable classification for waste disposal purposes by the contractor.

Specific Waste Acceptance Criteria (WAC) testing has been undertaken on one sample. The results of this testing indicate the soils may generally be classified as inert.

If soils are planned to be removed from the site, waste classification should be reviewed, completed and is the responsibility of the contractor generating/holding the waste soil. The waste classification should be determined in accordance with Environment Agency's Technical Guidance (WM3, 2018) and it may be appropriate to do so in conjunction with the intended landfill to receive it. If excavated soils are planned to be retained and reused on site after it may be appropriate to complete a materials management plan (MMP) according to CL:AIRE (2011) The Definition of Waste: Development Industry Code of Practice (DoW CoP), to appropriately reuse material without contravening the waste regulations.

5.8 Contamination Risk Evaluation – Pollutant Linkages

This stage of the risk-based system is intended to establish the requirements for risk management where a positive risk has been identified following the intrusive investigation, laboratory testing and monitoring. Action is recommended where deemed appropriate.

It is necessary to identify unacceptable risk situations where a pollutant link is deemed to be made. To examine the possible options available at this stage, a risk evaluation table has been produced as below. This is based on the previous sections, and three possible outcomes are listed below.

- NA – No action is required with respect to this pollutant linkage, as either the linkage is not made, or the risk may be considered negligible in this case.
- GI – Further investigation and assessment is required to fully assess the risk.
- AR – Action Recommended. An unacceptable level of risk was identified. Therefore, action is required to break the pollutant linkage.

<table>
<tr><th colspan="4">Hazard Identification</th><th rowspan="2">Evaluated Risk</th><th rowspan="2">Action Consideration</th></tr>
<tr><th>Link No.</th><th>Source/ Hazard</th><th>Pathway</th><th>Receptor</th></tr>
<tr><td>1</td><td rowspan="2">Hazardous vapours / soil gas from made ground, volatile hydrocarbons/ free product or migrating to site from backfill material</td><td>Ingress into excavations, structures and confined spaces, and subsequent inhalation.</td><td>People on the site during development construction.</td><td rowspan="2">N/A</td><td rowspan="2">The appropriate ground gas protection measures for the proposed buildings on the site are based on the GSV and building type. Based on the worst case GSVs for CO2 and CH4 in accordance with BS8485:2015, the site falls within CS1 ‘Very low hazard potential’. Based on the limited gas monitoring undertaken, a viable source of ground gases has not been found and an assessment of the levels recorded during monitoring suggests that remedial action is not required. However, data should be provided to contractors involved in development to allow them to undertake their own specific risk assessments.
Volatile Organic Compounds (VOCs) were recorded during the ground gas monitoring rounds at concentrations of <10ppm, recorded at a maximum of 4.7ppm and as such do not give cause for concern.</td></tr>
<tr><td>2</td><td>Ingress into structures and confined spaces, and subsequent inhalation.</td><td>People using the site post development and construction and residential users off site (to the south east</td></tr>
<tr><td>3</td><td rowspan="5">Contaminated soil and groundwater from previous and present contamination sources both on and off site</td><td rowspan="3">Ingestion of soil through direct contact, eating with dirty hands and dust inhalation.</td><td>People on the site during development construction.</td><td rowspan="3">N/A</td><td rowspan="3">No elevated concentrations were identified above any of the commercial end use criteria within the 3 No. soil samples analysed.
It should be noted that when the sample results were compared against the most stringent land use criteria ‘Residential with Homegrown Produce’, only one determinant marginally exceeded. From the sample taken at 0.50mbgl within the made ground, Mercury recorded a maximum recorded concentration of 1.4mg/kg, exceeding the criteria of 1.2mg/kg.
Based on the above, the levels of soil contaminants recorded in the soils are not considered to represent a significant risk to human health end users associated with the proposed development.
However, consideration should be given that the ground investigation was limited to a single accessible area (no locations currently undertaken in existing building) and that potential sources and extent of soil contamination across the site may not have been fully assessed.
Considering the results and that the proposed structures footprint will cover the whole site area, further investigation or remedial action is not considered to be warranted at this stage. The proposed development will break all potential pollutant linkages to human health end users with the exception of inhalation of soil gas/vapours. However, should indications of additional contamination be discovered during development, this should be further assessed, and appropriate action taken, as necessary.
The potential risk to construction workers should be mitigated through a contractor’s risk assessment prior to development. If any obviously contaminated soil is encountered the advice of a suitably qualified person should be sought regarding the appropriate course of action</td></tr>
<tr><td>4</td><td rowspan="2">People using the site post development construction.
Human end users (residential and commercial) and neighbours post development construction.</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td>Leaching.</td><td rowspan="2">Groundwater –
Secondary A aquifer superficial deposits.
Surface Waters -
The River Thames</td><td rowspan="2">N/A</td><td rowspan="2">The only determinant to exceed commercial criteria was copper, which marginally exceeded its initial EQS AA (freshwater 1ug/l) criteria with a maximum concentration of 1.9ug/l. The concentrations do not exceed relevant drinking water criteria (2000ug/l).
It is considered the concentration of copper is at a level which would be unlikely to be significantly detrimental to the identified controlled waters.</td></tr>
<tr><td>7</td><td>Infiltration</td></tr>
</table>

			Off-site human receptors and infrastructure.		
8		Via service pipes.	People using site after development completion.	N/A	It is recommended that this report is provided to the appointed water company to advise on appropriate materials to be used for construction of potable water supplies.
9		Plant uptake.	Local flora and fauna.	-	It is understood that no soft landscaping will be associated with the proposed redevelopment with the subject site completely covered by the footprint of the proposed building structure. However, should areas of soft landscaping be considered we would recommend BS3882:2015 testing for topsoil to be utilized.
10		Direct Contact	Building structures	-	Please refer to concrete classification in section 4.6.
11	Potential asbestos containing materials within existing structures and Made Ground soils	Inhalation of dust.	Humans on and in the vicinity of the site during demolition/ development construction.	N/A	The result of the asbestos analysis indicates that there were no asbestos fibres detected in any of the samples tested, however, based on the anthropogenic impacts observed as well as the potential contaminant sources identified in the HGE Stage 1 Tier 1 Preliminary Risk Assessment (Desk Study), there is potential that some ACM could be locally present within made ground across the area. Should further areas of made ground containing potential asbestos-containing materials (ACMs), or other forms of contamination be discovered during development, this should be further assessed. An asbestos survey is recommended prior to demolition of any structures. Any subsequent removal to be undertaken by controlled methods by appropriately qualified operators.

Table 5.8 Pollutant Linkage Risk Evaluation

The proposed development is detailed on ABA drawings ref: 1910-41-100 to 1910-41-130. It is proposed to construct a new 5-storey energy centre to supply the British Museum, with the existing temporary 3-storey modular building demolished to facilitate the redevelopment. It is understood that no soft landscaping will be associated with the proposed development and that the subject site area will be completely covered by the proposed structures footprint.

Due to the nature of the development detailed, this report and associated geoenvironmental assessment has assumed a proposed commercial end use for geoenvironmental assessment.

No elevated contamination concentrations were identified above any of the relevant commercial end use criteria within the 3 No. soil samples analysed.

Based on the above, the levels of soil contaminants recorded in the soils are not considered to represent a significant risk to human health end users associated with the proposed development. However, consideration should be given that the ground investigation was limited to a single accessible area (no locations currently undertaken in existing building) and that potential sources and extent of soil contamination across the site may not have been fully assessed.

Considering the results and that the proposed structures footprint will cover the whole site area, further investigation or remedial action is not considered to be warranted at this stage. The proposed development will break all potential pollutant linkages to human health end users with the exception of inhalation of soil gas/vapours. However, should indications of additional contamination be discovered during development, this should be further assessed, and appropriate action taken, as necessary.

The potential risk to construction workers should be mitigated through a contractor's risk assessment prior to development. If any obviously contaminated soil is encountered the advice of a suitably qualified person should be sought regarding the appropriate course of action.

The result of the asbestos analysis indicates that there were no asbestos fibres detected in any of the samples tested, however, based on the anthropogenic impacts observed as well as the potential contaminant sources identified in the HGE Stage 1 Tier 1 Preliminary Risk Assessment (Desk Study), there is potential that some ACM could be locally present within made ground across the area.

Should further areas of made ground containing potential asbestos-containing materials (ACMs), or other forms of contamination be discovered during development, this should be further assessed.

An asbestos survey is recommended prior to demolition of any structures. Any subsequent removal to be undertaken by controlled methods by appropriately qualified operators.

Groundwater from the superficial Lynch Hill Gravel Member (Secondary A Aquifer) has been analysed from the cable percussive borehole. Only copper was recorded slightly exceeding a relevant criteria (exceeded its initial EQS criteria of 1ug/l with 1.9ug/l but did not exceed relevant drinking water criteria).

It is considered the concentration of copper is at a level which would be unlikely to be significantly detrimental to the identified controlled waters and likely at background concentrations for the surrounding area.

The appropriate ground gas protection measures for the proposed buildings on the site are based on the GSV and building type. Based on the worst case GSVs for CO_2 and CH_4 in accordance with BS8485:2015, the site falls within CS1 'Very low hazard potential'. Based on the limited gas monitoring undertaken, a viable source of ground gases has not been found and an assessment of the levels recorded during monitoring suggests that remedial action is not required. However, data should be provided to contractors involved in development to allow them to undertake their own specific risk assessments.

Volatile Organic Compounds (VOCs) were recorded during the ground gas monitoring rounds at concentrations of <10ppm, recorded at a maximum of 4.7ppm and as such do not give cause for concern.

The potential risk to construction workers should be mitigated through a contractor's risk assessment prior to development. If any obviously contaminated soil is encountered the advice of a suitably qualified person should be sought with regard to the appropriate course of action.

The basic requirement for development standards in the UK is that land should be 'suitable for use' or 'fit for purpose'. It is important to consider the limited nature of the sampling for this investigation, and the possibility of higher concentrations of contaminants and differing ground conditions existing between sample positions. However, providing the recommendations are adhered to, we believe that the site can be suitable for the intended use.

We recommend that this report is submitted to Regulators as part of the planning process. It is recommended that correspondence with the regulators is undertaken before any additional ground investigation and associated assessments are undertaken.

Harrison Group Environmental Limited would be pleased to offer further assistance with the recommended works if requested, and if the client or regulators have any comments or questions, we would be glad to discuss them.

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LIST OF APPENDICES

APPENDIX A
DATASHEETS

DATASHEET: SITE INVESTIGATION METHODS

This datasheet provides basic details of the methods employed during the undertaking of site investigations. Detailed method statements may be provided if requested or further information may be obtained from the relevant British Standards or other quoted publications. Investigations are generally conducted in accordance with BS 5930:2015 + A1:2020, "Code of practice for ground investigations", BS 10175:2011+A2:2017, "Investigation of potentially contaminated sites – Code of Practice, and BS EN ISO 1997-2:2007, "Eurocode 7 – Geotechnical design – Part 2: Ground investigation and testing".

Prior to any excavation being undertaken, service plans are obtained and/or a service tracing team may be employed to locate and mark up service locations. A surface sweep using a cable avoidance tool (CAT) is undertaken, in order to avoid services and service inspection pits are generally hand excavated prior to commencing work with any mechanical plant.

CABLE PERCUSSIVE BOREHOLES

The cable percussive borehole drilling rig may be towed by a 4x4 pick up or similar vehicle and is capable of forming cased boreholes to depths of up to 50m. The hole may be formed at diameters from 300mm down to the more typical 150mm, with disturbed samples obtained direct from the drilling tools. The equipment requires a minimum 2m access width, and the rig itself is 6m long (11m including tow). A rough 3m x 5m base area is required for drilling, but each site should be considered on specifics.

The technique can penetrate dense made ground, rubble and concrete or weathered rock/thin bands of rock using a chisel. However, in some cases these materials can form obstructions.

Sampling is generally conducted in accordance with BS EN ISO 22475-1:2006, "Geotechnical investigation and testing – Sampling methods and groundwater measurements - Part 1 – Technical principles for execution". A variety of disturbed samples can be obtained for both geotechnical and environmental purposes and undisturbed samples including U100 (thick-walled OS-TK/W), UT100 (thin-walled OS-T/W) and piston samples (PS-T/W) may be obtained. Standard in-situ testing may include Standard or Cone Penetration Tests (SPT/CPT) to BS EN ISO 22476-3:2005+A1:2011, "Geotechnical investigation and testing – Field testing – Part 3 – Standard penetration test"; vane testing in accordance with BS 1377-9:1990, "Methods of test for soils for civil engineering purposes" and permeability testing in accordance with BS EN ISO 22282-1-6:2012, Geotechnical investigation and testing – Geohydraulic testing – Parts 1 to 6.

Instrumentation/standpipes/monitoring wells can be installed, otherwise the borehole would be backfilled with spoil, or where instructed bentonite, concrete or sand may be used. Excess spoil is either removed from site or left in a tidy heap nearby.

In wet drilling conditions (beneath groundwater level) or where water needs to be added to facilitate drilling, the spoil can spread over a wide area through splashing and flow of the spoil from the tools, unless precautions are taken to prevent this. Conversely, the system can be very clean for instance when drilling through dry clay soil.

MONITORING WELL INSTALLATIONS

All types of boreholes can be fitted with monitoring wells to enable subsequent sampling and monitoring of groundwater and ground gas levels. Monitoring wells are usually of upvc or hdpe material, although steel may also be used in certain circumstances. Various diameters are available from 19mm upwards, depending upon the size of the borehole. 38mm or 50mm diameter wells are the most commonly used. Wells generally have slotted lower sections which may have a geomesh filter and then are surrounded with a filter medium such as single sized gravel. The upper sections are generally solid casing which is usually grouted to produce a seal with the surrounding ground. The top of the well is generally fitted with a removable cap that may include a gas valve to enable future gas monitoring. The installation is usually protected by a lockable cover set in a concrete base. Details of monitoring well installations and associated backfill are given on the relevant borehole records.

BOREHOLE INSTRUMENTATION

Various types of instrumentation may be installed in boreholes to enable subsequent monitoring of groundwater levels and pressures and ground movements. Instruments that may be installed include piezometers (standpipe, vibrating wire or pneumatic), inclinometers, extensometers, settlement, and strain gauges.

GROUNDWATER MONITORING

Groundwater monitoring is undertaken using an electronic dip meter, which records the depth to water in a standpipe or monitoring well. Alternatively, down-hole pressure transducers cab be utilised which can record variations over an extended period, which is particularly useful in monitoring variations due to tidal influences or when undertaking permeability tests or draw down tests or when undertaking soakaway testing. Where a non-aqueous phase liquid (e.g., floating hydrocarbon layer) is present, an interface meter is utilised to measure the thickness.

GROUND GAS MONITORING

Ground gas composition and flow monitoring may be undertaken where monitoring wells have been installed. Both flow (litres per hour) and composition (%) are measured using a portable infra-red multi-gas meter, calibrated for methane, carbon dioxide, carbon monoxide, hydrogen sulphide and oxygen. Records are also taken of atmospheric pressure, and relative pressure. The results are presented in the appendix of the report on the relevant records.

Ground gas monitoring can also be undertaken on a continuous basis using in-situ GasClam instrumentation where specific projects warrant accurate identification and quantification of the ground gas regime.

HAND EXCAVATED TRIAL PITS

Hand excavated pits may be undertaken for a variety of reasons, which include service observation pits, obtaining near surface samples, and examining foundations of existing buildings. Pits are excavated using a shovel, postholers and other suitable equipment. Shoring is necessary where pits are to be extended greater than 1.2m and deep excavations may take a considerable time to undertake. Detailed records of hand excavated pits are only normally recorded where foundation depths and detailed information is required.

DATASHEET: GENERAL RISK ASSESSMENT METHODOLOGY

The pollutant links and initial conceptual ground model provide a potential ‘source-pathway-receptor’ analysis for the site based on the information presented in the report. Qualitative risk assessment allows for a consideration of the relative risk or hazard due to each potential linkage. Risk assessment is an iterative process, and as such must start at a general level, gradually becoming more specific as more cycles are performed based on better information.

An initial estimation of risk can be undertaken using the methodology set out in CIRIA 552 (2001), “Contaminated land risk assessment. A guide to good practice”. This involves classification of the magnitude of the potential consequence (severity) of risk occurring (Table D1) and magnitude of the probability (likelihood) of the risk occurring (Table D2). These are then used to produce a risk category (Table D3).

Classification	Definition	Examples
Severe	Short-terms (acute) risk to human health likely to result in “significant harm” as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution (note: Water Resources Act contains no scope for considering significance of pollution) of sensitive water resource. Catastrophic damage to buildings/property. A short-terms risk to a particular ecosystem or organism forming part of such ecosystem (note: the definitions of ecological systems within the Draft Circular on Contaminated Land, DETR, 2000).	High concentrations of cyanide on the surface of an informal recreation area. Major spillage of contaminants from site into controlled water. Explosion, causing building collapse (can also equate to a short-term human health risk if buildings are occupied).
Medium	Chronic damage to human health (“significant harm” as defined in DETR, 2000). Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution). A significant change in a particular ecosystem, or organism forming part of such ecosystem (note: the definitions of ecological systems within Draft Circular on Contaminated Land, DETR, 2000).	Concentrations of a contaminant from site exceed the generic or site-specific assessment criteria. Leaching of contaminants from a site to a Principal or Secondary Aquifer. Death of a species within a designated nature reserve.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services (“significant harm” as defined in the *Draft Circular on Contaminated Land*, DETR, 2000). Damage to sensitive buildings/structures/ services or the environment.	Pollution of non-classified groundwater. Damage to building rendering it unsafe to occupy (e.g., foundation damage resulting in instability).
Minor	Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. Non-permanent health effects to human health (easily prevented by means such as personal protective clothing etc.). Easily repairable effects of damage to buildings, structures, and services.	The presence of contaminants at such concentrations that protective equipment is required during site works. The loss of plants in a landscaping scheme. Discoloration of concrete.

Table D1 Classification of Consequence

Classification	Definition
High Likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollution linkage, and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible, under which an event could occur. However, it is by no means certain that even over a longer period such event would take place and is less likely in the shorter term.
Unlikely	There is a pollution linkage, but circumstances are such that it is improbable that an event would occur even in the long term.

Table D2 Classification of Probability

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probabilit y	**High Likelihood**	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/Low risk	Low Risk	Very Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

Table D3 Definition of Risk (Comparison of Consequence Against Probability)

DATASHEET: GENERAL RISK ASSESSMENT METHODOLOGY (CONT.)

Very High Risk	There is a high probability that severe harm could arise to a designated receptor from an identified hazard, or there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required.
High Risk	Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely to be necessary over the longer term.
Moderate Risk	It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term.
Low Risk	It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild.
Very Low Risk	There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe.

Table D4 Description of the Classified Risks and Likely Action Required

The process described above represents the general qualitative risk assessment methodology used by Harrison Group Environmental in the context of the report in which it was represented and may not necessarily be transferable to all situations.

DATASHEET: GROUNDWATER SCREENING VALUE

Appropriate water quality standards and screening thresholds were selected to assess existing groundwater quality using selected indicator contaminants. Specifically, the groundwater screening values were selected from the following published limits and guideline values:

EA, 2016, FRESH WATERS SPECIFIC POLLUTANTS AND OPERATIONAL ENVIRONMENTAL QUALITY STANDARDS (EQS)1

The EA has compiled applicable Environmental Quality Standards (EQS) for the assessment of surface water discharges from the following key sources:

- The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015
- The Groundwater (Water Framework Directive) (England), Direction 2016

The following EQS values are presented:

- EQS-AA - This is the Annual Average standard, sometimes referred to as the long-term standard. Releases for assessment against this standard are often called ‘long-term’ releases.
- EQS-MAC -This is the ‘Maximum Allowable Concentration’, sometimes referred to as the short-term standard. It is normally represented as a 95-percentile concentration over a year. Releases for assessment against this standard are often called ‘short-term’ releases.

THE WATER FRAMEWORK DIRECTIVE (STANDARDS AND CLASSIFICATION) DIRECTIONS (ENGLAND AND WALES) 2015. THE WATER FRAMEWORK DIRECTIVE (WFD) (2000/60/EC).

As part of the WFD implementation, 90th percentile standards are included for biochemical oxygen demand (BOD) and total ammonia, defining the water quality (high, good, moderate, poor) associated with different pollutant levels[2]. These are summarised in table 1 below:

Type of standard	Total ammonia (mg NH_4-N/l)	BOD (mg/l)
High	0.3	4
Good	0.6	5
Moderate	1.1	6.5
Poor	2.5	9

Table 1 WFD 90th percentile Standards for Ammonia and BOD in Rivers

SOCIETY OF BROWNFIELD RISK ASSESSMENT (SoBRA), 2017, DEVELOPMENT OF GENERIC ASSESSMENT CRITERIA FOR ASSESSING VAPOUR RISKS TO HUMAN HEALTH FROM VOLATILE CONTAMINANTS IN GROUNDWATER. VERSION 1.0

SoBRA has published a selected list of generic assessment criteria (GAC_{gwvap}) aiming to aid in the assessment of vapour risk arising from volatile contaminants in groundwater in the UK. The GAC_{gwvap} are intended as a conservative screening tool that may be used to aid in assessing long-term risks to human health from inhalation of vapours arising from contaminant-impacted groundwaters and accumulating in an indoor space.

The GAC_{gwvap} have been developed in line with UK risk assessment guidance (e.g., DEFRA and Environment Agency. They have been derived for two land use scenarios (residential and commercial) using generic assumptions regarding site setting, soil types, building construction, and receptor behaviour, though GAC_{gwvap} parameter values are precautionary for many commercial and residential properties.

DRINKING WATER STANDARDS

Since the bedrock aquifer at the site is classified as a ‘Principal Aquifer’, drinking water standards for the protection of public health were also included as part of the screening values. The values were selected according to the following hierarchy of source references:

- Schedule 1 - The Water Supply (Water Quality) Regulations 2016 (Drinking Water Standards)
- World Health Organization, 2011, Guidelines for drinking-water quality, fourth edition

Petroleum Hydrocarbons

There are no EQS or UK Drinking Water Standards for Total Petroleum Hydrocarbons (TPH) or aggregated TPH Fractions. EQS values have been published for individual constituent compounds (benzene, toluene, ethylbenzene) and PAH compounds; these have been compiled from the sources reviewed above. Recent guidance regarding the selection of groundwater screening values for TPH fractions has been provided in the following:

- CL:AIRE, 2017. Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies. CL:AIRE, London. ISBN 978-1-905046-31-7[3].

Table 2 summarises the fraction specific ground water quality standards reviewed in the CL:AIRE report (WHO Drinking Water Quality Guidelines, 2008)[4], which have been applied for reported TPH fractions. It is noted that the fractions analysed in this study do not exactly correspond to the published fractions. In that case, the lowest value for a published fraction included within the analysed range was used.

1 https://www.gov.uk/guidance/surface-water-pollution-risk-assessment-for-your-environmental-permit
[2] 90th percentile standards are standards require derivation of the 90th percentile for the monitored concentrations over a minimum of 8 quarterly sampling rounds over a 2-year period.
[3] Download at www.claire.co.uk/phg.
[4] World Health Organization (WHO), 2008. Petroleum products in drinking-water. Background document for development of WHO guidelines for drinking water quality. WHO/SDE/WSH/05.08/123.

TPH Fraction	Aliphatic fraction (μg/l)	Aromatic fraction (μg/l)
EC>5-EC6	15000	10 (benzene)
EC>6-EC8	15000	700 (toluene)
EC>8-EC10	300	300 (ethylbenzene), 500 (xylenes)
EC>10-EC12	300	90
EC>12-EC16	300	90
EC>16-EC21	-	90
EC>21-EC35	-	90

Table 2 Recommended Groundwater Screening Values based on WHO Drinking Water Guidelines

APPENDIX B
DRAWINGS

FM-Hn-D-0001

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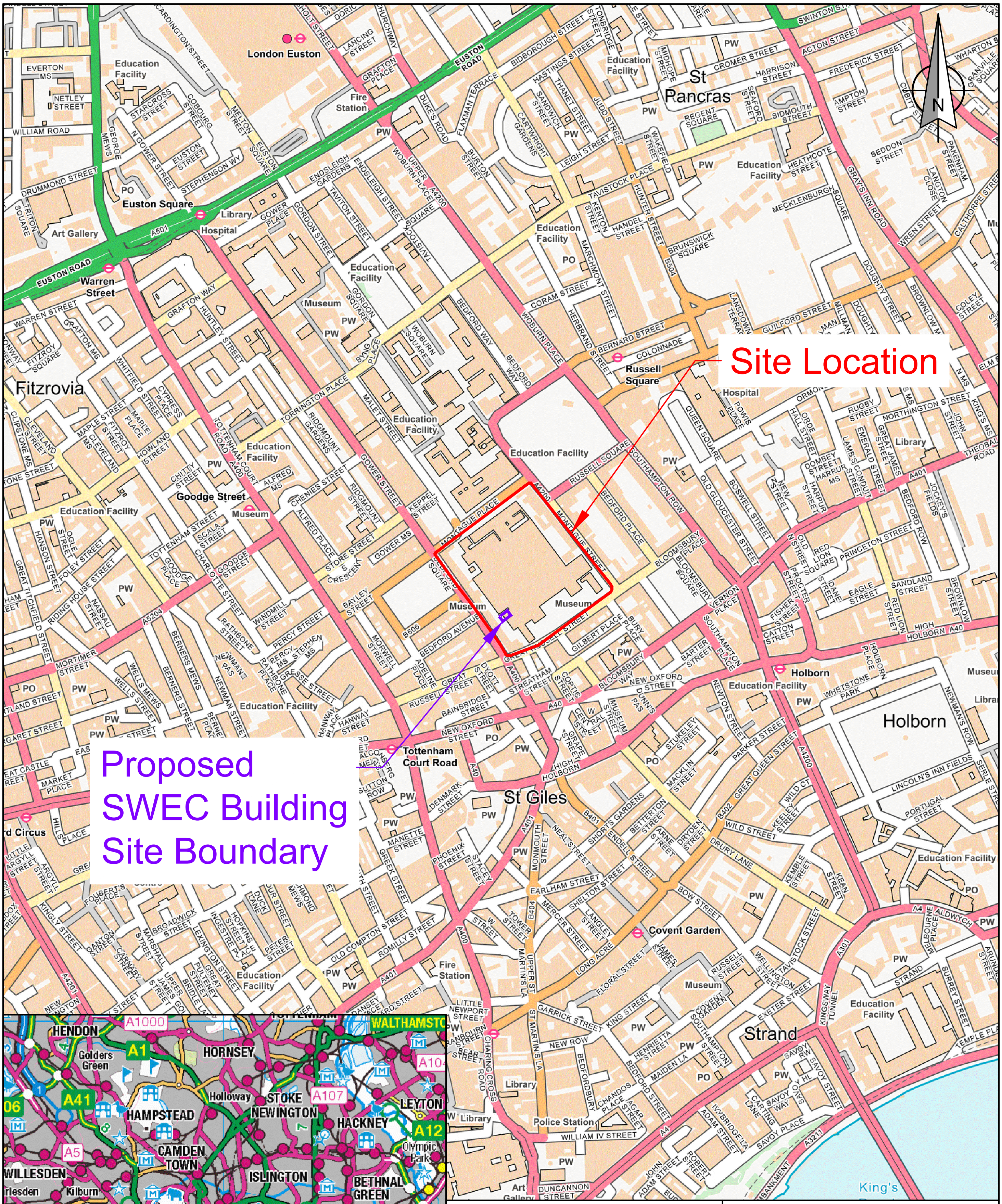

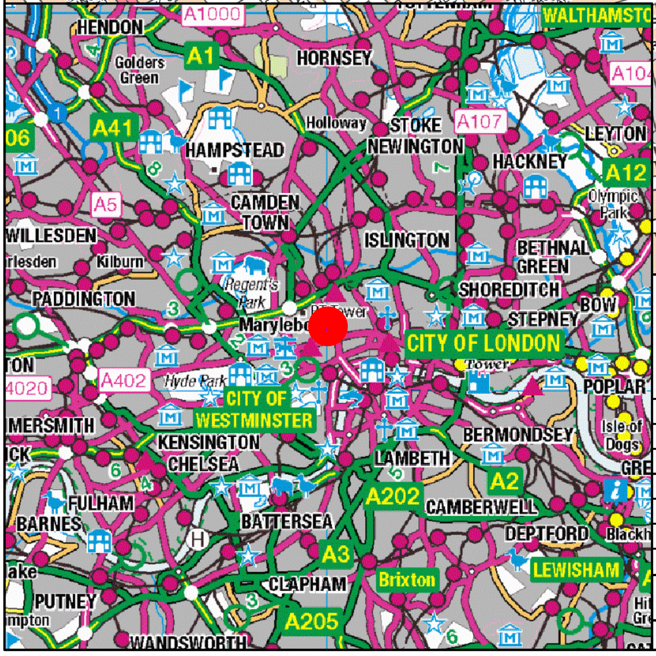

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Client : Steadberry Restoration Ltd	
Project : British Museum	
Job No : GL25243	Date : November 2022
Drawing No : GL25243 - DR101	
Scale : 1:10000 @ A4	
Drawn by : ES	Checked by : JK
Eastings : 530050	Northings : 181720

Certificate Number 5933
ISO 9001, ISO 14001

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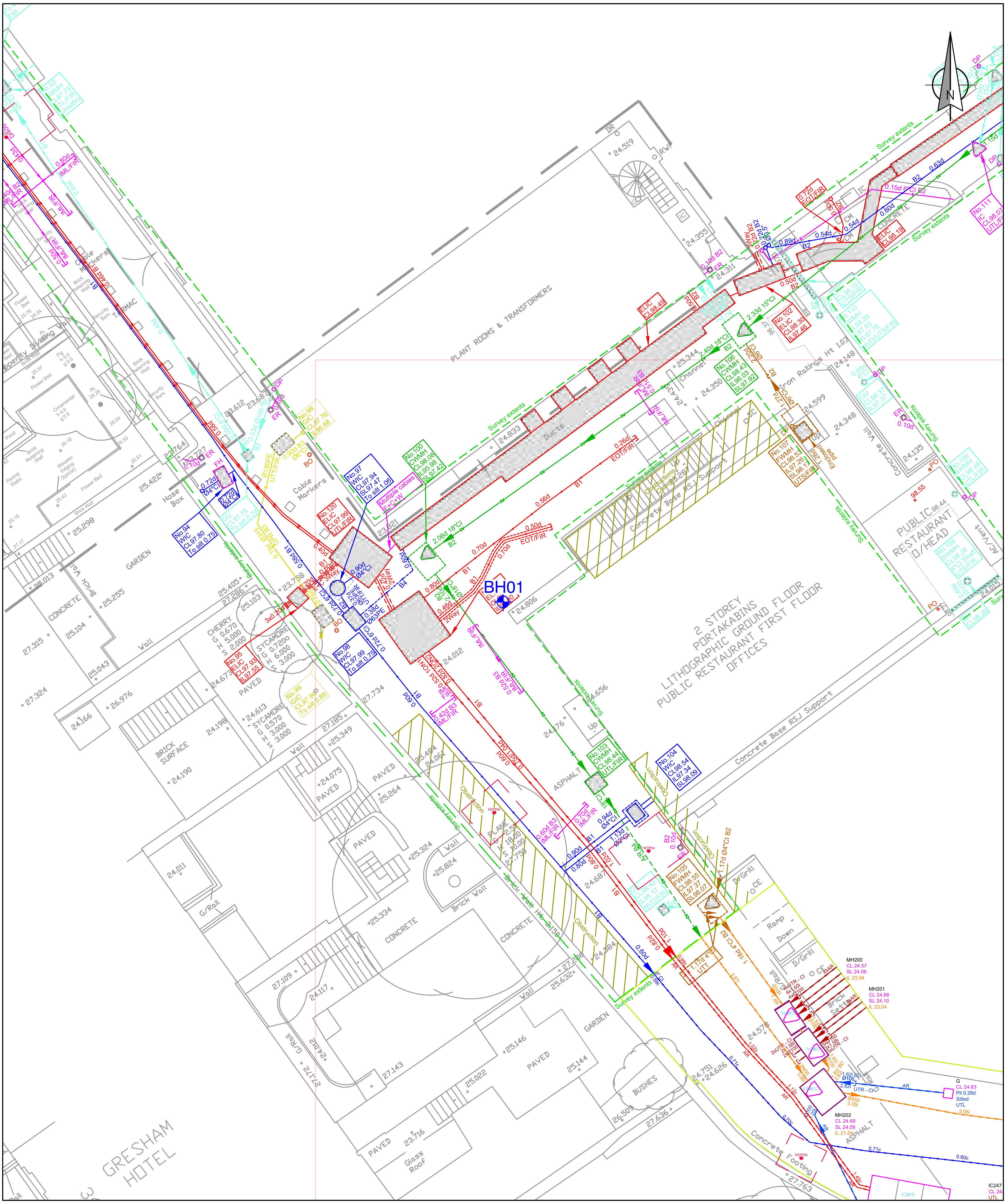

Client : Steadberry Restoration Ltd

Project : British Museum

Job No : GL25243 Date : July 2022

Drawing Title : Proposed Fieldwork Location Plan - BH01

Drawing No : GL25243 - DR002Q

Scale : 1:150 @ A3

Drawn by : ES Checked by : JK

Eastings : 530003 Northings : 181621

Revision history

Rev	Date	Revision Data

Key :

Site Boundary	
BH01	Cable Percussive Borehole

Utility Legend

EHV	Extra High Voltage Electricity	FWS	Foul Drainage
HV	High Voltage Electricity	SWS	Surface Drainage
LV	Low Voltage Electricity	CWS	Combined Drainage
SL	Street Lighting	EWS	Effluent Drainage
TS	Traffic Signals		
CATV	Cable Television	O	Offset Fill-Line
CCTV	Closed Circuit Television	V	Vent Line
COM	Communications	F	Fuel Line
BT	British Telecoms	VR	Vapour Recovery
FO	Fibre Optics	G	Gauge Line
GAS	Gas	OIL	Oil Pipe
HPG	High Pressure Gas	P	Heating Pipe
IPG	Intermediate Pressure Gas	ED	Empty Duct
W	Water		Chamber Extents
UNK	Unknown Asset		Approx. CE

Notes :

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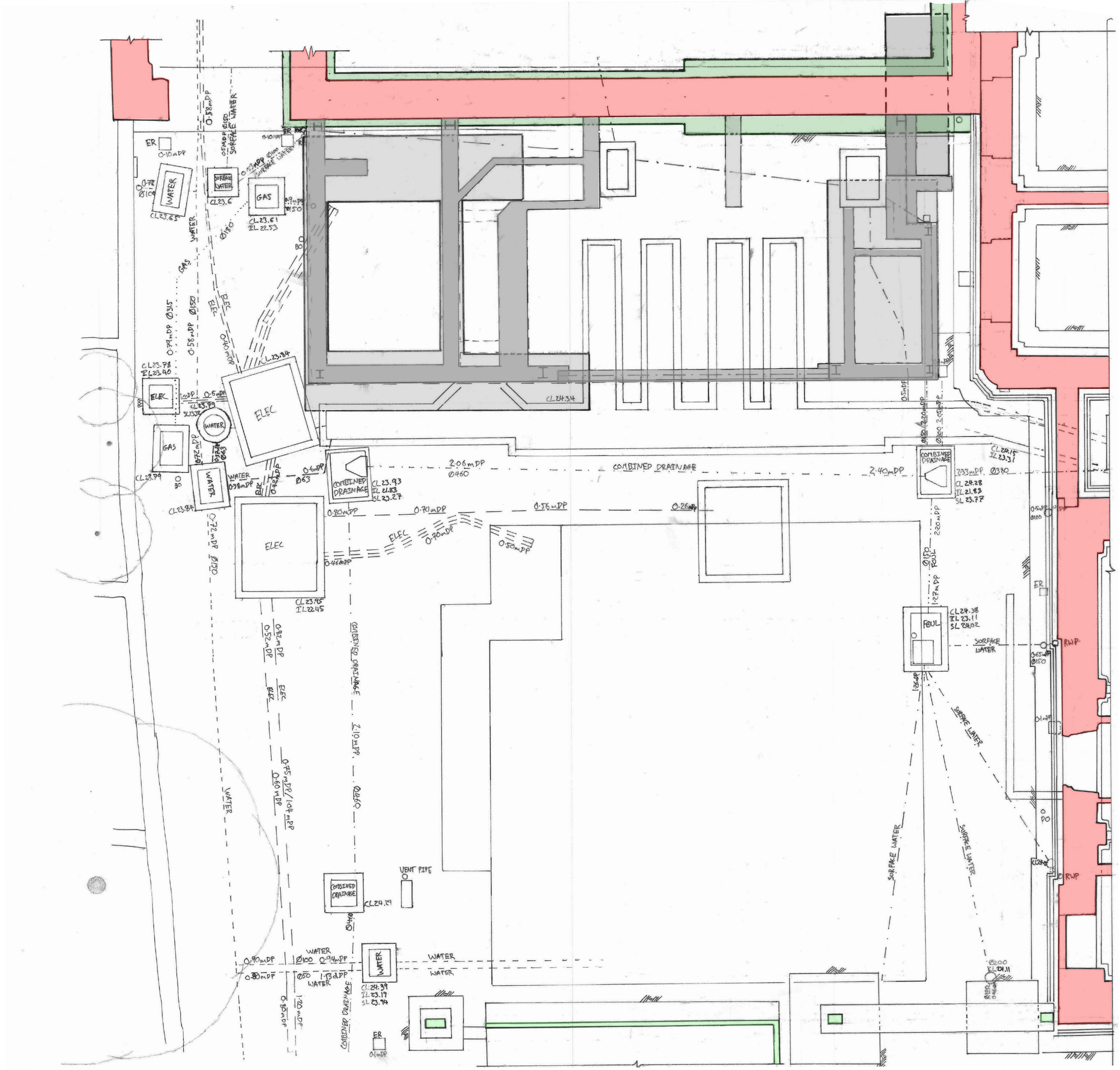
ISOQAR REGISTERED UKAS MANAGEMENT SYSTEMS 0026 UKAS TESTING

Certificate Number 5933 4031
ISO 9001, ISO 14001



notes

1. This drawing is to be read in conjunction with all relevant Architect's and Engineer's drawings and the specification.

KEY

- Reinforced Concrete
- Existing Masonry
- Existing SWEC Ground Beams
- Existing SWEC Mass Concrete Foundations

-	04.11.22	ISSUED FOR INFORMATION	LK

job

BRITISH MUSEUM SOUTH WEST ENERGY CENTRE

title

SWEC EXISTING SITE PLAN

drawn	checked
ZW	LK
date	scale (original - A1)
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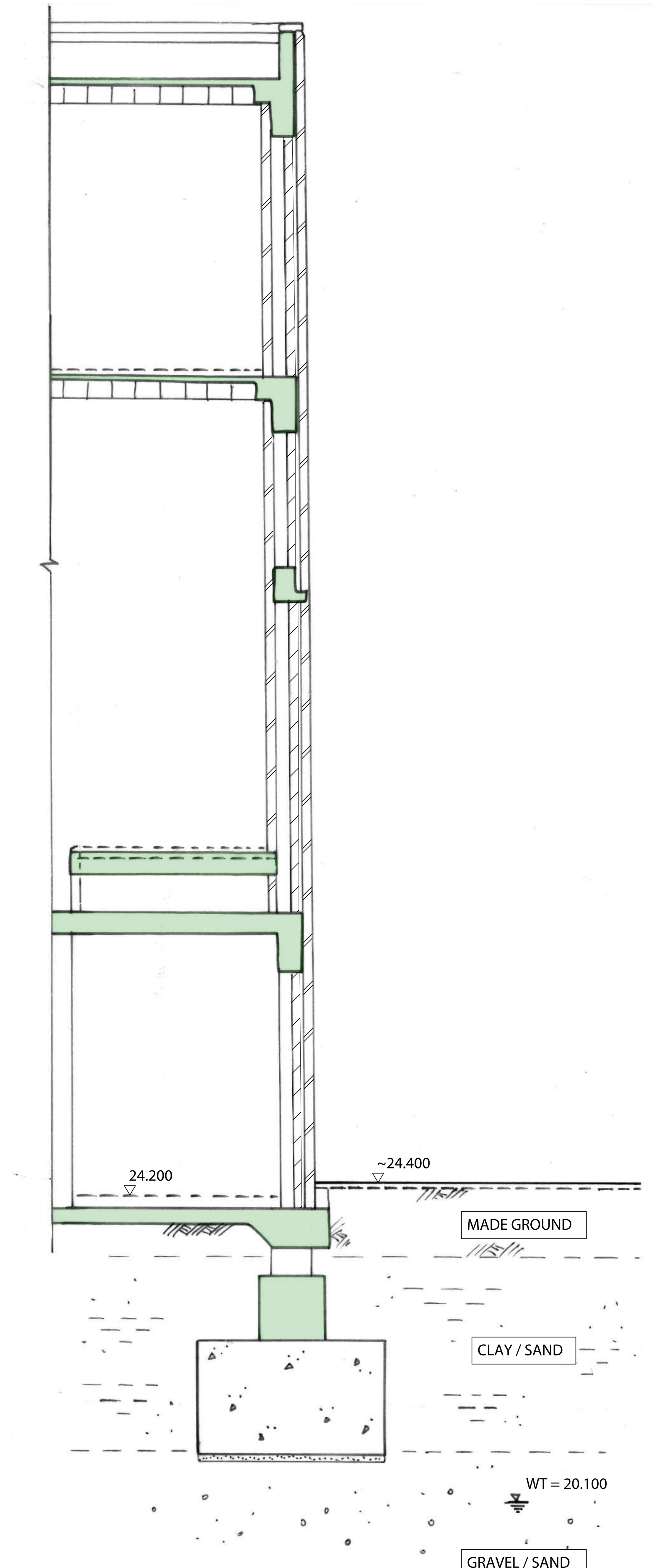
drg. no.	rev.
1910/41/100	**-**



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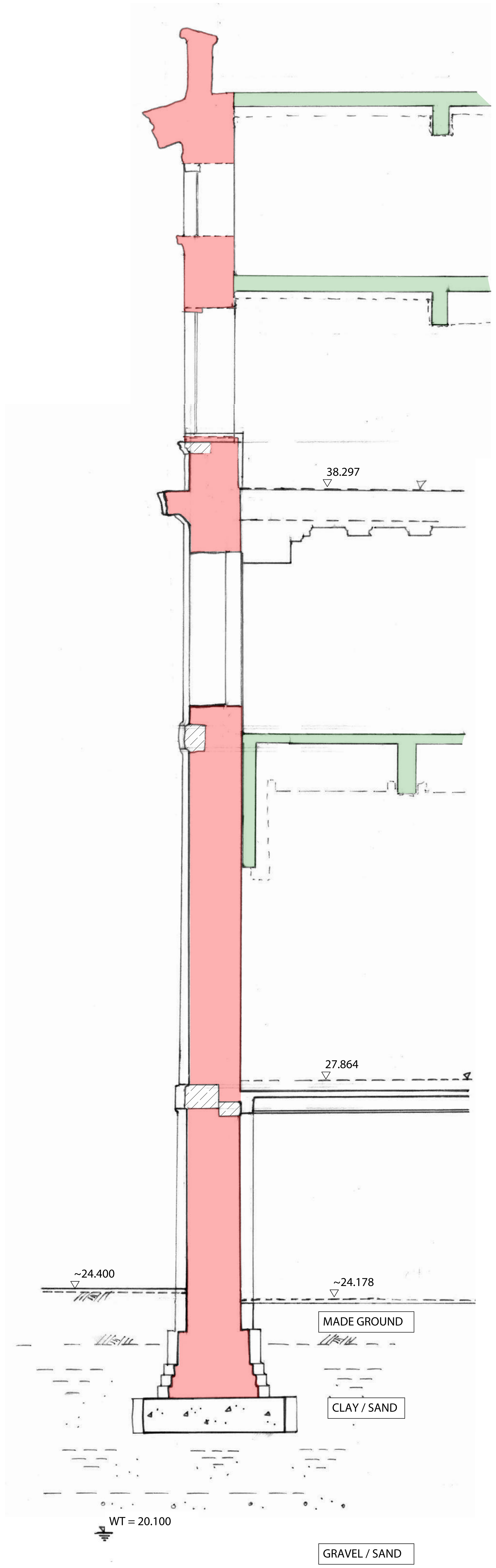

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notes

1. This drawing is to be read in conjunction with all relevant Architect's and Engineer's drawings and the specification.

rev.	date	description	checked
-	04.11.22	ISSUED FOR INFORMATION	LK

job

BRITISH MUSEUM SOUTH WEST ENERGY CENTRE

title

EXISTING STRUCTURE
LOCAL SECTIONS
SHEET 1

drawn: RG/ZW	checked: LK
date: AUG '22	scale (original - A1): 1:50

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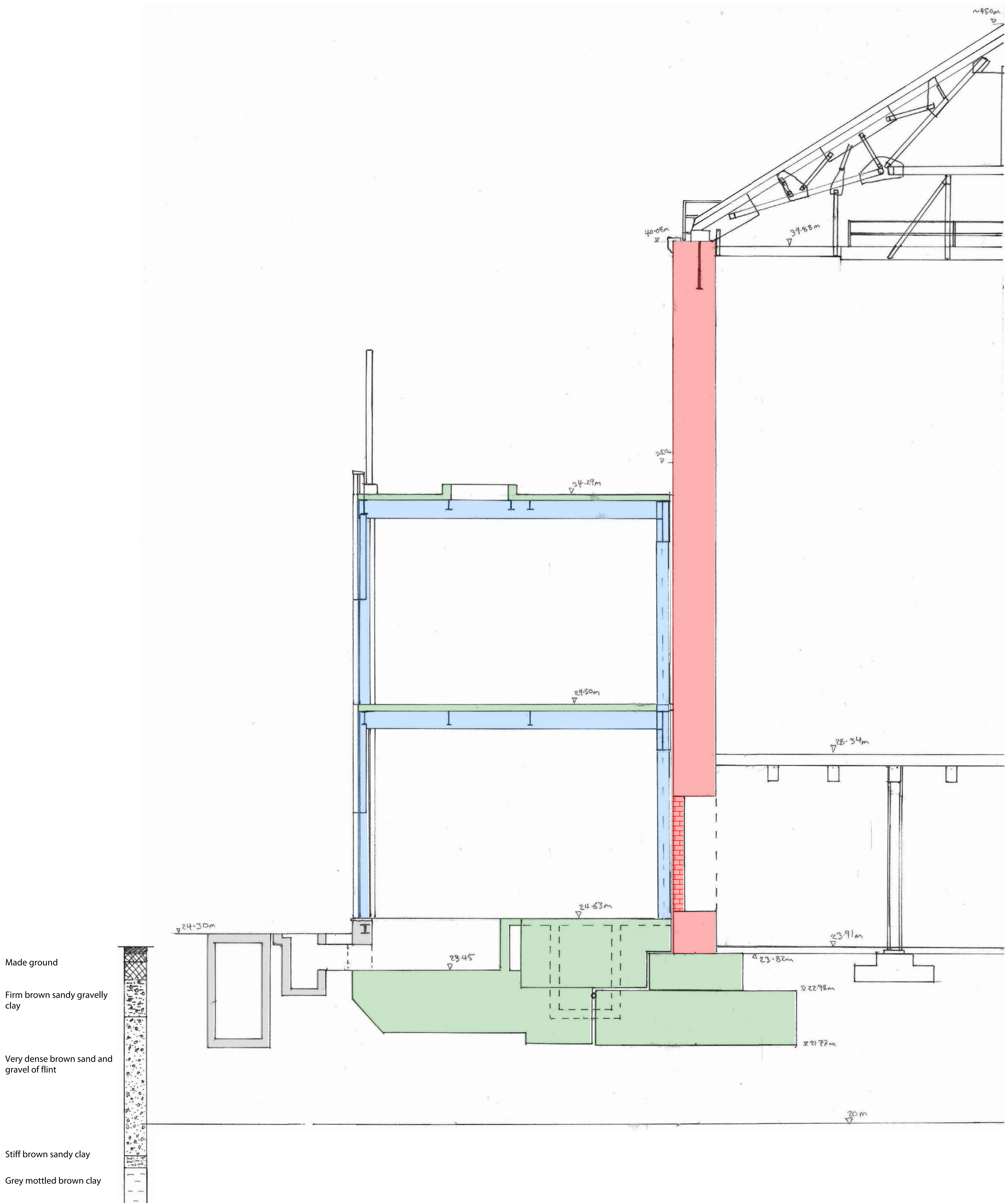
rev. **-**



notes

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BRITISH MUSEUM SOUTH WEST ENERGY CENTRE

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SWEC EXISTING STRUCTURE SECTIONS SHEET 2

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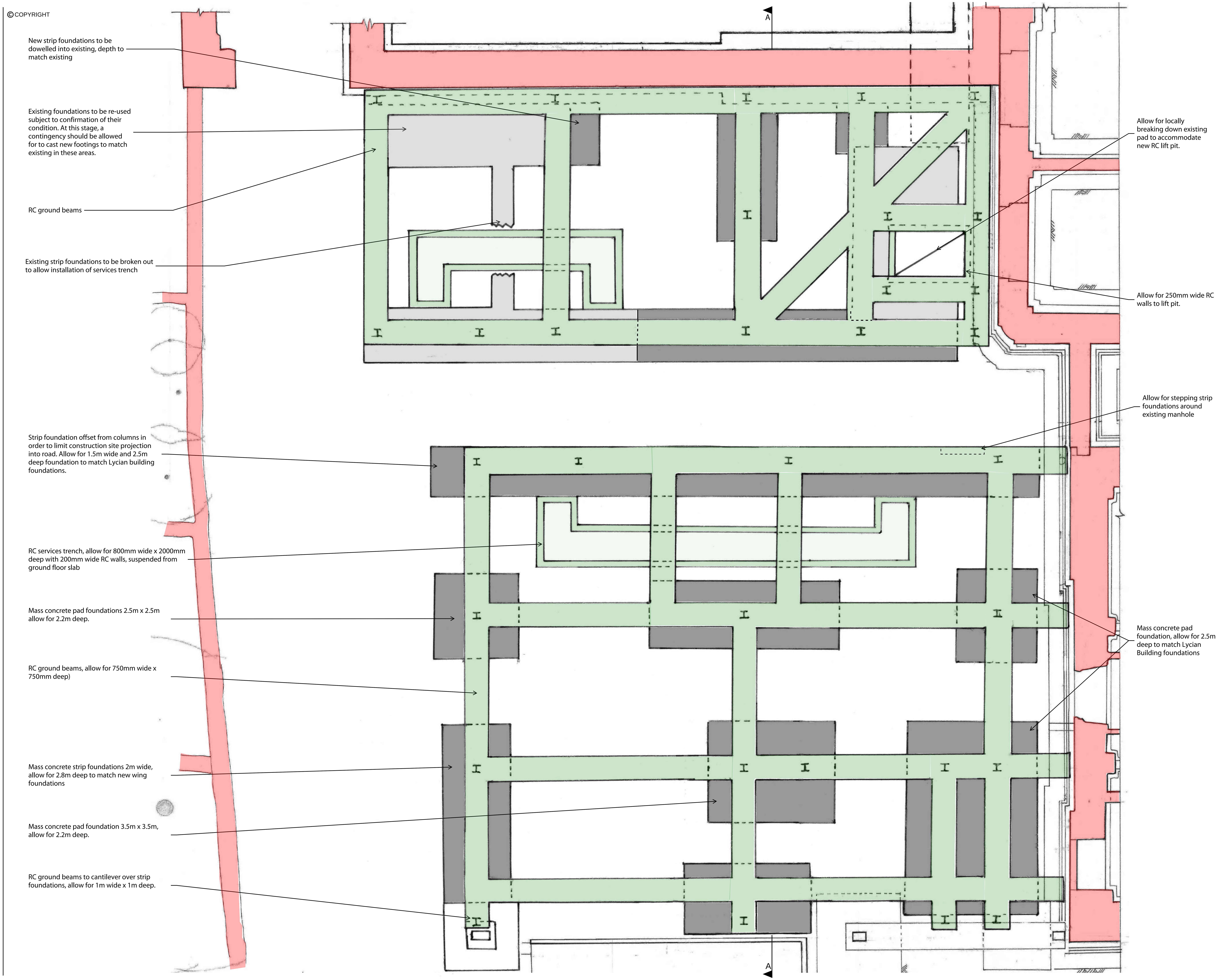

notes

1. This drawing is to be read in conjunction with all relevant Architect's and Engineer's drawings and the specification.

KEY

- Existing Mass Concrete Foundations
- Proposed Mass Concrete Foundations
- Proposed Reinforced Concrete
- Existing Masonry

-	04.11.22	ISSUED FOR INFORMATION	XT

job

BRITISH MUSEUM SOUTH WEST ENERGY CENTRE

title

PROPOSED SOUTH WEST ENERGY CENTRE FOUNDATION PLAN

drawn	checked
XT	LK
date	scale (original - A1)
OCT'22	1:50

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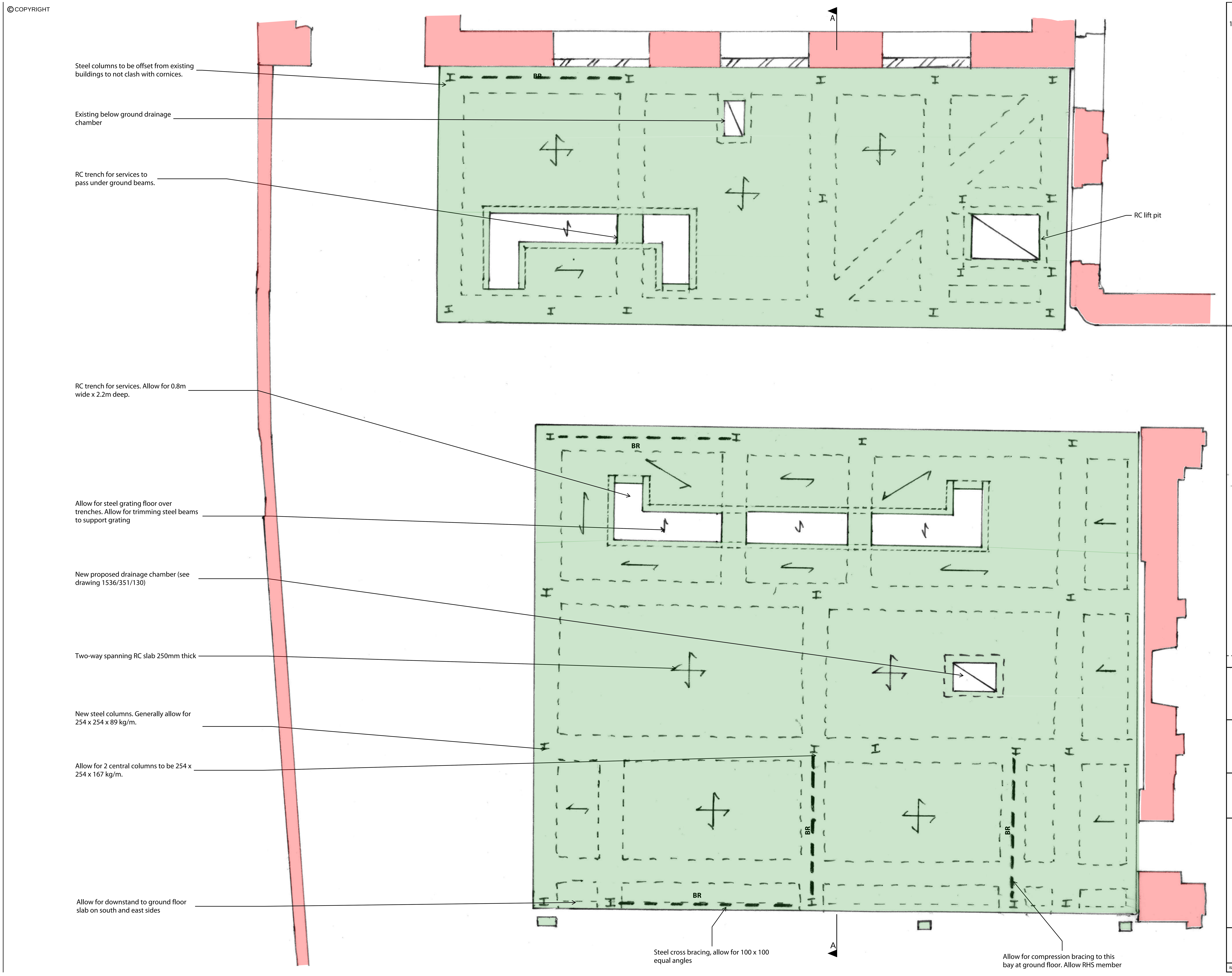
1941/41/110	-



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KEY

- Proposed Reinforced Concrete
- Existing Masonry

rev.	date	description	by
-	04.11.22	ISSUED FOR INFORMATION	XT

job
BRITISH MUSEUM SOUTH WEST ENERGY CENTRE

title
PROPOSED SOUTH WEST ENERGY CENTRE GROUND FLOOR PLAN.

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XT	LK
date	scale (original - A1)
OCT '22	1:50

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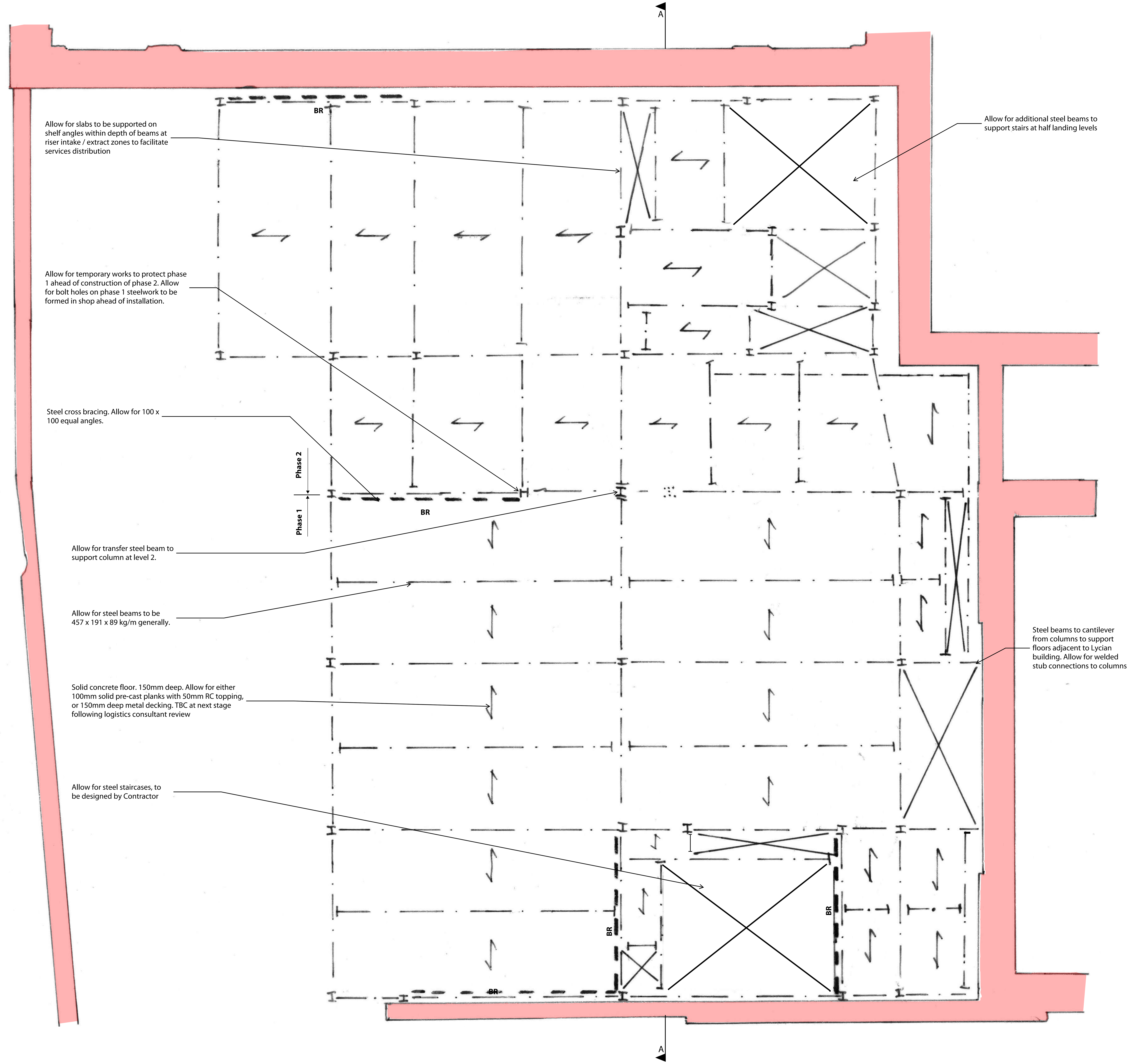

notes

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-	04.11.22	ISSUED FOR COMMENT	XT

job

BRITISH MUSEUM SOUTH WEST ENERGY CENTRE

title

PROPOSED SOUTH WEST ENERGY CENTRE - LEVEL 02 SUPERSTRUCTURE PLAN.

drawn	checked
XT	LK
date	scale (original - A1)
OCT '22	1:50

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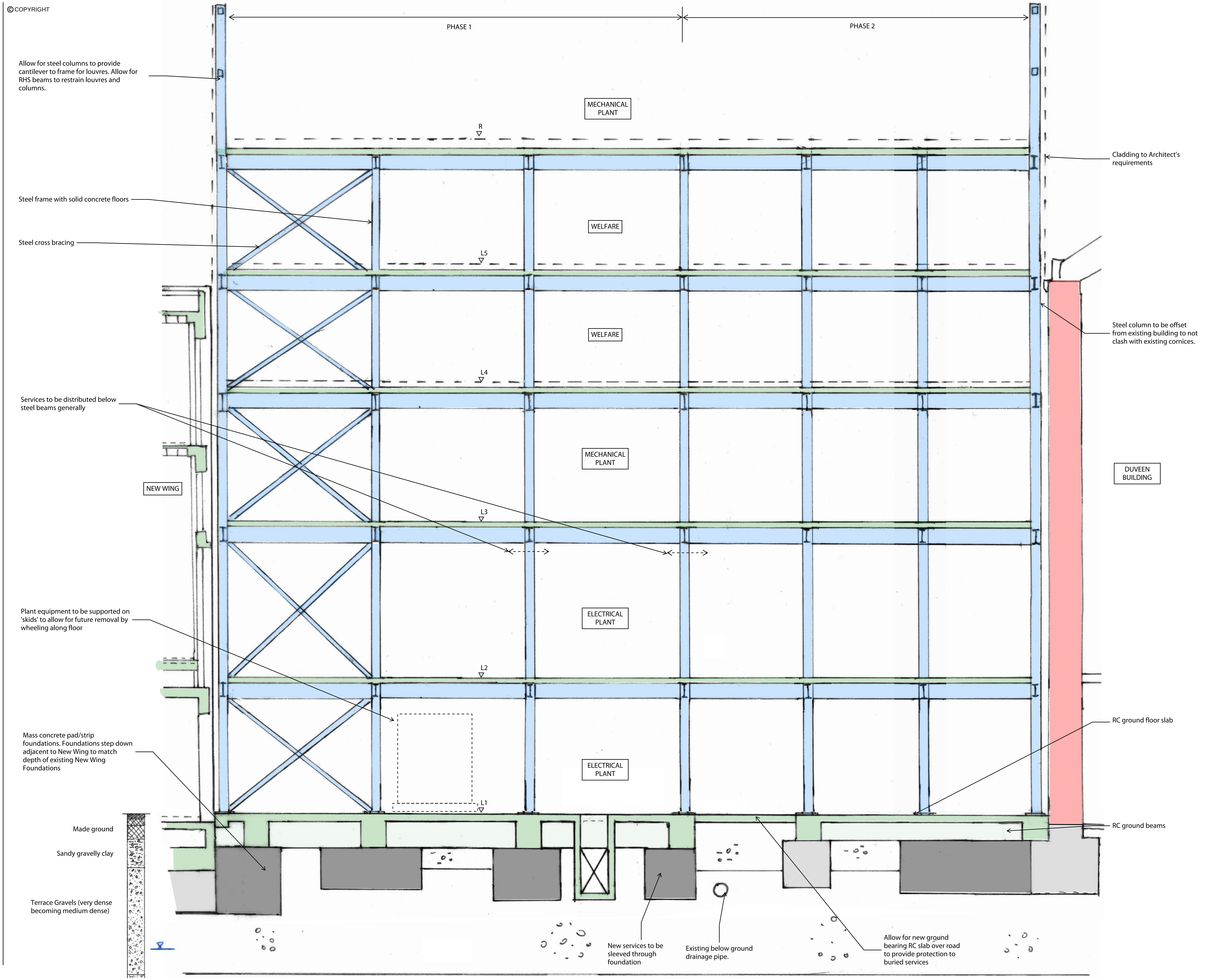

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1. This drawing is to be read in conjunction with all relevant Architect's and Engineer's drawings and the specification.

KEY

Existing Mass Concrete Foundations

Proposed Mass Concrete Foundations

-	04.11.22	ISSUED FOR INFORMATION	Chk

job

BRITISH MUSEUM SOUTH WEST ENERGY CENTRE

title

PROPOSED SOUTH WEST ENERGY CENTRE SECTION A-A

drawn	checked
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date	scale (original - A1)
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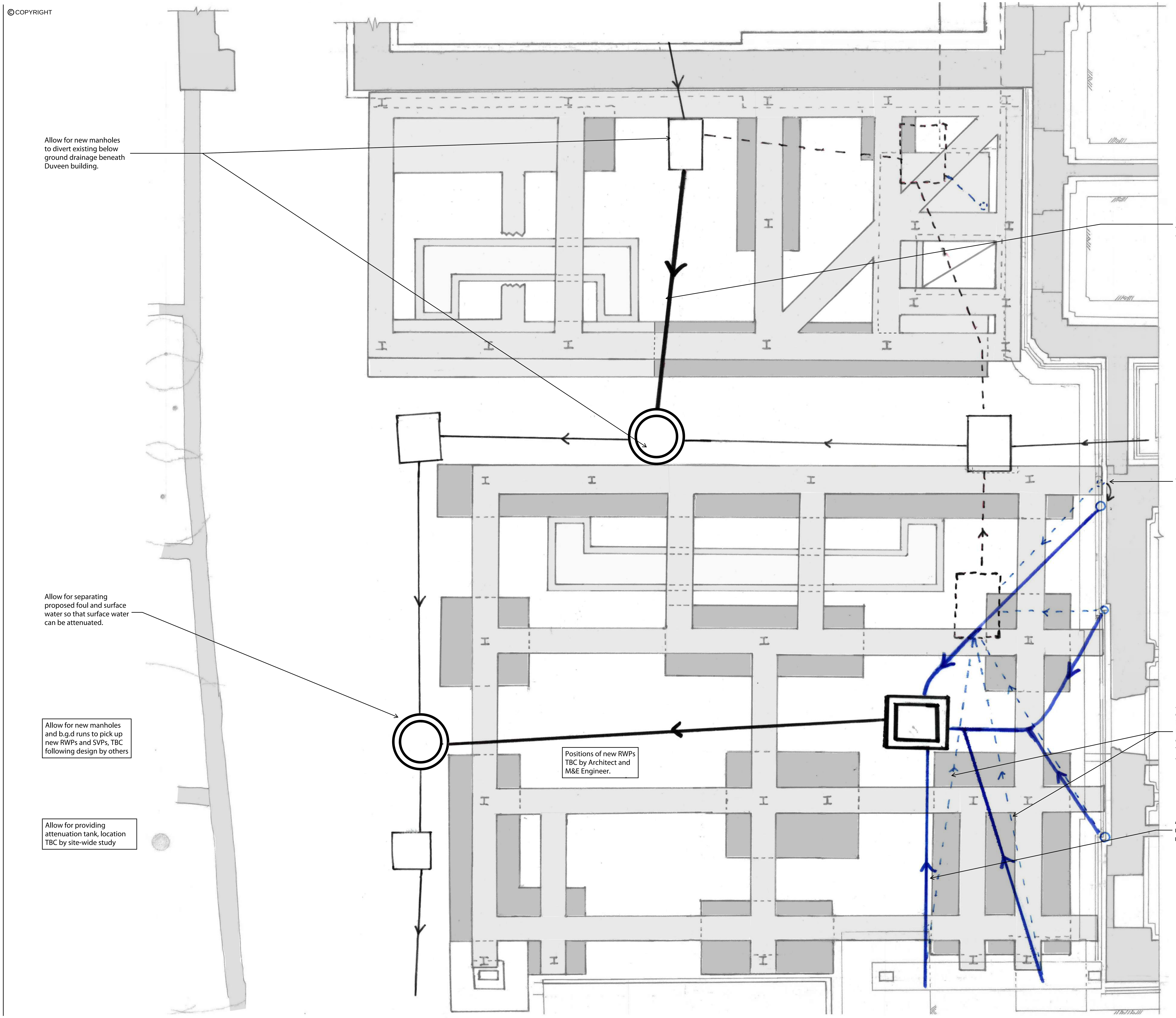

notes

1. This drawing is to be read in conjunction with all relevant Architect's and Engineer's drawings and the specification.

KEY

- Proposed combined water drainage pipe
- Existing combined water drainage pipe
- Proposed surface water drainage pipe
- Existing surface water drainage pipe to be abandoned & grubbed up
- Existing combined water drainage pipe to be abandoned & grubbed up
- Existing manhole to be abandoned and broken out
- Existing manhole
- Proposed manhole

-	04.11.22	ISSUED FOR INFORMATION	XT

job

BRITISH MUSEUM SOUTH WEST ENERGY CENTRE

title

PROPOSED BELOW GROUND DRAINAGE ALTERATION

drawn	checked
XT	LK
date	scale (original - A1)
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1941/41/130	-

APPENDIX C
BACKGROUND INFORMATION

HARRISON GROUP ENVIRONMENTAL LIMITED

Document: **Desk Study Report**

Project: **The British Museum (Proposed SWEC)**

Reference No.: **GL25243**

Date: **December 2022**

Prepared For: **Steadberry Restoration Ltd**

REPORT STATUS:

Revision	Comments	Prepared By	Approved By	Issued By	Audited By
Rev0		Init JBL Sign Comments Date 25/11/2022	Init JK Sign Comments Date 08/12/2022	Init JBL Sign Comments Date 25/11/2022	Init JK Sign Comments Date 08/12/2022
		Init Sign Comments Date	Init Sign Comments Date	Init Sign Comments Date	Init Sign Comments Date
		Init Sign Comments Date	Init Sign Comments Date	Init Sign Comments Date	Init Sign Comments Date
		Init Sign Comments Date	Init Sign Comments Date	Init Sign Comments Date	Init Sign Comments Date

Document:	**Desk Study Report**
Project:	**The British Museum (Proposed SWEC)**
Reference No:	**GL25243**
Date:	**December 2022**
Prepared For:	**Steadberry Restoration Ltd**

harrisongeotechnical
ENGINEERING

A division of Harrison Group Environmental Limited

CONTENTS

FOREWORD

General Conditions Relating to A Desk Study Report

This investigation has been devised to generally comply with the relevant principles and requirements of BS10175:2011+A2:2017 'Investigation of potentially contaminated sites - Code of practice', the 'Land contamination: technical guidance' collection (Environment Agency, 2016) and 'Land contamination: risk management' (Environment Agency, 2019) and BS EN 1997 (Eurocode 7). This report is a preliminary stage of investigation designed to identify potential contamination hazards and undertake preliminary hazard assessment, as such it is possible that further work may be recommended based on the findings.

The recommendations made and opinions expressed in this report by the writers are based on the information obtained from the sources described using a methodology intended to provide reasonable consistency and robustness.

The desk study has been compiled and extended into hazard identification and assessment in line with the risk-based methods referred to in Part IIA of the Environment Protection Act 1990, introduced by section 57 of the Environment Act 1995 and brought into force in April 2000.

Information gained during the initial stages of the desk study was collated to form a conceptual ground model of the site, which detailed the characteristic ground conditions and the elements of the surrounding environment. The ground model assists with identifying the potential sources of contamination, the possible receptors to the contamination and the conceivable pathways between them. It is referred to as the source-pathway-receptor linkage (or pollutant linkage), and is defined in Part IIA of the Environment protection Act 1990, and is in accordance with BS10175:2011+A2:2017.

Some items of the desk study have been provided by third parties and whilst Harrison Group have no reason to doubt the accuracy, the items relied on have not been verified. No responsibility can be accepted for errors within third party items presented in this report.

Parts of the study based on non-invasive techniques cannot guarantee that the area investigated has the properties described in the report. Furthermore, there may be additional issues on the site, not foreseen during the survey, which involve potentially hazardous substances.

This report is produced in accordance with the scope of Harrison Group's appointment and is subject to the terms of appointment. Harrison Group accepts no liability for any use of this document other than by its client and only for the purposes, for which it was designed and produced. No responsibility can be accepted for any consequences of this information being passed to a third party who may act upon its contents/recommendations.

Any advice, opinions, or recommendations within this document should be read and relied upon only in the context of the document as a whole. The contents of this document are not to be construed as providing legal, business or tax advice or opinion.

CLIENT SUMMARY

Location	The site was located within the grounds of the British Museum in central London. The site can be accessed from Great Russell Street, London, WC1B 3DG centred at approximate National Grid Reference (NGR) 530008, 181621.
Previous Site Use	The site is known to have been heavily influenced by human activity to as far back as the Roman period, and especially from c. 1643 onwards, when the large scale earthworks of the 'Lines of Communication' were undertaken in very close proximity to the site during the Civil War. Various incarnations of Montagu House and the British Museum followed, with the surrounding farmland yielding to urbanization by the turn of the 19th century until Montagu House was surrounded on all sides by high-status residential townhouses and their gardens. From the mapping available, the site is shown to have been part of the gardens of the terraced townhouses lining Charlotte Street, the present day Bloomsbury Street, from the late 19th century until the 1950s. The British Museum expanded their site boundary at this time to incorporate much of these gardens, including the proposed site. A new building, part of the Museum, was shown to have been present on-site until the early 1980s, at which point the building was demolished and the site remained vacant once again. Although the mapping available does not detail the modern building present on-site, it is assumed this was constructed during the early 2000s.
Current Site Use	At the time of the walkover the site was in active use as a service road and partially occupied by a two storey modular building, used for office space, kitchens, and welfare facilities. Part of the site was also used for waste storage. Where not developed by buildings the site surface was primarily covered by asphalt hardstanding.
Proposed Site Usage	We understand it is proposed to construct a new energy centre (SWEC) to supply the British Museum. It is currently not known if the proposed development includes any soft landscaped areas, or if all external areas are proposed for hardstanding.
Geology/Hydrology	The site is detailed to be underlain by superficial deposits of the Lynch Hill Gravel Member deposits (sand and gravel). Underlying the superficial deposits, the solid geology is detailed as the London Clay Formation. 16 No. boreholes are recorded within 50m of the site. The closest BGS borehole (TQ38SW2081) was located on site and detailed made ground and intact brickwork to 1.30mbgl, overlying dense sands and gravels of the 'Taplow Gravel Member' to 5.40mbgl. London Clay Formation was recorded below to the final borehole depth of 15mbgl. 1 No. record of unknown made ground was recorded within 250m of the site, situated 217m to the west of the site. Information from the historical boreholes indicates the water table is expected to be approximately 4mbgl, situated within the superficial Lynch Hill Gravel Member. The aquifer status of the site is linked to the underlying soil types. The superficial geology of the Lynch Hill Gravel Member is designated as a Secondary A aquifer and the solid geology London Clay Formation is classified as unproductive.
Background Information	No active groundwater abstraction licences (above 20m^3 per day), surface water abstractions or potable abstractions were noted within 250m of the site. The closest active groundwater abstraction is located some 277m northwest of the site and is detailed as a heat pump. The closest abstraction associated with a Potable Water Supply is located some 923m west, detailed as drinking, cooking, sanitary and washing. The closest active surface water abstraction is located some 1912m to the north for non-evaporative cooling from the River Thames. The site is not situated within a source protection zone. No surface water features are recorded within 250m of the site. It should be noted that the River Thames is located approximately 1.2km to the southeast of the site. The site is located within a coastal catchment of the Water Framework Directive. A negligible risk is considered from surface water flooding. A moderate risk is considered from groundwater flooding. The site is located within a SSSI Impact Risk Zone. The site is in an area where less than 1% of homes are affected by radon is recorded by data obtained from the British Geological Survey and Public Health England. As such, no further assessment is deemed necessary and radon protection measures are not required at this location. Free-to-access online UXO information suggests a high risk is considered. It is recommended that a Detailed UXO Risk Assessment is undertaken for the site.

Geotechnical Hazards	The potential for uncontrolled backfill and relict structures have been identified as potential geotechnical hazards. An intrusive geotechnical investigation is recommended across the site prior to any construction, to allow for adequate design of foundations and to confirm the geology. The potential presence of a considerable thickness of dense granular Lynch Hill Gravel Member and the anticipated loads associated with the proposed structures are likely to make shallow foundations (including rafts) a suitable foundation solution although the proximity of nearby structures, the unknown foundational detailing of these structures and there ability to tolerate additional settlement needs to be considered when making a foundation choice. Consideration of the sulphate content of the soils should be given with respect to the grade of concrete suitable for use at this location. The density and permeability of shallow soils should be assessed in order to consider pavement and drainage design. The likely granular nature of the superficial deposits covering the site, suggest that conventional soakaways maybe suitable in the absence of significant made ground deposits. Although groundwater levels will need to be confirmed. Examination of available historic map data shows since the 1950s a portion of the site has been occupied by buildings intermittently. Unless they and all existing underground structures are thoroughly ‘grubbed out’, demolition of the existing buildings may lead to the presence of relict substructures. There is also the possibility for underground services to cross the site.
Contamination	The site is currently partially occupied by a temporary 3-storey modular building, providing office, welfare, and kitchen facilities. The site also covers a portion of the west service road to the Museum, comprising of tarmac hardstanding and a waste storage area. During a long history, the site is shown to have been part of the gardens of the terraced townhouses lining present day Bloomsbury Street, from the late 19th century until the 1950s. The British Museum expanded their site boundary at this time to incorporate much of these gardens, including the proposed site. A new building, part of the Museum, was shown to have been present on-site until the early 1980s, at which point the building was demolished and the site remained empty once again. It is assumed the present day structure was constructed during the early 2000s. Given the recent construction of the building on-site it is assumed that no asbestos is present. However, the presence of ACM cannot be ruled out and an asbestos survey is recommended. The soils should also be investigated for the potential presence of ACM. No historic or current underground or overground tanks were identified on-site. Localised areas of waste storage were observed on-site which could be a potential source for contamination. Prior to the commencement of any redevelopment, we would advocate direct investigation and assessment in order to identify whether contamination is present, and whether a significant risk exists to people using the site and to controlled waters (groundwater – secondary A aquifer).
Recommendations	The basic requirement for redevelopment standards in the UK is that land should be ‘suitable for use’ or ‘fit for purpose’, rather than apply a blanket ‘clean’ or ‘all uses policy’. It is important to consider the limited nature of this investigation, and the possibility of as yet unknown contaminant sources existing. The potentially contaminative uses and geotechnical hazards identified on site lead us to the conclusion that intrusive investigation is appropriate before the site can be considered suitable without remedial action. The investigation should include an assessment of the potential for contaminated soil from the historic uses of the site and the potential for migration of contamination from surrounding areas. However, based on the information available, it is not considered likely that gross contamination is likely to be present which may otherwise limit the development potential. Intrusive investigation of the site should be reserved by a pre-commencement condition.

PHASE ONE ASSESSMENT (DESK STUDY REPORT)

FOR A SITE AT

THE BRITISH MUSEUM (PROPOSED SWEC)

1 TERMS OF REFERENCE & INTRODUCTION

The work covered by this report was undertaken on behalf of Steadberry Restoration Ltd (Client), in accordance with Harrison Geotechnical Engineering (HGE) quotation GL25243 - The British Museum - Quote 1 BoQ Rev 2 dated July 2022. The work was undertaken in accordance with the relevant specification Ref. 1910/40/LK/lk and drawing (Ref. 1910/40/02) issued by Alan Baxter Ltd (ABA) who acted as the engineer.

The purpose of the report was to provide environmental and geotechnical information for a site referred to as The British Museum (Proposed SWEC) in order to inform the client of possible hazards prior to potential redevelopment as well as for submission to the local authority as part of the planning process.

The site was located within the grounds of the British Museum in central London. The site can be accessed from Great Russell Street, London, WC1B 3DG centred at approximate National Grid Reference (NGR) 530008, 181621. The site boundary is indicated on drawing GL25243-DR001 presented in the appendix.

At the time of our assessment the site was partially occupied by a temporary 3-storey modular building, providing office, welfare and kitchen facilities. The building appears to have been constructed in the early 2000s according to the historical maps available. The site also covers a portion of the west service road to the Museum, comprising of tarmac hardstanding and a waste storage area.

A copy of the walkover site plan has been presented in the appendix as GL25243-DR002, showing the approximate boundary and the location of features within the site. Representative site photos are presented in the appendix as site walkover photograph plates.

We understand it is proposed to construct a new energy centre to supply the British Museum, as set out in the plans provided by ABA.

It is currently not known if the proposed development has soft landscaped areas or if all external areas are proposed for hardstanding.

A Topographical Survey for the subject site was provided by ABA, undertaken by John Robinson Associates Survey Specialists Ltd (Ref: UM21-669-JRA dated 04/01/21).

2 BACKGROUND INFORMATION

2.1 Site Description

The site under consideration is located in the southwestern corner of the British Museum grounds. The site covers an area of approximately 0.02ha and can be identified by National Grid Reference 530008, 181621. Examination of the supplied topographical survey shows elevation of the site as approximately 24 – 24.5 metres above Ordnance Datum (maOD).

The site is bounded by the main Grade I listed British Museum buildings to the northwest, northeast and southeast. Notably the building immediately to the northwest of the site is the current South West Energy Centre (SWEC), containing a substation, switch room, boiler house, generator room and chiller enclosure. To the southwest, the site is bounded by an approximately 3m high boundary wall, separating the museum from residential and commercial townhouses and associated gardens along Bloomsbury Street. A London plane tree, approximately 18m high is located close to the boundary wall.

The main access into the site was located to the southeast and consisted of an asphalt service road which led from the South West Gate on Great Russell Street. At the time of the walkover the site was in active use as a service road and partially occupied by a two storey modular building, used for office space, kitchens, and welfare facilities. The site surface was primarily covered by asphalt hardstanding.

The site had a secondary pedestrian access point located to the northeast of the site, leading into the main British Museum buildings.

A site walkover was undertaken on 5th August 2022 and the findings are presented in Table 2.1 below, which should be read in conjunction with the appended annotated site plan (GL25243-DR002). Photographs referred to below have been included in the appendix. Harrison Group Environmental Limited (HGE) did not access the existing SWEC buildings adjacent to the site.

Current Uses	At the time of the walkover the site was in active use as a service road and partially occupied by a two storey modular building, used for office space, kitchens, and welfare facilities. Part of the site was also used for wheelie bin waste storage. The site surface was primarily covered by asphalt hardstanding.
Access	The main access into the site was located to the southeast and consisted of an asphalt service road which led from the South West Gate on Great Russell Street. The site had a secondary pedestrian access point located to the northeast of the site, leading into the main British Museum buildings.
Vegetation	No vegetation was present on site, however a large London plane tree, approximately 18m high is located close to the southwest boundary of the site.
Topography	Examination of the supplied topographical survey shows elevation of the site as approximately 24 – 24.5 metres above Ordnance Datum (maOD).
Existing buildings/structures	At the time of the walkover the site was in active use as a service road and partially occupied by a two storey modular building, used for office space, kitchens, and welfare facilities. The foundation details of this structure are not known.
Site surface	The areas of the site not occupied by buildings primarily consisted of asphalt hardstanding.
Above/below ground tanks	No tanks were noted above or below ground during the walkover.
Services	Overhead services were not observed on site, however numerous service covers were noted during the walkover.
Surface Water	No surface water was present on site.
Surrounding Area	The site is bounded by the main Grade I listed British Museum buildings to the northwest, northeast and southeast. Notably the building immediately to the northwest of the site is the current South West Energy Centre (SWEC), containing a substation, switch room, boiler house, generator room and chiller enclosure. To the southwest, the site is bounded by an approximately 3m high boundary wall, separating the museum from residential and commercial townhouses and associated gardens along Bloomsbury Street.

Table 2.1: Details of the site walkover

2.2 Environmental Setting

The environmental setting background information (geology, hydrology, hydrogeology and database information) and site history have been researched as part of this report. A summary of the environmental and geological setting is given in the following sections.

Table 2.2 below gives background information from mapping, online and literature sources.

	Data Source	Data Summary
Topography	Survey by John Robinson Associates Survey Specialists Ltd (Ref: UM21-669-JRA dated 04/01/21)	Examination of the supplied topographical survey shows elevation of the site as approximately 24 – 24.5 metres above Ordnance Datum (maOD).

	Data Source	Data Summary
Geology	1:50,000 BGS Digital Mapping. GroundSure Report Reference GS-8994887 BGS Borehole Reference: TQ38SW2081	The site is detailed to be underlain by superficial deposits of the Lynch Hill Gravel Member deposits (sand and gravel). Underlying the superficial deposits, the solid geology is detailed as the London Clay Formation. 16 No. boreholes are recorded within 50m of the site. The closest BGS borehole (TQ38SW2081) was located on site and detailed made ground and intact brickwork to 1.30mbgl, overlying dense sands and gravels of the Taplow Gravel Member to 5.40mbgl. London Clay Formation was recorded below to the final borehole depth of 15mbgl. 1 No. record of unknown made ground was recorded within 250m of the site, situated 217m to the west of the site.
Hydrogeology	GroundSure Report Reference GS-8994887 BGS Borehole Reference: TQ38SW2081	Information from the historical boreholes indicates the water table is expected to be approximately 4mbgl, situated within the superficial Lynch Hill Gravel Member. The aquifer status of the site is linked to the underlying soil types. The superficial geology of the Lynch Hill Gravel Member is designated as a Secondary A aquifer and the solid geology London Clay Formation is classified as unproductive. No active groundwater abstraction licences (above $20m^3$ per day), surface water abstractions or potable abstractions were noted within 250m of the site. The closest active groundwater abstraction is located some 277m northwest of the site and is detailed as a heat pump. The closest abstraction associated with a Potable Water Supply is located some 923m west, detailed as drinking, cooking, sanitary and washing. The closest active surface water abstraction is located some 1912m to the north for non-evaporative cooling from the River Thames. The site is not situated within a source protection zone.
Hydrology	GroundSure Report Reference GS-8994887	No surface water features are recorded within 250m of the site. It should be noted that the River Thames is located approximately 1.2km to the southeast of the site. The site is located within a coastal catchment of the Water Framework Directive. A negligible risk is considered from surface water flooding. A moderate risk is considered from groundwater flooding. The site is located within a SSSI Impact Risk Zone.
Geotechnical Hazards	GroundSure Report Reference GS-8994887	The hazard rating for shrink swell clays, compressible deposits and ground dissolution of soluble rocks is considered negligible on site, however a moderate risk of shrink swell clays is considered 3m southwest of the site. The hazard rating for running sands, collapsible deposits and landslides is considered to be very low.
Radon Potential	GroundSure Report Reference GS-8994887	The site is in an area where less than 1% of homes are affected by radon is recorded by data obtained from the British Geological Survey and Public Health England. As such, no further assessment is deemed necessary and radon protection measures are not required at this location.
Unexploded Ordnance	Zetica UXO accessed November 2022	Review of free-to-access online mapping indicates that the site is situated within a high risk area.
Environmental Database Information	GroundSure Report Reference GS-8994887	2 No. historical industrial land uses were recorded within 250m of the site. These relate to a brewery recorded 115m to the southwest and an unspecified tank 181m to the west of the site. 4 No. electrical substations were recorded within 250m of the site. The closest was situated 19m southeast of the site. No historical petrol stations were recorded within 500m of the site. The closest historical garage was recorded 260m southeast of the site. The closest historical tank was located 389m northwest of the site.

	Data Source	Data Summary
Environmental Database Information	GroundSure Report Reference GS-8994887	1 No. licensed waste site was recorded 152m southeast of the site, detailed as a mobile plant treatment for soil. 4 No. waste exemptions are recorded within 250m of the site, the nearest being situated 191m northwest of the site, for aerobic composting and associated prior treatment. 31 No. recent industrial land uses are recorded within 250m of the site. Examples of these include electronic stores, electrical substations, publishers, house clearance companies, machinery and photographic stores. An obsolete petrol station was recorded 291m northwest of the site. 4 No. radioactive substance authorisations were located within 250m of the site, all of which were recorded 111m northeast at the British Museum. A London Underground railway (Central Line) is detailed as being located 183m south of the site. A Mail Rail tunnel is detailed as being located 177m south of the site, as well as a disused Mail Rail tunnel located 183m to the south. Historical railway sidings were recorded 72m east of the site from maps dating to 1896. The site is located within a conservation zone, detailed as Bloomsbury. 60 No. listed buildings are located within 250m of the site. This includes the British Museum itself, designated as Grade I listed. Bedford Square, located 112m west of the site is a registered park and garden, designated as Grade II* listed. Bedford Square is also listed as a priority habitat for deciduous woodland.
Regulator Contact	London Borough of Camden Petroleum Office	Direct contact was not made.
Additional Background	***Excavations at the British Museum:*** *An Archaeological and Social History of Bloomsbury* by Rebecca Haslam and Victoria Ridgeway	Given the nature of the site in question, being a part of the grounds of the British Museum, we were provided with an extensive document by the Museum detailing past excavations and known history of the site (ref: *Excavations at the British Museum: An Archaeological and Social History of Bloomsbury*). The below is an extract from the summary of this document: *'The results of these studies suggest that the Bloomsbury area may have begun the transformation from undeveloped land to farmland as early as the Roman period and had certainly made that transition before the Norman Conquest. It remained rural in character until c. 1643, then the outer ring of London's Civil War defences was constructed the future site of the British Museum estate. The monumental earthworks that formed part of those 'Lines of Communication' remained fully extant for only a handful of years before the area was returned to pastoral use in the wake of the conflict.* *The next major event to affect the evolution of the British Museum site involved the construction of Montagu House and its grounds in 1675-7. Built by the famous architect and polymath Robert Hooke, this structure was commissioned as the London residence of the Montagus, an important landowning family. Although the building burned down just nine years after its completion, it was rapidly rebuilt in a similar style and served as an aristocratic residence into the 18th century. After a brief period of abandonment, the sale of the mansion to the government in 1754 propelled it to international fame after it was converted into the first incarnation of the British Museum.* *The ensuing decades saw the surrounding farmland yield to urbanization as the growth of London's wealthy western suburbs gathered pace, and by the turn of the 19th century Montagu House was surrounded on all sides by high-status residential townhouses and their gardens.*

	Data Source	Data Summary
Additional Background	***Excavations at the British Museum:*** *An Archaeological and Social History of Bloomsbury* by Rebecca Haslam and Victoria Ridgeway	*As the remit of the institution grew in tandem with the size of its collections, Montagu House was demolished so that the core of the British Museum as we know it today could be constructed according to the designs of the architect Robert Smirke. During the next decades his creation was modified and extended as the Museum strived to acquire the resources and space it needed to display, curate and care for its collections. Inevitably this impacted upon the surrounding residential properties and their grounds, some of which were subsumed as it was enlarged.* *Thanks to repeated waves of expansion throughout the 19th, 20th and 21st centuries, the most recent of which involved the construction of the Great Court and the World Conservation and Exhibitions Centre, the British Museum has maintained its status as pone of the world's leading depositories of archaeological and ethnographic treasures from around the globe. Its success has greatly influenced the development of Bloomsbury itself, which, thanks to the arrival of the plethora of universities and colleges that followed in the wake of the Museum and the Library, is now an area of London that most Britons immediately associate with intellectualism and academia.'*

Table 2.2: Background Information

2.3 Site History

In addition to the information contained within "Excavations at the British Museum" the history of the site has also been researched from commercial available historical mapping sources. Copies of the Ordnance Survey maps examined have been presented in the appendix and a summary is provided in table 2.3.

Date of Mapping	Scale of Mapping	Detail
1875 1882	1:1,056 1:10,560	**On-site:** The site comprised of gardens and associated boundary walls belonging to the terraced townhouses lining Charlotte Street. At this stage, the site lay outside of the grounds of the British Museum. **Off-site:** The main buildings of the British Museum were recorded immediately to the northeast of the site. Bedford Square was located approximately 100m northwest of the site. The surrounding area mainly comprised of terraced residential housing, with a few commercial premises, including a post office and public house recorded approximately 100m southeast of the site.
1896 1894-1895	1:1,056 1:10,560	**On-site:** No significant changes were recorded. **Off-site:** Construction of a large building, assumed residential, was recorded approximately 50m southwest of the site on Charlotte Street.
1916 1920	1:2,500 1:10,560	**On-site:** A small outbuilding was recorded at the end of the residential garden. **Off-site:** Charlotte Street approximately 50m to the southwest is now called Bloomsbury Street. An area of previously empty land approximately 100m southwest of the site has been infilled by Bedford Avenue and other buildings. A previously unannotated building approximately 150m to the south west of the site is now shown as a brewery. A new block listed as the Y.M.C.A Headquarters replaced terraced housing approximately 200m southwest of the site. Notable change was recorded approximately 150m to the north of the site where the British Museum has extended to take over some terraced housing along Montague Place. Approximately 200m to the north a large area of terraced housing has been cleared to make way for British Museum Avenue. Montague Mews approximately 250m north east of the site was also shown to have been cleared.
1938	1:10,560	**On-site:** No significant changes were recorded. **Off-site:** No significant changes were recorded.
1951-1953 1948-1951	1:2,500 1:10,560	**On-site:** The site is shown to have been incorporated into the grounds of the British Museum, with the residential gardens being shortened to allow for a new building and service road to be constructed. **Off-site:** The British Museum is shown to have been further developed off-site, with the western section of the Museum extended towards the terraced townhouses on the western boundary, incorporating much of their gardens. The central square Reading Room block is shown to have changed shape. A number of hotels are recorded in the surrounding area for the first time. Land formerly occupied by a brewery approximately 200m southwest of the site has been redeveloped to including buildings such as The Dominion Theatre Y.M.C.A, a bank

Date of Mapping	Scale of Mapping	Detail
		and a car park. Approximately 200m to the north of the site Senate House was recorded as a part of the University of London. Notably the surrounding area shows a number of Ruins or empty plots of land, likely to have been caused by bombing during WWII.
1966-1970 1972 - 1973	1:1,250	**On-site:** The layout of the buildings on-site were shown to have been slightly altered. **Off-site:** The British Museum was shown to have been altered further, including the central section. The car park approximately 150m southwest of the site is shown to have been redeveloped into Congress and Bainbridge Houses.
1982-1987 1989-1991	1:1,250	**On-site:** The buildings previously recorded on-site are shown to have been removed. **Off-site:** Buildings approximately 150m to the south of the site were shown to have been redeveloped.
2003 *British Museum website*	1:1,250	**On-site:** No significant changes were recorded. **Off-site:** The British Museum was shown to have been further redeveloped, based around the central portion of the site. It is known that the Great Court was the library for the Museum up until 1997, with work starting in 1999 to convert the space into a new public space incorporating a new iconic domed glass and steel roof.
2010	1:10,000	**On-site:** No significant changes were recorded. **Off-site:** The surrounding area was shown to have remained largely unchanged, with a slight alteration of the road layout recorded in Bedford Square.
2022	1:10,000	**On-site:** The main buildings of the British Museum are shown to have been extended, covering the north-eastern half of the site. **Off-site:** No significant changes were recorded.

Table 2.3: Historical setting from maps

2.4 Summary of Background Research

The site was in active use as a service road and partially occupied by a two storey modular building, used for office space, kitchens, and welfare facilities. Part of the site was also used for waste storage. The site surface was primarily covered by asphalt hardstanding.

The site is bounded by the main Grade I listed British Museum buildings to the northwest, northeast and southeast. Notably the building immediately to the northwest of the site is the current South West Energy Centre (SWEC), containing a substation, switch room, boiler house, generator room and chiller enclosure. To the southwest, the site is bounded by an approximately 3m high boundary wall, separating the museum from residential and commercial townhouses and associated gardens along Bloomsbury Street.

The geology underlying the site is detailed to comprise superficial Lynch Hill Gravel Member overlying London Clay Formation.

The site area is detailed as having a Secondary A aquifer designation (Lynch Hill Gravel Member). The underlying solid geology (London Clay Formation) is identified as unproductive. The site does not lie within a source protection zone.

No surface water features are recorded within 250m of the site. It should be noted that the River Thames is located approximately 1.2km to the southeast of the site.

A negligible risk of flooding from either rivers or the sea was identified on site. However, a moderate risk is considered from groundwater flooding.

The site is located within a SSSI Impact Risk Zone and a conservation zone.

The closest active groundwater abstraction is located some 277m northwest of the site and is detailed as a heat pump. The closest abstraction associated with a Potable Water Supply is located some 923m west, detailed as drinking, cooking, sanitary and washing.

The closest historical tank was located 389m northwest of the site, an obsolete petrol station was recorded 291m northwest of the site and the closest historical garage was recorded 260m southeast of the site.

4 No. electrical substations were recorded within 250m of the site. The closest was situated 19m southeast of the site.

2 No. historical industrial land uses were recorded within 250m of the site. These relate to a brewery recorded 115m to the southwest and an unspecified tank 181m to the west of the site.

31 No. recent industrial land uses are recorded within 250m of the site. Examples of these include electronic stores, electrical substations, publishers, house clearance companies, machinery and photographic stores.

Review of free-to-access online UXO mapping indicates that the site is situated within a high risk area.

The site is known to have been heavily influenced by human activity to as far back as the Roman period, and especially from c. 1643 onwards, when the large scale earthworks of the 'Lines of Communication' were undertaken in very close proximity to the site during the Civil War. Various incarnations of Montagu House and the British Museum followed, with the surrounding farmland yielding to urbanization by the turn of the 19th century until Montagu House was surrounded on all sides by high-status residential townhouses and their gardens.

From the mapping available, the site is shown to have been part of the gardens of the terraced townhouses lining Charlotte Street, the present day Bloomsbury Street, from the late 19th century until the 1950s. The British Museum expanded their site boundary at this time to incorporate much of these gardens, including the proposed site. A new building, part of the Museum, was shown to have been present on-site until the early 1980s, at which point the building was demolished and the site remained empty once again. Although the mapping available does not detail the modern building present on-site, it is assumed this was constructed during the early 2000s.

Given the recent construction of the building on-site it is assumed that no asbestos is present, and no external structural issues were identified during the site walkover.

3 HAZARD IDENTIFICATION AND ASSESSMENT

Contamination hazard identification has been undertaken and this has been developed to include source-pathway-receptor principles. Geotechnical hazards are also identified and commented upon.

3.1 Geotechnical Hazard Identification

Table 3.1 below contains an initial assessment of the geotechnical hazards that could be present at the site.

Hazard	Requires further consideration?	Comment
Shrink/swell potential	No	Granular soils of the superficial Lynch Hill Gravel Member are expected to be present on-site. The hazard rating of shrink swell potential is considered to be negligible.
Sulphate bearing soils	**Yes**	Sulphate bearing soils of the London Clay Formation are expected to be present at approximately 5mbgl. Ground investigation should be undertaken to confirm the soil types present on the site, with geotechnical testing and assessment to allow for appropriate foundation design
High groundwater level/flooding	**Yes**	No surface water features are recorded within 250m of the site. The site is not recorded as being within a flood risk zone, with negligible risk considered from surface water. A moderate risk is considered from groundwater flooding, therefore a ground investigation should be undertaken to confirm groundwater levels.
Slope Stability	No	The site is relatively flat. Therefore, there is no potential risk posed from slope instability. There is a very low risk of landslides and collapsible deposits on site.
Poor drainage	No	The expected superficial deposits of the Lynch Hill Gravel Member are considered to offer high to very high permeability rates and good drainage characteristics.
Dissolution Features	No	The potential hazard presented by ground dissolution is considered negligible. Soluble rocks are thought not to be present.
Potential variable	**Yes**	Given the historical land uses identified on-site, variable made ground is

Hazard	Requires further consideration?	Comment
deposits		expected across the site from previous development and demolition.
Unexploded ordnance	**Yes**	Free-to-access online UXO information suggests a high risk is considered. It is recommended that a Detailed UXO Risk Assessment is undertaken for the site.
Uncontrolled backfill/Potential for unknown made/filled ground	**Yes**	Due to the current and past site uses, there is potential for unknown, and variable made ground throughout the site.
Relict foundations/ below ground structures and tanks.	**Yes**	Examination of available historic map data shows since the late 19th century the site was occupied by gardens, boundary walls, garden outbuildings and British Museum buildings. Unless they and all existing underground structures are thoroughly 'grubbed out', demolition of the existing buildings may lead to the presence of relict substructures. There is also the possibility for underground services to cross the site. The closest tunnels associated with the London Underground are located 183m south of the site, with a Mail Rail tunnel is detailed as being located 177m south of the site.

Table 3.1: Initial geotechnical hazard identification

This table is based on local empirical knowledge, geology and topography; however, it should be revised if additional relevant data was identified at any time.

3.2 Environmental Hazard Identification

In this part of the report, environmental hazard identification is undertaken, leading to the development of a conceptual ground model for the site. Contamination sources are specified based on the information previously presented in this report as well as identified receptors, in association with a list of potential contaminants.

As an initial step, the viability of the potential sources are considered in table 3.2a below.

Potential Source	Distance (m)	Direction	Initial Assessment	Requires Further Consideration?
Historic Site Usages- Garden outbuildings Unknown British Museum buildings Service road	On site	-	Contamination may have been caused by the storage, use, or spillage of fuels or chemicals used during the historic uses of the site. In addition, on site disposal activities may also have been a cause of soil contamination hazards and includes possible waste. Possible contaminants - Petroleum hydrocarbons (diesel, lubricating oils, greases and/or petrol). Polycyclic Aromatic Hydrocarbons (PAH). Metals. Coal Ground Gases.	**Yes**
Curent Site Usages Moduler British Museum buildings Service road Waste storage	On Site	-	Contamination may have been caused by the storage, use, or spillage of fuels or chemicals used during the historic uses of the site. In addition, on site disposal activities may also have been a cause of soil contamination hazards and includes possible waste. Possible contaminants - Petroleum hydrocarbons (diesel, lubricating oils, greases and/or petrol). Polycyclic Aromatic Hydrocarbons (PAH). Metals. Coal. Ground Gases.	**Yes**
Asbestos	On Site	-	Asbestos containing materials (e.g. cement asbestos building products) within demolition rubble of former buildings across site.	**Yes**
Electrical substations	19, 31, 161, 196	SE, SE, NW, N	Possible source of Polychlorinated biphenyls (PCBs) due to the proximity to site.	**Yes**
Historical railway sidings	72	E	May be considered a low risk source of a general suite of contaminates and ground gas. Metals. Hydrocarbons., Volatile Organic Compounds, Asbestos, Polycyclic Aromatic Hydrocarbons. Likely to	No

			be down gradient from the site.	
3 No. current publishers	88, 92, 98	W, SE	Localised metals, acids and solvents.	No
Brewery	115	SW	May be considered a low risk source of a general suite of contaminates and ground gas. Metals. Hydrocarbons., Volatile Organic Compounds, Asbestos, Polycyclic Aromatic Hydrocarbons. Likely to be down gradient from the site.	No
Unspecified tank	181	W	Localised hydrocarbon contamination.	No
4 No. other current Industrial Sites	<100	S, SE, SW, NW	May be considered a low risk source of a general suite of contaminates and ground gas. Metals. Hydrocarbons., Volatile Organic Compounds, Asbestos, Polycyclic Aromatic Hydrocarbons.	No

Table 3.2a: Initial assessment of potential sources of contamination

Of these potential sources, made ground associated with the historic nature of the site, the current site usages and possible asbestos (buried from historic buildings) are believed to be the most significant sources of potential contamination and will be considered further in the assessment process.

The hazard identification is based on the assumptions presented below:

- The site under consideration is proposed for redevelopment for commercial / industrial use and is assumed that no soft landscaped or private gardens will be associated with the development.
- The site will be assessed based on its former and proposed use from information provided in 'Land contamination: risk management' (EA/DEFRA, 2019) and science report SC050021/SR3 'Updated technical background to the CLEA model' (Environment Agency, 2008).
- Drinking water will be from mains supply

In addition to the assessment on the current buildings on-site detailed in table 3.2a, older buildings on site could have contained ACM, which could be present in the immediate surrounding made ground.

The identified contamination hazards/sources and sensitive receptors are summarised in tables 3.2b and 3.2c below.

Contamination Hazards/Sources			
On Site		**Off Site**	
Source	**Implication**	**Source**	**Implication**
Made ground	Soils and groundwater impacted by total & leachable contaminants. Ground gas/vapour generation.	Historical and Current Potential Sources as detailed in table 3.2a	Soil and groundwater are impacted by total & leachable contaminants. Ground gas/vapour generation.
Historical and Current Potential Sources as detailed in table 3.2a	Soil and groundwater impacted by total & leachable contaminants. Ground gas/vapour generation.		
Possible asbestos containing materials in historical buildings or in soils.	Inhalation of fibres if disturbed during demolition, refurbishment, or development.		

Table 3.2b: Potential contamination sources and implications

Sensitive Receptors
Humans using the site during development (groundworkers) and post development (staff)
Groundwater (The Lynch Hill Gravel Member is considered a Secondary A aquifer).
Proposed buildings and services (including water pipes)

Sensitive Receptors
Local flora & fauna.

Table 3.2c: Potential sensitive receptors

3.3 Key Contaminants List

The investigation of the site history and the has indicated potentially contaminative past and current uses associated with the site as detailed in section 3.2.

It is normal to consider the contamination implications of a specific land use to formulate a list of key contaminants, using documents such as CLR 8 'Potential Contaminants for the Assessment of Land', and the relevant Department of the Environment Industry Profiles.

Potential contaminants identified based on the current and previous use could include but not inclusive to metals/metalloids and their compounds, inorganic compounds, total petroleum hydrocarbons (TPH), and polycyclic aromatic hydrocarbons (PAH).

It is recommended that the potential for ACMs within buildings and structures proposed for demolition or refurbishment are assessed through an appropriate survey, with removal and disposal undertaken in accordance with the 'Duty of Care' and applicable legislation.

An asbestos fibre screen should be included as part of the recommended suite to rule out its' presence within the near surface soils where physical contact is anticipated with future site users.

If visually contaminated or malodourous material is encountered during development, or other observations suggest the potential presence of other contaminants, additional analysis may be advised. These are not suggested as part of initial testing, but in some cases, may form part of follow-up analysis, particularly where initial test results indicate greater potential for other contaminants.

3.4 Schematic Section

In order to identify potential pollutant linkages, a schematic section has been included below as figure 3.4b, with figure 3.4a showing the trend line for the section.

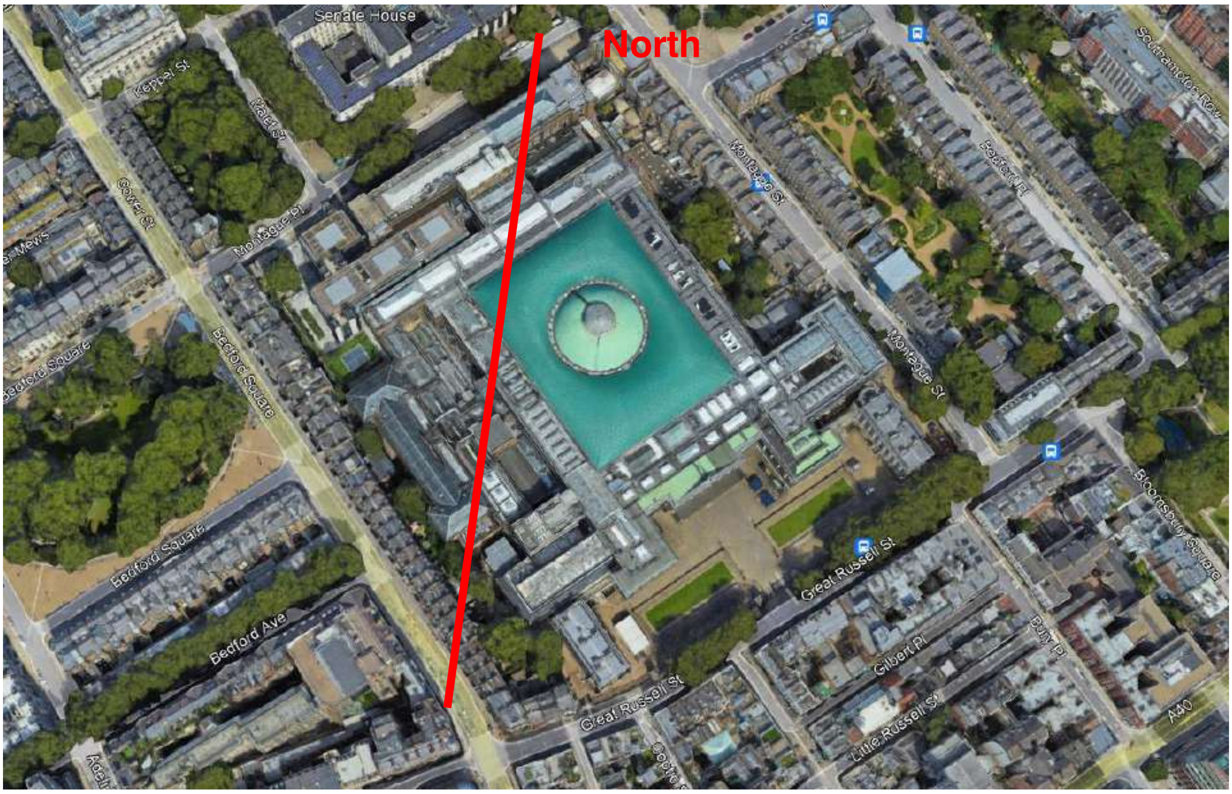

Figure 3.4a. Trend line of the schematic

The model shows predicted geology and topography, potential contamination sources and receptors from data present in the report. Generalised pathways are shown, which are discussed throughout the report and are developed in section 3.5 to allow an initial hazard assessment. The schematic section should not be considered to scale. The section should be revisited and updated if the proposed use changes, or if additional information comes to light.

3.5 Hazard Assessment

An initial assessment of the risk posed by each pollutant linkage has been carried out. This is included as table 3.5 below and identifies a medium to high hazard with recommended subsequent activity having the potential to include:

- Action required (AR) in the short term to break existing source-pathway-receptor link;
- Site investigation (SI) with objectives for risk estimation, or;
- No action (NA) at this stage

Most pollutant linkages (source-pathway-receptor relationships) have been assessed to require further action. Recommendations for further work are largely with regard to the investigation of the ground conditions; these are discussed in section 4.

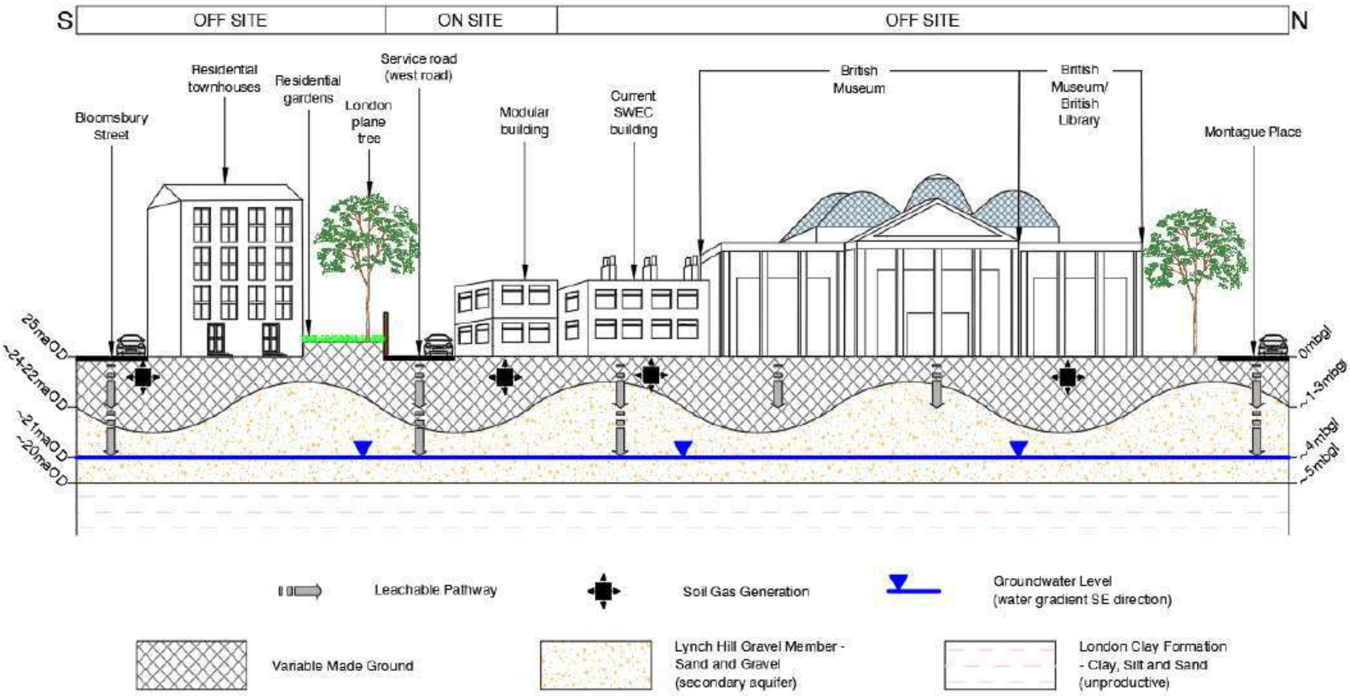

Figure 3.5: Schematic Section

Hazard Identification				Hazard Assessment			
Link No.	**Source/ Hazard**	**Pathway**	**Receptor**	**Probability**	**Consequence**	**Hazard Ranking**	**Hazard Assessment:** - **Action required (AR)** - **Site Investigation (GI)** - **No Action (NA)**
1	Hazardous vapours / soil gas from made ground, volatile hydrocarbons/free product or migrating to site from backfill material	Ingress into excavations, structures and confined spaces, and subsequent inhalation.	People on the site during development construction.	Low Likelihood	Minor	Very Low Risk	**GI** - Ground gas monitoring/assessment with ground worker risk assessment required.
2		Ingress into structures and confined spaces, and subsequent inhalation.	People using the site post development construction.	Low Likelihood	Mild to Medium	Moderate / Low Risk	
3	Contaminated soil from previous and present contamination sources both on and off site	Ingestion of soil through direct contact, eating with dirty hands and dust inhalation.	People on the site during development construction.	Low Likelihood	Minor	Low Risk	**GI** - Possibility of contamination across the site. Requires quantification through investigation and chemical testing followed by ground worker risk assessment.
4			People using the site post development construction. Human end users and neighbours post development construction.	Low Likelihood	Minor	Low Risk	**GI** - Possibility of contamination across the site. Requires quantification through investigation and chemical testing followed by ground worker risk assessment.
5							
6		Leaching.	Groundwater – Secondary A aquifer superficial deposits. Surface Waters - The River Thames Off-site human receptors and infrastructure.	Low Likelihood	Mild to Medium	Moderate / Low Risk	**GI -** Possibility of contamination across the site which could be affecting groundwater and surface waters. Groundwater chemical analysis and leachate soil analysis should be undertaken as part of intrusive investigation with subsequent assessment. There could be a requirement for DQRA depending on the conditions encountered and the results of the proposed chemical analysis.
7		Infiltration					
8		Via service pipes.	People using site after development completion.	Low Likelihood	Medium	Moderate / Low Risk	**GI** - Chemical testing and assessment of risk required only if significantly deleterious conditions encountered during invasive investigation works and/or in proposed landscape and garden areas. This excludes private gardens which is considered under link 2.
9		Plant uptake.	Local flora and fauna.	Low Likelihood	Minor	Very Low Risk	NA - Chemical testing and assessment of risk required only if significantly deleterious conditions encountered during invasive

							investigation works.
10		Direct Contact	Building structures	Low Likelihood	Minor	Very Low Risk	**GI** - Chemical testing and assessment of risk required only if significantly deleterious conditions encountered during invasive investigation works and/or in proposed structure areas.
11	Potential asbestos containing materials within Made Ground soils	Inhalation of dust.	Humans on and in the vicinity of the site during demolition/ development construction.	Low Likelihood	Severe	Moderate Risk	**GI -** Possibility of asbestos in existing Made Ground and so it is recommended that the potential for ACMs is assessed through an appropriate survey, with removal and disposal undertaken in accordance with the 'Duty of Care' and applicable legislation.

Table 3.5: Initial Hazard Identification and Hazard Assessment (Table of Pollutant Links)

4 DISCUSSION & RECOMMENDATIONS

4.1 Discussion

This phase one contamination and geotechnical assessment (desk study report) was undertaken for a site located within the grounds of the British Museum in central London. The site can be accessed from Great Russell Street, London, WC1B 3DG. The phase one investigation was undertaken in order to establish how potential contamination and geotechnical hazards could impact the future development of the site. The proposed end use of the site is for commercial / industrial purposes, and this has been considered throughout this report. It is currently not known if soft landscaped areas will be associated with the development.

At the time of our assessment the site was partially occupied by a temporary modular building, providing office, welfare and kitchen facilities. The building appears to have been constructed in the early 2000s according to the historical maps available. The site also covers a portion of the west service road to the Museum, comprising of tarmac hardstanding and a waste storage area.

The site is bounded by the main Grade I listed British Museum buildings to the northwest, northeast and southeast. Notably the building immediately to the northwest of the site is the current South West Energy Centre (SWEC), containing a substation, switch room, boiler house, generator room and chiller enclosure. To the southwest, the site is bounded by an approximately 3m high boundary wall, separating the museum from residential and commercial townhouses and associated gardens along Bloomsbury Street. A London plane tree, approximately 18m high is located close to the boundary wall.

The main access into the site was located to the southeast and consisted of an asphalt service road which led from the South West Gate on Great Russell Street. At the time of the walkover the site was in active use as a service road and partially occupied by a two storey modular building, used for office space, kitchens, and welfare facilities. The site surface was primarily covered by asphalt hardstanding.

The site had a secondary pedestrian access point located to the northeast of the site, leading into the main British Museum buildings.

The site is detailed to be underlain by superficial deposits of the Lynch Hill Gravel Member deposits (sand and gravel). Underlying the superficial deposits, the solid geology is detailed as the London Clay Formation.

The most sensitive receptors identified were humans using the site during development (construction workers) and post development (end-users), an the groundwater (secondary A aquifer).

No intrusive investigation has been undertaken as part of the phase one assessment. Based on the site history and background information, it is deemed necessary to consider an investigation in relation to the potential for contamination and the assessment of geotechnical issues.

It should be made clear that the contamination hazards may not prove to be significant, but their nature and number lead us to recommend site investigation in order to properly assess them. Intrusive investigation of the site should be reserved by a pre-commencement condition.

4.2 Geotechnical Risks

The potential for uncontrolled backfill and relict structures have been identified as potential geotechnical hazards. An intrusive geotechnical investigation is recommended across the site prior to any construction, to allow for adequate design of foundations and to confirm the geology.

The potential presence of a considerable thickness of dense granular Lynch Hill Gravel Member and the anticipated loads associated with the proposed structures are likely to make shallow foundations (including rafts) a suitable foundation solution.

Consideration of the sulphate content of the soils should be given with respect to the grade of concrete suitable for use at this location. The density and permeability of shallow soils should be assessed in order to consider pavement and drainage design. The likely granular nature of the superficial deposits covering the site, suggest that conventional soakaways maybe suitable in the absence of significant made ground deposits. Although groundwater levels will need to be confirmed.

Examination of available historic map data shows since the 1950s a portion of the site has been occupied by buildings intermittently. Unless they and all existing underground structures are thoroughly ‘grubbed out’, demolition of the existing buildings may lead to the presence of relict substructures. There is also the possibility for underground services to cross the site.

4.3 Environmental Risks

The site is currently partially occupied by a temporary modular building, providing office, welfare, and kitchen facilities. The site also covers a portion of the west service road to the Museum, comprising of tarmac hardstanding and a waste storage area.

During a long history, the site is shown to have been part of the gardens of the terraced townhouses lining present day Bloomsbury Street, from the late 19th century until the 1950s. The British Museum expanded their site boundary at this time to incorporate much of these gardens, including the proposed site. A new building, part of the Museum, was shown to have been present on-site until the early 1980s, at which point the building was demolished and the site became vacant once again. It is assumed the present day structure was constructed during the early 2000s.

Given the recent construction of the building on-site it is assumed that no asbestos is present. However, the presence of ACM cannot be ruled out and an asbestos survey is recommended. The soils should also be investigated for the potential presence of ACM.

The potential for uncontrolled backfill on site, possible ACM in soil and ground gas generation from off-site sources were also noted.

No historic or current underground or overground tanks were identified on-site.

Localised areas of waste storage were observed on-site which could be a potential source for contamination.

Prior to the commencement of any redevelopment, we would advocate direct investigation and assessment in order to identify whether contamination is present, and whether a significant risk exists to people using the site and to controlled waters (groundwater – secondary A aquifer).

4.4 Site Investigation Strategy

A Ground Investigation has been scoped by Alan Baxter Ltd (Ref. 1910/40/LK/lk) with the purpose to:

- Verify the ground conditions across the site.
- Derive soil parameters for the geotechnical design of the proposed structures.

The Scope of the Investigation will include:

- Liaison and negotiation to secure access to borehole location.
- Construction of 1 No. exploratory borehole to depths of 20m using cable percussive technique.
- Completion of field testing within the boreholes, to include Standard Penetration tests (SPT) at 1.5m intervals.
- Recovery of disturbed and undisturbed samples.
- Logging and photographing of samples.
- Installation and monitoring of standpipes, gas monitoring standpipes and piezometers.
- Monitoring and sampling of groundwater to determine chemistry, including for aggressive ground conditions and for geo-environmental purposes to detect and determine the nature of any groundwater contamination.
- Sampling of hazardous or volatile materials for chemical analysis, including headspace analysis of samples on site using PID and/or FID methods (if necessary).
- Monitoring and, if applicable, sampling of gas wells for vapours and land gases.
- Laboratory testing including, but not limited to: classification tests; triaxial tests; chemical testing and groundwater chemistry.

- The presentation of field and laboratory data in digital and paper format in a draft format as soon as practical during the works and subsequently a factual report including data and drawings in digital format.
- The scoping and carrying out of a geo-environmental investigation and the production of an interpretative report to address geo-environmental issues.

Harrison Group feel the scope detailed above would be currently adequate for an initial assessment of potentially contaminated land and for providing a geotechnical hazard assessment for the proposed development.

4.5 Summary and Implications

The basic requirement for redevelopment standards in the UK is that land should be 'suitable for use' or 'fit for purpose', rather than apply a blanket 'clean' or 'all uses policy'. It is important to consider the limited nature of this investigation, and the possibility of as yet unknown contaminant sources existing.

The potentially contaminative uses and geotechnical hazards identified on site lead us to the conclusion that intrusive investigation is appropriate before the site can be considered suitable without remedial action. The investigation should include an assessment of the potential for contaminated soil and groundwater from the historic uses of the site and the potential for migration of contamination from surrounding areas. However, based on the information available, it is not considered likely that gross contamination is likely to be present which may otherwise limit the development potential. Intrusive investigation of the site should be reserved by a pre-commencement condition.

Harrison Group Environmental Limited would be pleased to offer further assistance with the recommended works if requested, and if the client or regulators have any comments or questions, we would be glad to discuss them.

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