Clarion Housing Group

Phase 2 Area, Richmond upon Thames College

Supplementary Site Investigation

1921744 R02 (00)

RSK GEOSCIENCES

January 2023

RSK GENERAL NOTES

Project No.: 1921744

Title: Supplementary Site Investigation: Phase 2 Area, Richmond Upon Thames College, Egerton Road, Twickenham, TW2 7SJ

Client: Clarion Housing Group

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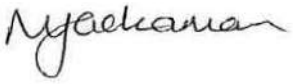
Signature		Signature	
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EXECUTIVE SUMMARY

Commissioning and purpose of assessment	RSK Environment Limited (RSK) was commissioned by Clarion Housing Group to carry out a Preliminary Risk Assessment of the land at Richmond Upon Thames College, Egerton Road, Twickenham, TW2 7SJ, grid reference 515403, 173745. The overall aim of the project was to assess land contamination sources and geotechnical constraints to the proposed development.
DESK-BASED ASSESSMENT	
Site description and proposed development	The site currently comprises College Buildings, occupies an area of 2.54 hectares and is being considered for development for residential use. The site boundaries define Phase 2 of the proposed development.
History of site and surrounding area	The site was formerly used for educational purposes. Potential sources of contamination identified on-site specifically relate to the made ground on site, as identified in the previous 2016 report. There are negligible potentially contaminative current activities have been identified in the surrounding area.
Previous site investigation (SI) reports	One previous SI report has been made available for review. This is: "Proposed redevelopment, Richmond Upon Thames College, Egerton Road, Twickenham, TW2 7SJ (report ref. STM3361D-G01, Rev 02, May 2016), prepared by Soiltechnics Ltd. This was peer reviewed by RSK and can be seen in 1921744 R01 (01)

Geology and environmental setting	The Site is underlain by the Kempton Park Gravel Member over the London Clay Formation according to published geological data and previous site investigation data for the site. Made Ground was encountered at all of the 2016 exploratory hole locations constructed across the site. Environmental receptors identified comprise: • Groundwater within the Kempton Park Gravel Member classified as a principal aquifer. • The London Clay Formation is classified as unproductive strata. • There are no groundwater abstractions within a 1 km radius of the site. • The depth to groundwater recorded in 2015 in the monitoring standpipes BHB, BHD and BHE (in the Central and Northern portions of the RUTC site) varied between 1.10 m bgl and 1.70 m bgl. Overall, groundwater strikes and resting groundwater levels recorded in trial the pits and driven sampler probe holes at other locations across the site ranged between 1.40 m bgl and 2.5 m bgl. • The nearest identified surface water feature is the River Crane located approximately 175 m to the south of the site. • The site is not located within or close to a (groundwater) source protection zone. • The site is not located within an 'Affected Area' for Radon. • Ground Gas: Based on the 2016 ground gas assessment, the site was classified as characteristic gas situation two (for the adjacent college area to the North) and traffic light colour 'Green' (for the proposed Central residential area). The 2016 report concluded, therefore, that no gas protection measures were required in the proposed Central residential area, however, these were considered necessary in the college area to the North. • There are no designated environmentally sensitive areas identified within 250 m of the site. With reference to the historical data, there have clearly been several phases of construction and demolition on the site and therefore the presence of made ground (including ACM) should be expected.
Site reconnaissance findings	RSK visited site on 24th August 2022, the majority of the site is covered with hardstanding with limited soft landscaping along the southern boundary. There were no notable streams or ditches on site, and no trees, hedges or other substantial vegetation. The site contains a three storey building and several single story buildings. There were no potentially contaminative sources immediately off-site and no evidence of contamination on site.
Geotechnical constraints assessment	Potential constraints include: • Shrinkable clay soils • Silt-rich soils susceptible to rapid loss of strength in wet conditions • Filled and made ground • Adverse ground chemistry

Initial conceptual site model (CSM) and preliminary risk assessment (PRA)	Potentially complete contaminant linkages identified with a risk estimate of moderate to low or above include: • Future site users (residential) - exposure to potentially contaminative made ground on site • Future site users (open/public spaces) - exposure to potentially contaminative made ground on site • Current adjacent site users - exposure to potentially contaminative made ground from onsite through migration of dust and/or groundwater • Controlled water - leaching of made ground contaminants into controlled waters Uncertainties and data gaps have been identified in the CSM at desk study stage and should be considered in the design of future intrusive investigation if proposed.
INTRUSIVE INVESTIGATION & ASSESSMENT	
SI scope	Using data collected from three cable percussive boreholes, five dynamic window sampler holes, surface water sampling, and groundwater and ground gas monitoring over a period of 6 weeks this investigation aimed to: • to establish the ground conditions underlying the site including the extent and thickness of any made ground • to investigate specific potential sources of contamination identified in initial CSM • to determine groundwater depth and flow direction • to determine the ground gas regime underlying the site • to assess geotechnical properties of soils
SI factual findings	Three boreholes were drilled to 20 m bgl and installed and groundwater monitoring wells. Five window sample wells were drilled and two installed to facilitate ground gas monitoring. Made ground was found within all intrusive investigation to a maximum depth of 1.7 m. Kempton Pak Gravel Member was also encountered across site between 4.3 – 5.8 in thickness overlying London Clay Formation which was encountered in the deeper boreholes only. Six rounds of ground gas and groundwater monitoring were conduced on a weekly basis. One round of groundwater and surface water sampling were completed. Groundwater was recorded within the groundwater monitoring wells between 6.99 – 7.90 m AOD. There was no visual or olfactory evidence of contamination observed within the soils or groundwater during the course of the investigation or subsequent monitoring.

Refined conceptual site model and geo-environmental assessment	Based on the results of the site investigation and generic quantitative risk assessment (GQRA), the contaminant linkages that have been identified to be potentially complete and to require further action are • Dissolved phase copper within the groundwater exceeds the assessment criteria for risks to nearby surface waters. • Asbestos fibres within the made ground presents an inhalation risk to future site users. The ground gas monitoring has indicated the site is characterised as CS1 and therefore no ground gas protection measures are required within this development. The preliminary waste assessment indicates the sample analysed did not exceed the leaching limit value and total content of organic parameters and therefore the waste may be suitable for disposal at an inert landfill.
Geotechnical assessment	Foundation options across the site are determined by the many phases of development across the site and for the proposed 5 story building piled foundations are considered the most appropriate option and for the low rise housing along the southern boundary traditional spread footings may be suitable. With the variable thickness of made ground encountered across Phase 2 it is recommended that ground floor slabs should be suspended. Assuming that disturbed ground will be minimised by the use of piled foundations, the recommended ACEC Classification is therefore; o AC-2 with a Design Sulphate Class of DS 2 (London Clay). o AC-1 with a Design Sulphate Class of DS 1 (Kempton Park Gravel Member) However, if the proposals include the reuse of the London Clay, e.g. excavation and backfill arisings, the recommended ACEC Classification will increase to AC-4 with a Design Sulphate Class of DS-4.
Recommendations including issues for further assessment	The following recommendations are made for further assessment and remediation of the site to address the risks identified above to address remaining uncertainties: • A clean capping layer may be appropriate for areas of proposed soft landscaping and any private garden to break the pollutant linkage between the made ground and future site users. • Inhalation of dust and direct contact with the made ground locally impacted with lead
The information given in this summary is necessarily incomplete and is provided for initial briefing purposes only. The summary must not be used as a substitute for the full text of the report.	

1 INTRODUCTION

1.1 Commissioning

RSK Environment Limited (RSK) was commissioned by Clarion Housing Group to carry out a Supplementary Site Investigation of the land known as Phase 2, at Richmond upon Thames College, Egerton Road, Twickenham, TW2 7SJ. The project was carried out to an agreed brief as set out in RSK's proposal (Ref. 1921744 T02 (00), dated 25/07/2022).

RSK's service constraints are shown in Appendix A.

The Site in question is being considered for development for residential use.

1.2 Objectives

The objective of the work is:

- to identify any land contamination to the proposed development and to support discharge of relevant planning conditions and relevant building control requirements.
- to identify the need for any additional investigation or remediation works to demonstrate that the site is suitable for its proposed use.
- to inform land asset management and provide geotechnical data to enable design of proposed residential buildings.

1.3 Scope of works

The scope of this assessment has been developed in accordance with relevant British Standards and authoritative technical guidance as referenced through the report. The assessment of the contamination status of the site is in line with the technical approach presented in Land Contamination Risk Management (LCRM) (Environment Agency, 2021) – which supersedes CLR11 Model Procedures for Land Contamination – and in general accordance with BS 10175: 2011 + A2 2017 (BSI, 2017). It is also compliant with relevant planning policy and guidance.

The scope of the intrusive investigation has been designed in line with the recommendations of BS5930:2015+A1:2020 Code of practice for ground investigations (BSI, 2020), which maintains compliance with BS EN 1997-1 and 1997-2 and their related standards. It has also been developed in general accordance with BS 10175: 2011 + A2 2017. Ground gas assessment has been undertaken in general accordance with BS8576: 2013 and BS 8485:2015+A1:2019.

A brief summary of relevant legislation and policy relating to land contamination is given in Appendix C.

The scope of works for the assessment has included the following:

Desk Study:

- Review of the previously completed works

- review of the history of development on the site and surroundings
- assessment of local geology, hydrogeology and hydrology
- review of relevant information held by appropriate statutory authorities
- review of any previous site investigation reports made available
- completion of a site reconnaissance survey to assess the visual condition of the site
- development of an initial conceptual site model (CSM)
- preliminary consideration of geotechnical constraints and hazards

Intrusive Investigation

- design and implementation of an intrusive investigation, in situ testing, soil sampling, laboratory geo-environmental and geotechnical testing, groundwater and ground gas monitoring of installed boreholes.
- interpretation of data to develop a refined conceptual site model (CSM)
- generic quantitative risk assessment (GQRA) of relevant contaminant linkages
- interpretation of ground conditions and geotechnical data to provide preliminary recommendations with respect to foundations and infrastructure design
- preliminary assessment of the potential waste classification
- preparation of this factual and/or interpretative report.

1.4 Existing reports

The following reports detailing previous works at the site were made available for review:

- Soiltechnics, Ground Investigation report – Proposed Redevelopment, Richmond Upon Thames College, Report ref. STM3361D-G01 – Rev 02, May 2016.
- RSK, Peer Review & Update of the Soil Technics Ground Investigation Report, Richmond Upon Thames College, Report ref. 1921744 – R01 (00), June 2021

Pertinent information from these reports has been summarised in Section 2.

1.5 Limitations

This report is subject to the RSK service constraints given in Appendix A and limitations that may be described through this document.

2 PREVIOUS REPORTS REVIEW

The site was initially investigated by Soil Technics Group Investigation in 2016. RSK undertook a peer review of the 2016 Soil Technics Ground Investigation report “Proposed redevelopment, Richmond Upon Thames College, Egerton Road, Twickenham, TW2 7SJ” (report ref. STM3361D-G01, Rev 02, May 2016) in June 2021.

The 2016 report targeted the land within the original wider college site boundary, as indicated in Figure 2.

The fieldwork comprised the following activities:

- Excavation of three exploratory hand dug trial pits.
- Excavation of thirteen exploratory trial pits using a tracked mini digger to enable infiltration testing.
- Excavation of five exploratory boreholes using cable and tool percussion drilling techniques.
- Excavation of fifteen exploratory boreholes formed using driven tube sampling equipment.
- Dynamic cone penetration testing in four locations.

The ground investigation encountered Made Ground overlying Kempton Park Gravel Member and London Clay Formation at depth. Ground water was encountered in most of the excavations at a depth of between 1.4 m-2.5 m. Foundation solutions were provided for the different buildings proposed across the investigated site.

Chemical contamination was identified across the site, which was considered to pose a risk to proposed end users of the residential area, construction operatives and vegetation in addition to water receptors. Localised PAH (benzo(a)pyrene) and TPH contamination was identified in one driven tube sampler location (DTD111), on the Northern College site area. The concentrations recorded were slightly elevated above guideline values and the results considered as “outliers”, related to the inclusion of bituminous coated gravels in the shallow (0.4 m bgl) soil sample. All other hydrocarbon results were below guideline values. For the Central site area, all values of inorganic contaminants were below guideline values with exception of lead. Three out of seven samples were over the guideline value of 276 mg/kg. These samples were located in DTS03, DTS12 and DTS13, all of which data were taken from a previous 2008 report. All measured concentrations of selected inorganic contaminants and 95 percentile upper confidence limits (UCL) were below relevant adopted guideline values with the exception of benzo(a)pyrene (1.3 mg/kg at DTS05, compared to the GAC guideline value of 0.83 mg/kg), and which the report considered an outlier for all PAH contaminants, which was considered to be associated with the clinker that was encountered at this depth. The results of all asbestos/free fibres and bulk ID tests were all “non-detect”.

Ground gas monitoring indicated that the former college area of the site in the north is classified as characteristic situation 2 and therefore required gas protection measures to be installed. The residential area of the site is classified as ‘green’ in accordance with NHBC guidance and therefore does not warrant gas protection measures.

The 2016 report indicates that there is potentially an air raid shelter buried towards the centre of the site. Separate investigations have attempted to locate the shelter, however, the report notes that these were unsuccessful. Should the shelter prove to still be in situ, it should be noted that the shelter will require removing prior to development. It is likely that Made Ground in this area will be locally deeper than in the remainder of the site, resulting in the requirement for extending foundations further through to natural soils at depth.

The following recommendations were made within the RSK made for further assessment of the site to address the risks identified above and to address remaining uncertainties:

- Areas (e.g. Phase 2) which have not been investigated at this stage, may exhibit higher levels of contamination. If such areas are exposed at any time during construction works phase, the site conditions should be further assessed, and appropriate measures adopted to allow the development to safely proceed.
- Stripping and removal of Made Ground soils including all bituminous bound material and any soils with bituminous coated material incorporated in the gravels, where identified.
- Provision of a clean capping layer in garden and soft landscaping areas.
- Adoption of adequate hygiene precautions for construction operatives.
- The status of the Japanese Knotweed eradication programme is unknown and should be ascertained.

It was therefore recommended that a remedial strategy be prepared for the Phase 1 area of the site and that supplementary investigations be completed within the Phase 2 area prior to redevelopment.

This document provides results of the supplementary site investigation within the Phase 2 area.

3 SITE DETAILS

3.1 Site location

Site location details are presented in **Table 1** and a site location plan is provided on Figure 1.

Table 1 Site location details

Site name	Richmond Upon Thames College
Full site address and postcode	Egerton Road, Twickenham, TW2 7SJ
National Grid reference (centre of site)	515403, 173745

3.2 Site description

The Phase 2 Area forms a part of the wider Richmond College redevelopment site, which is bound by the Chertsey Road to the North and the Harlequins Stoop Stadium to the west. Within the wider development, Phase 2 forms the southwestern corner, with new college buildings and a secondary school to the north, and residential neighbours to the south.

The Site boundary and current site layout are shown on Figure 2. The Site is rectangular in shape and slopes gently down towards the south. It is currently occupied by several college buildings of varying age, between one and four stories. The building layout contains a number of enclosed courtyards and sparse areas of some limited soft landscaping. The college buildings were at the time of investigation still occupied by various departments covering science, arts, social science, engineering and other vocational disciplines. Ancillary facilities were also present within the site including a bicycle parking area, an electricity substation and a sewage pumping station at the southern boundary.

The Phase 2 area surroundings comprise a new college building and a vacant land that recently undergone demolition works to the north, former school buildings on Phase 1 area to the east and residential housing and sports facilities to the west and south.

The access to the new college building, located to the north of Phase 2, is off Langhorne Drive. The access to the Phase 2 Area is via a gated entrance off the main entrance to the new college building to the north.

According to The Development Brief, prepared by Clarion, and dated 5th November 2020, the land was previously owned by Richmond Upon Thames College ("RUTC") and Clarion are in the process of purchasing the site in two parcels. Phase 1 has been purchased and has been leased back to RUTC. At the time of preparation of this report all of the Phase 2 buildings are still occupied, and

Clarion do not yet own this land. RSK understands that the Phase 2 acquisition is due to be completed imminently.

3.3 Surrounding land uses

The Site is located in Twickenham, London within a predominantly residential and commercial amenity setting. Immediate surrounding land uses are described in **Table 2**.

Table 2 Surrounding land uses

North	New Richmond College, with the A316 Chertsey Road and Twickenham stadium beyond
East	East Egerton Road with residential properties beyond
South	South Residential properties with playing fields beyond
West	Soft landscaped area with apartment blocks and Harlequins “The Stoop” stadium located beyond

3.4 Development plans

The proposed layout of the site, at the time of preparing this report, is shown in Appendix B.

In 2018, Clarion Housing Association entered into an agreement to purchase two parcels of land from Richmond College. The site forms the residential phase of a wider mixed use redevelopment (to include 180 homes), which benefits from Outline planning permission (REF: DC/JEF/15/3038/OUT/OUT dated 16th August 2016).

Reserved Matters planning permission (REF: 18/4157/RES dated 2nd August 2019) was granted for the delivery of 180 homes to be delivered in two phases with the S106 affordable delivered in Phase 1.

Current applications in progress include REF: 21/3136/FUL that proposes the demolition of existing college buildings, removal of hard-surfacing, site clearance and groundworks together with the redevelopment of the site to provide new residential units; together with associated parking, cycle parking, open space and landscaping.

4 DESK-BASED ASSESSMENT

The desktop study was designed generally to meet the objectives of a preliminary (phase 1) investigation, as defined by BS 10175:2011 + A2 2017 (BSI, 2017) and this assessment relates to LCRM Stage 1, Tier 1 preliminary risk assessment. The "vicinity" of the site for the purposes of this report is defined as locations situated within an approximate 250 m radius of the site, although certain sources and/ or sensitive targets further than 250 m may also have been considered.

The study aims principally to identify and assess the potential risks and liabilities associated with contamination of the ground, on and in the vicinity of the site. While this includes consideration of current operations and housekeeping on the site, the report does not constitute a comprehensive environmental audit of the site, as covered under ISO 14001.

4.1 Site history

4.1.1 Historical development record

The development history of the site and surrounding area based upon assessment of historical plans and records is detailed in **Table 3**. The historical maps reviewed are shown within the environmental database report in Appendix D. It should be noted that the Envirocheck report in Appendix D includes the area of Phases 1 and 2.

Table 3 Summary of historical development on Phase 2

Date from	Date to	Historical Land Use (on-site)	Area of site
1869	1874	The site is undeveloped farm land	Entire
Pre 1874-1875	1891	Undeveloped farm land (Marsh Farm on southern boundary Small water feature located in centre	Entire
1896	1915	Tramway bisects the site east to west Fountain Marsh Farm outbuilding and orchard	East to West Centre South centre
1915	1934	Reconfiguration of farm buildings with additional long buildings (greenhouses) on Phase 2, an orchard shown in the eastern area of Phase 2.	Entire
1934		The long buildings are no longer on the maps and the orchard has extended across the length of the site	Entire
1946		Grass land on Phase 2. Twickenham Technical College and associated development extended across Phase 1.	Eastern and Western portions

1960-1961	1974-1982	New buildings constructed on Phase 2, with a chimney on Phase 1, in the vicinity of the boiler house in the sub-basement. Pump House identified in the south western corner of Phase 2.	South Western corner
1982	1996	No further significant layout changes	
Date from	**Date to**	**Historical Land Use (off-site)**	**Distance (m) and orientation**
1869	Current	Railway Line runs from east to west	250 m S
1896	1960-1966	Sewage Works filter beds expand northwards in 1934 and are filled in by 1946.	250 m SW
1896	1920	Gravel Pit (known as Twickenham gravel pit)	200 m SW
1896	Current	Allotment Gardens	50 m E 100 m S 250 m S 250 m E 250 m SW
1920	1933 1938	Electrical Works Engineering Works	250 m S 450 m SW
1934		Miniature rifle range	300 m S
1946	Current	Residential properties on site boundary	0 m S
1960-1966	Current	Recycling centre	150 m SW
1961	Current	Sports stadium is constructed with associated infrastructure	250 mE
2021	Current	Pipelines	250 m SW
Relevant information sources: Historical OS maps ☒ Town plans ☒ Information from the Local Planning Authority ☐ Aerial photography ☒ Additional information ☐ Previous reports ☒			
Note: Reference to published historical maps provides invaluable information regarding the land use history of the site, but historical evidence may be incomplete for the period pre-dating the first edition and between successive maps.			

4.1.2 Unexploded ordnance

A review of publicly available unexploded ordnance (UXO) risk maps indicates that the site is located in an area with low potential for wartime bombs to be present (Zetica, 2022).

https://zeticauxo.com/downloads-and-resources/risk-maps/

4.2 Information from environmental database report

Relevant environmental permits and incidents detailed within the environmental database report (see Appendix D) are summarised below in **Table 4**.

Table 4 Summary of environmental permits, landfills and incidents

Data type	Entries on-site	Entries <250m from site	Entries >250m from site of relevance	Details
Agency and hydrological				
Environmental permits – incorporating Integrated Pollution Prevention and Control, Integrated Pollution Controls, Local Authority Integrated Pollution Prevention and Control	-	-	14	Nearest located 263 m S, Proper Energy Limited, Effective, Energy Limited, Organic chemicals, oxygen containing compounds permit ref: BP3334GY
Enforcement and prohibition notices	-	-	-	-
Pollution incidents to controlled waters, Prosecutions relating to controlled waters, Substantiated pollution incident register, Water Industry Act referrals	-	-	53	Nearest located 269 m S, pollutant – oils, 1994, minor incident
Discharge consents	2	-	8	Thames Water Utilities Limited, pumping station on sewerage network (water company), effective 1989, surrendered under EPR 2010, discharging into R. Crane, ref: Tem 2134 Nearest off site located 526 m N, discharge of other matter – surface matter, authorisation revoked
Registered radioactive substances	-	-	-	-

Data type	Entries on-site	Entries <250m from site	Entries >250m from site of relevance	Details
Landfill and waste				
Active landfills	-	-	-	-
Historic / closed landfills	-	-	4	Off site within 500 m: 449 m N, St Maragarets, Isleworth, Hounslow, first input date 1946, last input date 1963, specified waste: deposited waste included inert waste. WRCRef: 5540/0036
Other waste management licences	-	1	2	Off site <250 m: 233 m SW Central Depot, Langhorne Drive, Twickenham, issued May 2013, Household, commercial and industrial transfer stations
Potentially in-filled land (pit, quarry, pond, marsh, river, stream, dock etc)	-	-	4	Nearest located 327 m S, unknown filled ground, 1992 mapping
Hazardous substances/ industrial land uses				
Control of Major Accident Hazards (COMAH) sites	-	-	-	-
Explosives sites, Notification of Installations Handling Hazardous Substances (NIHHS), Planning hazardous substance consents/ enforcements	-	-	-	-
Contaminated land Part 2A register entries and notices	-	-	-	-

Data type	Entries on-site	Entries <250m from site	Entries >250m from site of relevance	Details
Contemporary trade directory entries	-	3	275	Off site < 250 m: 135 m SW, Council depot, Langhorn Drive, commercial vehicle servicing, Inactive. 210 m E, Homepride Cleaning services, carpet, curtain & upholstery cleaners, active. Off-site <500 m including commercial cleaning services 300 m S Inactive, Dry cleaners 309 m NE Inactive, Dry cleaners 305 m S Inactive, Oil recycling and disposal services 485 m E Inactive, Waste disposal services 487 m S Inactive
Fuel station entries	-	1	3	362 m NE, Currie Motors, obsolete
Note: Entries have only been included within the table where they are located within a 250m radius of the site or, where they fall outside of this radius but are considered to comprise a significant entry.				

4.3 Information from regulatory authorities

4.3.1 Planning records

Planning records held by the Local Authority Planning Department pertaining to the site and relevant to the current assessment are summarised in **Table 5**.

Table 5 Planning information

Year	Details and application reference no.	Part of site
2021	21/3136/FUL Demolition of existing college buildings, removal of hard-surfacing, site clearance and groundworks together with the redevelopment of the site to provide new residential units; together with associated parking, cycle parking, open space and landscaping.	All Site

4.3.2 Local Authority environmental health department information

The Environmental Protection Officer of the Regulatory Services Partnership serving Merton, Richmond and Wandsworth Councils has been contacted for relevant information.

The Environmental Health Department of Hertfordshire and North London has no records of contamination in connection with the site.

Responses from the Council to RSK's enquiries are included within Appendix E and can be summarised as follows:

They are not aware of any contamination in connection with the site and there is no declaration of the site under Part 2A of the EPA 1990 with no imminent plans to investigate.

There are no recorded landfill sites existing within 500 m of the site boundary and whilst Twickenham gravel pit existed 200 m to the south west this is known to have been backfilled around 1915.

The Council is aware of one environmental assessment for the site conducted by RSK in 2014 relating to the Normansfield Avenue, Teddington.

4.3.3 Site services

Buried utility services and their backfill can provide preferential pathways for gas, vapour or groundwater to migrate along to another part of the site or to a receptor. They can also represent significant constraints to development.

Service plans obtained from utility companies either by RSK or the client are contained in Appendix F; these are dated 1/09/2022. Buried services present on-site or located adjacent to site boundaries that could represent a pathway for migration of groundwater and gases / vapours comprise:

- Indigo Pipelines - Loddon Reach, Reading Road, Arborfield, Reading, Berkshire, RG2 9HU – Services run along Craneford way up to the Southwestern corner of the phase 2 site area.
- Cadent - Brick Kiln Street, Hinckley, Leicester, LE10 0NA – Services run along Craneford Way, 50 m to the south of the site, and follow the Eastern boundary of the Phase 1 Site area.

- Richmond and Wandsworth Council - Richmond upon Thames, Civic Centre, 44 York Street, Twickenham,TW1 3BZ – Services run along Craneford Way, 50 m to the south of the site. Then follow the western boundary of the Phase 2 site area, and the Eastern boundary of the Phase 1 area.
- Virgin Media - Griffin House, 161 Hammersmith Road, Hammersmith, London, W6 8BS - Services run parallel 50 m from the southern boundary of the site along Craneford Way and up the west boundary cutting into the bottom of the Phase 2 area.
- BT Open Reach - 1 Braham Street, London, E1 8EE
- Thames Water - Thames Water Utilities Ltd Property Searches, PO Box 3189, Slough, SL1 4WW, DX 151280 Slough 13 – Services run parallel 50 m from the southern boundary of the site.

4.4 Site geology

4.4.1 Anticipated geological sequence

Published records (British Geological Survey, 2022) for the area and available historical borehole logs indicate the geology of the site to be characterised by the succession recorded in **Table 6**. There are several publicly available BGS historical boreholes located within 250 m of the site, a selection of which is presented in Appendix E.

Table 6 Site geology

Strata	Description	Estimated thickness	Permeability
Made ground	Fill material of dark and orange, brown sandy clay and clayey sand, with gravels of brick, flint and locally, whole bricks. Occasional pockets of ash observed.	0.3 -1.2 m	Permeable
Kempton Park Gravel Member	Superficial - Sands and Gravels	c. 6 m	Permeable
London Clay Formation	Bedrock – Clays	c. 50 m	Impermeable
Relevant information sources: BGS Geoindex ☒ BGS borehole logs ☒ Previous SI reports ☒			

With reference to the historical data there have clearly been some phases of construction and demolition on the site and therefore the presence of made ground should be expected.

4.4.2 Radon

The environmental database report indicates that the site is not located within an 'Affected Area'. An 'Affected Area' is one with 1% or more homes above the radon Action Level of 200 Bq m^{-3}. Therefore, the risk of significant ingress of radon into structures on-site is considered to be low and no radon protective measures are required within new dwellings

(or extensions) at the site. Note the site-specific assessment within the environmental database report is at a higher resolution and therefore provides greater detail than that publicly available in the indicative radon atlas at www.ukradon.org.

4.5 Mining and quarrying

An initial site appraisal has been carried out based on the information provided on the Coal Authority Interactive Viewer of the UK Coalfield areas. This indicates the site lies outside the Coal Authority Consultation Area and is not located within a coalfield area.

A historical gravel pit, also known as Twickenham gravel pit, was historically located 200 m to the southwest of the site.

4.6 Hydrogeology

A summary of the hydrogeological setting of the site, with respect to the anticipated geological sequence set out in **Section 4.5** is presented below in **Table 7**.

Table 7 Summary of hydrogeological setting

Condition	Description
Aquifer characteristics	The site is underlain by the Kempton Park Gravel Member (Principal Aquifer designation), and beneath that by the London Clay Formation (unproductive strata designation). Principal aquifers are defined as deposits exhibiting high permeability capable of high levels of groundwater storage. Such deposits are able to support water supply and river base flows on a strategic scale. Unproductive strata are defined as deposits exhibiting low permeability with negligible significance for water supply or river base flow. Unproductive Strata are generally regarded as not containing groundwater in exploitable quantities
Depth to groundwater and flow	The depth to groundwater recorded during the November 2015 monitoring events in the monitoring standpipes located within the wider college area varied between 1.30 m bgl and 1.70 m bgl on 4th November 2015, and between 1.10 m bgl and 1.55 m bgl on 18th November 2015 respectively. Overall, groundwater strikes and resting groundwater table levels recorded in trial pits and driven sampler probe holes at locations across the wider site area ranged between 1.40 m bgl and 2.5 m bgl. Shallow groundwater in the site area is anticipated to flow in a southerly direction, i.e. towards and in the direction of flow of the River Crane, located directly to the south. There is likely to be some drainage and flow towards and in the direction of The Duke of Northumberland's River located to the west.
Groundwater recharge/ attenuation	Most of the site is currently covered with buildings and hardstanding and therefore this will limit infiltration to ground and groundwater recharge, except where SUDS are present.
Historical implications for hydrogeology	None

Condition	Description
Licensed groundwater abstractions	The environmental database report indicates that there are no groundwater abstractions within a 1 km radius of the site.
Source protection zones	Information available in the Envirocheck report and the MAGIC website indicates that the site does not lie within a currently designated groundwater Source Protection Zone (SPZ).

4.7 Hydrology

A summary of the hydrology within the site area is summarised in **Table 8**.

Table 8 Summary of hydrology in site area

Condition	Description
Surface watercourses	There are no ponds, streams or drainage ditches on or adjacent to the site The nearest identified surface water feature is the River Crane located approximately 175 m to the south of the site. The River Crane is at the reach of The Duke Of Northumberland's River (Lower) – Tideway has a GQA grade rating of River Quality C.
Surface water abstractions	There are no surface water abstractions identified by the environmental database, within a 1 km radius of the site.
Site drainage	Surface drainage from the site appears to be discharged into municipal sewer and potentially the River Crane to the South.
Preliminary flood risk assessment	The site is located within a fluvial flood plain. There is a low risk potential for Groundwater Flooding to occur at the surface on site and in the adjacent areas, mainly to the north and beyond Chertsey Road. It should be noted that this information does not constitute a site-specific Flood Risk Assessment (FRA), and a full FRA may be required for the development to support a planning application or satisfy planning conditions. Based on the Government's 'Flood Map for Planning' website: https://flood-map-for-planning.service.gov.uk/ the site is classed as being in Flood Zone 1 (low probability of flooding). The wider site area (Phases 1 and 2) is greater than 1 Hectare and a flood risk assessment (FRA) may be required as part of the planning process for redevelopment. Further information can be obtained from the following source: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?easting=471054&northing=261111&address=15112141

4.8 Sensitive land uses

There are no designated environmentally sensitive areas identified within 250 m of the site based on the environmental database report.

5 SITE RECONNAISSANCE FINDINGS

A site reconnaissance survey was completed on 24 August 2022 by RSK. The characteristics of the site observed during the walkover and from current ordnance Survey maps are summarised in **Table 9**.

A site plan is provided in Figure 2 with photographic records included in Appendix G detailing the main features identified below.

Whilst the walkover summary includes consideration of current operations and housekeeping on the site as potential sources of contamination, it does not constitute a comprehensive environmental audit of the site, as covered under ISO 14001.

Table 9 Site reconnaissance findings

Feature	Description
Physical characteristics	
Access constraints	The Site is easily accessed from the A316. Two sets of gates restrict access to Phase 2 area, however, these allow full access once opened through communication with the College. The area to the north of Phase 2 recently undergone above ground demolition. Crushed demolition materials were stockpiled and ready for potential reuse.
Site topography	The Site is essentially level or the ground slopes gently downwards towards the south.
Surface cover	The majority of the Phase 2 site area (approximately 90%) is surfaced with hardstanding, the other areas are surfaced with crush and rubble (in the northern area) and limited soft landscaping at the southern boundary.
Site drainage	The surface water on site drains into the on site drainage, potentially joining outfalls that drain into the River Crane. No areas were waterlogged or had evidence of flooding.
Surface water	There are no streams or drainage ditches on or adjacent to the site. The nearest surface watercourse/feature are the River Crane and the Duke of Northumberland's River located south and west respectively from the site boundary.
Trees and hedges	The site contains no trees, hedges or other substantial vegetation, however, there are some trees present at site's western boundary.
Invasive species	Based upon the walkover survey obvious evidence of Japanese Knotweed or other invasive species has not been identified on-site. However, it should be noted that a detailed survey of the possible presence or absence of invasive species is outside of the scope of investigation and consideration should be given to commissioning a specialist survey, as necessary.
Existing buildings on-site	The Site contains a three-storey office/college building, and multiple single storey buildings. The Site contains the remnants of former buildings/structures, demolished down to ground slab level, in the North area of the site.

Feature	Description
Retaining walls and adjacent buildings on or close to site boundary	There were no retaining structures/walls noted to be present on site and the existing buildings are located 10-15 m from site's western boundary.
Basements on-site	No evidence of existing or infilled basements was observed, however, it was noted in the previous reports that some buildings on Phase 1 contain a basement.
Made ground, earthworks and quarrying	Made ground is present on site and is estimated to be approximately 1 m thick.
Potentially unstable slopes on or close to site	None observed
Buried and overhead services present	There are several manhole covers on-site Overhead services were noted too.
Environmental characteristics	
Underground/ above ground storage tanks and pipework	None observed
Potentially hazardous materials storage and use	None observed
Asbestos-containing materials	No obvious asbestos construction materials were observed but a detailed survey of the buildings would be required to confirm the presence or otherwise of asbestos-containing materials.
Waste storage	Waste from the college facilities is stored in wheelie bins.
Fly-tipping	None observed
Electricity sub-stations/ transformers	None observed on or close to site
Evidence of possible land contamination on-site	None observed
Potential off-site sources of ground contamination	Based on the site walkover, there are no potentially contaminative sources immediately off site.

No potentially significant land contamination or geotechnical issues were identified during the site reconnaissance survey.

6 PRELIMINARY GEOTECHNICAL CONSTRAINTS

6.1 Preliminary geotechnical hazards assessment

A summary of commonly occurring geotechnical hazards associated with the anticipated geology outlined in **Section 3** above is given in **Table 10** together with an assessment of whether the site may be affected by each of the stated hazards.

Table 10 Summary of preliminary geotechnical risks that may affect site

Hazard category	Hazard status based on desk study findings and proposed development		Engineering considerations if hazard affects site
	Could be present and/or affect site	Unlikely to be present and/or affect site	
Sudden lateral changes in ground conditions associated with the inherent nature of the drift deposits (Kempton Park Member)	☒	☐	Likely to affect ground engineering and foundation design and construction
Shrinkable clay soils (predominantly granular within the upper portions of the anticipated soil profile)	☐	☒	Design to NHBC Standards Chapter 4 or similar
Highly compressible and low bearing capacity soils, (localised peat lenses possibly present within the drift deposits)	☒	☒	Likely to affect ground engineering and foundation design and construction
Silt-rich soils susceptible to rapid loss of strength in wet conditions (predominantly granular within the upper portions of the anticipated soil profile)	☐	☒	Likely to affect ground engineering and foundation design and construction
Running sand at and below water table (assuming foundations above the groundwater table)	☐	☒	Likely to affect ground engineering and foundation design and construction
Karstic dissolution features (including 'swallow holes' in Chalk terrain)	☐	☒	May affect ground engineering and foundation design and construction – refer to **section 4.1.2**

Hazard category	Hazard status based on desk study findings and proposed development		Engineering considerations if hazard affects site
	Could be present and/or affect site	Unlikely to be present and/or affect site	
Evaporite dissolution features and/or subsidence	☐	☒	May affect ground engineering and foundation design and construction
Ground subject to or at risk from landslides	☐	☒	Likely to require special stabilisation measures
Ground subject to peri-glacial valley cambering with gulls possibly present	☐	☒	Likely to affect ground engineering and foundation design and construction
Ground subject to or at risk from coastal or river erosion	☐	☒	Likely to require special protection/stabilisation measures
High groundwater table (including waterlogged ground)	☐	☒	May affect temporary and permanent works
Rising groundwater table due to diminishing abstraction in urban area	☐	☒	May affect deep foundations, basements and tunnels
Geological faults, fissures and break lines	☐	☒	May affect ground engineering and foundation design and construction
Underground mining including shafts and adits (e.g. coal, mineral)	☐	☒	Likely to require further assessment including potentially special stabilisation measures
Effects of extreme temperature (e.g. cold stores or brick kilns/furnaces)	☐	☒	Likely to affect ground engineering and foundation design and construction
Existing sub-structures (e.g. tunnels, foundations, basements, and adjacent sub-structures)	☒	☐	Likely to affect ground engineering and foundation design and construction
Filled and made ground (including embankments, infilled ponds and quarries)	☒	☐	Likely to affect ground engineering and foundation design and construction
Adverse ground chemistry (including expansive slags and weathering of sulphides to sulphates) associated with shallow ground conditions	☐	☒	May affect ground engineering and foundation design and construction

Hazard category	Hazard status based on desk study findings and proposed development		Engineering considerations if hazard affects site
	Could be present and/or affect site	Unlikely to be present and/or affect site	
Site topography	☐	☒	May affect ground engineering and foundation design and construction
Note: Seismicity is not included in the above table as this is not normally a design consideration in the UK.			

7 INITIAL CONCEPTUAL SITE MODEL

In the UK land contamination is assessed using a risk-based approach taking account of the magnitude (severity of the hazard) and likelihood (probability) of occurrence. A 'receptor' is something that could be adversely affected by contamination (e.g. people, an ecological system, property or a water body). A 'pathway' is a route or means by which a receptor is or could be exposed to or affected by a contaminant. A 'contaminant source' is a hazard but it can only pose a risk to a receptor where a pathway is present. The relationship between sources, pathways and receptors are referred to as a conceptual site model. A risk can only be released where a contaminant source, pathway and receptor are all in place, referred to as a 'pollutant linkage'.

In line with LCRM (Environment Agency, 2021) and BS 10175: 2011 + A2 2017 (BSI, 2017), RSK has used information in the preceding sections to identify hazards (sources of contaminants), receptors that may be impacted and plausible linking pathways. Where all three are present this is termed a potentially complete contaminant linkage and a qualitative risk estimation is made.

7.1 Potential soil, soil vapour and groundwater linkages

7.1.1 Potential sources of contamination

Potential sources of soil and groundwater contamination identified from current activities and the history of the site and surrounding area are presented in **Table 11**. Ground gas sources are addressed in the next section.

Table 11 Potential sources of soil and groundwater contamination

Potential sources	Contaminants of concern
On-site	
Made ground (i.e. fill material) as identified in the Soiltechnics 2016 report.	Fill material of dark and orange brown sandy clay and clayey sand, with gravels of brick, flint and locally, whole bricks. Occasional pockets of ash observed. Potential for inorganics, polycyclic aromatic hydrocarbons (PAHs), asbestos containing materials
Off-site	
Council depot, Langhorn Drive, commercial vehicle servicing, (Inactive); 135 m SW	Petroleum hydrocarbons
Carpet and upholstery cleaners 210 m E (active)	Chlorinated solvents
Infilled former pit (Twickenham Gravel Pit, 200 m to the SW infilled by 1915)	Potentially contaminative material e.g. Inert/ commercial/ industrial/ municipal waste or landfill leachate including ammoniacal nitrogen, chloride.

7.1.2 Sensitive receptors and linking exposure/ migration pathways

Sensitive receptors identified at or in the vicinity of the site that could be affected by the potential sources identified above comprise:

- Future site users – residential users [oral, dermal and inhalation exposure with impacted soil, soil vapour and dust/fibres, ingestion of home-grown produce, inhalation of vapours from groundwater]
- Future site users – public open space users, [oral, dermal and inhalation exposure with impacted soil, soil vapour and dust, inhalation of vapours from groundwater]
- current adjacent site users – residential and public open space users [migration of contamination via dust/fibre deposition, vapour or groundwater migration combined with inhalation]
- Future buildings and services [direct contact with contaminated soils or groundwater and chemical attack]
- Groundwater in principal aquifer within Kempton Park Gravel Member deposits [percolation through permeable strata to aquifer/ lateral migration of dissolved phase]
- surface water course (River Crane and The Duke of Northumberland River) [lateral migration of dissolved phase / site run-off/ drainage]

Potential linking pathways are show in brackets for each item above.

Please note that construction workers and future maintenance workers have not been identified in the conceptual model as receptors because risks are considered to be managed through health and safety procedures according to the CDM Regulations.

Ecological receptors are only considered within the conceptual model in the context of statutory protected sites.

7.2 Potential ground gas linkages

7.2.1 Ground gas generation potential

Potential ground gas sources identified for the site and surrounding are shown in **Table 12**.

Table 12 Potential ground gas sources

Potential sources	Indicative ground gas generation potential (CIEH, 2008)	Additional information
On-site		
Made ground with low degradable organic content (e.g. up to 5% organic material and no easily degradable waste).	Very low	Unknown fill material but potentially including brick, ash and clinker and containing toxic and phytotoxic metals, inorganics, polycyclic aromatic hydrocarbons (PAHs), asbestos
Off-site		
Twickenham Gravel Pit, 200 m SW infilled by 1915	Low	The precise size of the former pit and nature of the fill material are unknow, however, considering that the pit was relatively small and the fill material likely included domestic waste types generated prior to 1915, the gas generation and migration potentials from this potential source to the site is considered low.

The potentially contaminative made ground material potentially present up to 1.2 m depth has a very low gas generation potential, while the offsite source in a form of a historic infilled pit has a low ground gas generation potential.

7.3 Preliminary risk assessment

The preliminary risk assessment findings and potentially complete contaminant linkages are shown in **Table 13** overleaf. The risk classification based on the combination of hazard consequence and probability using a risk matrix from CIRIA C552 (Rudland et al., 2001), a summary of which is included in Appendix H. This relates to Tier 1 preliminary risk assessment in LCRM (Environment Agency, 2021). The initial conceptual site model is shown schematically in Figure 3.

Table 13 Risk estimation for potentially complete contaminant linkages

Potential source	Potential receptor	Possible pathway	Likelihood	Severity	Potential risk	Justification
Made ground (potentially containing metals, inorganics, organics, asbestos contaminants)	Future site users – residential	Exposure to potential contaminants in Made Ground via oral, dermal and inhalation exposure with impacted soil, soil vapour and dust/fibres, ingestion of home-grown produce	Low likelihood	Medium	Low/Moderate	Some contamination was previously detected in the made ground on Phase 1, however, further chemical testing and assessment of the made ground soils on Phase 2 are required to inform the remediation strategy and requirements for any contamination mitigation measures.
	Current adjacent site users	Migration of potential contaminants via dust/fibre deposition, vapour or groundwater migration combined with inhalation	Low likelihood	Medium	Low/Moderate	Chemical testing and assessment of shallow made ground soils on Phase 2 is required to confirm any potential risk associated with dust and fibres inhalation by of site users, specifically during the site redevelopment.
	Controlled waters	Leaching of contaminants in Made Ground into groundwater	Unlikely	Medium	Low	Kempton Park Gravel Member beneath site is permeable and classed as an aquifer. The shallow made ground is unlikely to leach significant contamination into the groundwater.

Potential source	Potential receptor	Possible pathway	Likelihood	Severity	Potential risk	Justification
	Future buildings & services	Direct contact with contaminated soils or groundwater and chemical attack	Low Likelihood	Minor	Very Low	Potable water services (plastic material) can be adversely affected by presence of hydrocarbons in ground. Low likelihood of risk due to absence of significant hydrocarbon contamination identified.
Off site sources Council depot, Langhorn Drive, commercial vehicle servicing, (Inactive); 135 m SW Carpet and upholstery cleaners 210 m E (active) Infilled former pit (Twickenham Gravel Pit, 200 m to the SW infilled by 1915)	Future site users / residents	Migration of contamination to the site, vapours generation from groundwater and inhalation of vapours	Unlikely	Medium	Low	It is unlikely that volatile hydrocarbons would migrate to the site in concentrations that would represent a risk from volatilisation/migration and inhalation of hydrocarbon vapours.
	Controlled Waters	Migration of NAPL and dissolved phase to the site from off site sources	Low likelihood	Medium	Moderate / Low	Considering the distance and nature of the offsite sources (inactive depot, a small gravel pit infilled in 2015) there is a low likelihood for contamination migration into the site. The overall risk associated with the potential pollutant pathway is Moderate to Low and that chemical testing of groundwater would be required to confirm the risks.

Risk matrix		Consequences			
		Severe	Medium	Mild	Minor
Probability	Highly likely	Very high	High	Moderate	Moderate/low
	Likely	High	Moderate	Moderate/low	Low
	Low likelihood	Moderate	Moderate/low	Low	Very low
	Unlikely	Moderate/low	Low	Very low	Very low

Potentially complete contaminant linkages with a potential risk of moderate to low or higher identified in in **Table 13** comprise:

- Future site users (residential) - exposure to potentially contaminative made ground on site
- Future site users (open/public spaces) - exposure to potentially contaminative made ground on site
- Current adjacent site users - exposure to potentially contaminative made ground from on site through migration of dust and/or groundwater
- Controlled water - leaching of made ground contaminants into controlled waters

These potentially complete contaminant linkages need to be assessed further through appropriate site investigation to target the identified sources of potential contamination and assess the feasibility of identified pathways.

7.4 Data gaps and uncertainties

Key data gaps and uncertainties identified in the CSM at desk study stage include:

- Gaps in available historical OS maps between 1976 and 1992.
- The previous 2016 intrusive investigations were restricted to areas where access was permitted and no drilling was undertaken within the footprints of the buildings. Therefore, some data gaps may exist for potential contamination in soil and groundwater in the locations of the present day workshops on site.
- Access not available to some areas of the south of the site due to building cover, and buildings being used as an active educational facility.
- Groundwater depth and flow direction are conceptual at this stage.

8 SITE INVESTIGATION STRATEGY & METHODOLOGY

8.1 Introduction

RSK carried out intrusive investigation works and subsequent monitoring of boreholes between September 20th and September 27th 2022.

8.2 Objectives

The specific objectives of the investigation were as follows:

- to establish the ground conditions underlying the site including the extent and thickness of any made ground
- to investigate specific potential sources of contamination identified in initial CSM
- to determine groundwater depth and flow direction
- to determine the ground gas regime underlying the site
- to assess geotechnical properties of soils
- to address some of the data gaps identified in Section 6.4.

8.3 Selection of investigation methods

The techniques adopted for the investigation were chosen with consideration of the objectives and site constraints, which are described below.

Cable percussion drilling was chosen based on the targeted drill depth, requirement for in-situ geotechnical data, the opportunity to collect both disturbed and undisturbed samples and install monitoring wells. This was supplemented by window sampling at 5 investigation locations to achieve greater visibility across the site of the Made Ground.

Prior to conducting intrusive works, utility service plans were obtained and buried service clearance undertaken in line with RSK's health and safety procedures. Copies of statutory service records obtained by RSK as part of the agreed scope of works are contained in Appendix F.

8.4 Investigation strategy

The ground investigation was carried out using intrusive ground investigation techniques in general accordance with the recommendations of BS5930:2015+A1:2020, which maintains compliance with BS EN 1997-1 and 1997-2 and their related standards. Whilst every attempt was made to record full details of the strata encountered in the boreholes, techniques of hole formation and sampling will inevitably lead to disturbance, mixing or loss of material in some soils and rocks.

The investigation strategy involved non-targeted boreholes and window sampling. The investigation comprised an exploratory investigation focussing on the phase 2 site area.

The constraints to the investigation were as follows:

- No access was provided inside the footprint of the existing buildings;
- The site remains an active education facility and so access was restricted in some areas;
- Concrete cover and hardstanding meant the intrusive locations had to be broken out prior to hand pitting and drilling

Details of the investigation locations, installations and rationale are presented in **Table 14**. Three cable percussive boreholes were drilled to a maximum depth of 30 m bgl and each was installed with a combined gas and groundwater monitoring well. An exploratory hole location plan is shown on Figure 4.

Table 14 Exploratory hole and monitoring well location rationale

Investigation type	Number	Designation	Monitoring well installation	Rationale examples below
Boreholes by cable percussive methods	3	BH1 to BH3	Groundwater	To prove the geological succession beneath the site and obtain geotechnical data.
Boreholes by dynamic/ windowless sampling methods	5	WS1 to WS5	Gas	To determine the contamination status of the ground beneath the site and to install additional dual purpose groundwater and gas monitoring wells.

8.4.1 Implementation of investigation works

The exploratory holes were logged by an engineer in general accordance with the recommendations of BS5930:2015+A1:2020 (which incorporates the requirements of BS EN ISO 14688-1, 14688-2 and 14689-1).

The monitoring well construction and associated response zones are detailed on the exploratory hole records in Appendix I. The response zones were installed to target identified gas generation sources or migration pathways detailed in the initial preliminary CSM. In the boreholes, wells were installed with 3 m of plain 50 mm diameter piping, and 5 m of slotted 50 mm diameter piping, resulting in a total install depth of 8 m bgl. Window sample holes WS02 and WS04 were installed with 1 meter of plain piping and 2 m of slotted piping, to a total depth of 3 m bgl.

The soil sampling and analysis strategy was designed to characterise each encountered soil strata, permit an assessment of the potential contaminant linkages identified and investigate the geotechnical characteristics. In addition, samples were taken to allow for geo-environmental and geotechnical testing to be undertaken.

Soils collected for laboratory analysis were placed in a variety of containers appropriate to the anticipated testing suite required. They were dispatched to the laboratory in cool boxes under chain of custody documentation. Samples were stored in accordance with

the RSK quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination.

Selected samples were placed in polythene bags for headspace screening with a photo-ionisation detector (PID) fitted with a 10.6 eV bulb. The PID screening results are presented on the exploratory hole records.

8.5 Monitoring programme

8.5.1 Ground gas monitoring

In line with the initial CSM, response zones were installed to target the sources or pathways as detailed in **Table 15**.

Six monitoring rounds have been undertaken to provide data to support refining of the CSM. The number of monitoring rounds undertaken is in general accordance with the decision matrix presented as Figure 6 of BS8576 for a low source generation potential and medium sensitivity development.

A calibrated infrared gas meter was used to measure gas flow, concentrations of carbon dioxide (CO_2), methane (CH_4) and oxygen (O_2) in percentage by volume, while hydrogen sulphide (H_2S) and carbon monoxide (CO) were recorded in parts per million.

Initial and steady state concentrations were recorded. In addition, during the first monitoring round, all wells were screened with a PID to establish if there are any interferences and cross-sensitivity of other hydrocarbons with the infrared gas meter

The atmospheric pressure before and during monitoring, together with the weather conditions, were recorded. The monitoring included periods of falling atmospheric pressures and after/during rainfall.

All ground gas monitoring results together with the temporal conditions are contained within Appendix J. Equipment calibration certificates are available on request.

8.5.2 Groundwater monitoring and sampling

Six rounds of groundwater monitoring were undertaken on a weekly basis and one round of groundwater sampling was carried out. The monitoring records, including dates, are shown in Appendix K.

Development of the monitoring wells following installation was undertaken comprising the removal of three well volumes using a pump.

Depths to groundwater were recorded using an electronic dip meter on each of the return monitoring visits.

Groundwater samples were retrieved using a United States Environment Protection Agency (USEPA) approved low-flow purging and sampling methodology. Details of the low-flow sampling procedure are set out in Appendix J. Water samples were dispatched to the laboratory in cool boxes under chain of custody documentation.

8.5.3 Surface water sampling

One surface water sample was collected from the River Crane on the 23rd September 2022 using a bailer. The sample was dispatched to the laboratory in a cool box under a change of custody documentation.

8.6 Laboratory testing

Laboratory testing was undertaken at a UKAS accredited laboratory with ISO17025 and MCERTS accredited test methods were specified where applicable for contamination testing and as shown in the laboratory test certificates appended.

8.6.1 Chemical analysis of soil samples

The soil sampling strategy was designed to characterise made ground typically within the upper 1.5 m of the ground profile whilst also characterising deeper strata and the potential for contaminant migration from relevant sources of identified within the preliminary CSM.

The programme of chemical tests undertaken on soil samples obtained from the intrusive investigation is presented in **Table 15** with the laboratory testing results contained in Appendix L.

Table 15 Summary of chemical testing of soil samples

Stratum	Tests undertaken	No. of tests
Made ground	Asbestos screening and ID	10
	Soil Suite 2 - Speciated PAH-16MS, TPHCWG (spec.TPH), pH, As, Cd, Cr, Cu, Hg, Pb, Ni, Se, Zn, Total Sulphate, ws Sulphate	5
	Chromium VI	5
	TCN	4
	TOC	3
Kempton Park Gravel	Soil Suite 2 - Speciated PAH-16MS, TPHCWG (spec.TPH), pH, As, Cd, Cr	3
	TOC	3

8.6.2 Geotechnical analysis of soils

Where appropriate disturbed, bulk and undisturbed soil samples were taken for geotechnical classification testing with the depth and nature of samples detailed within the exploratory hole records.

Where appropriate, testing was undertaken in accordance with BS 1377:1990 Method of Tests for Soils for Civil Engineering Purposes or, where superseded, by the relevant part of BS EN ISO 17892:2014 Geotechnical investigation and testing - Laboratory Testing of Soil. Tests carried out in order to classify the concrete class required on-site have been undertaken following the procedures within BRE SD1:2005.

The programme of geotechnical tests undertaken on samples obtained from the intrusive investigation is presented in **Table 16**. The results and UKAS accreditation of tests methods are shown in Appendix M.

Table 16 Summary of geotechnical testing undertaken

Strata	Tests undertaken	No. of tests
Made Ground	Particle Size (S.A.)	1
Kempton Park Gravel	Moisture Content %	3
	Atterberg Limits	1
	Particle Size (S.A.)	4
London Clay	Moisture Content %	6
	Atterberg Limits	6
	Triaxial Test (100 mm)	6

8.6.3 Chemical analysis of groundwater and surface water samples

Groundwater and surface water samples were collected in containers appropriate to the anticipated testing suite required. The containers were filled to capacity and placed in a cool box to minimise volatilisation.

Chemical testing undertaken on water samples obtained during the monitoring programme is presented in **Table 17** with the laboratory testing results contained in Appendix N.

Table 17 Summary of chemical testing of water samples

Sample type	Tests undertaken	No. of tests
Groundwater	Dissolved metals, pH, TPH-CWG, PAH-16, sulphate	3
Surface water (River Crane)		1
	pH	1
	Calcium	1
	DOC	1

9 SITE INVESTIGATION FACTUAL FINDINGS

The results of the intrusive investigation and subsequent geo-environmental and geotechnical laboratory analysis undertaken are detailed below.

9.1 Ground conditions encountered

The descriptions of the strata encountered, notes regarding visual or olfactory evidence of contamination, list of samples taken, field observations of soil and groundwater, in-situ testing and details of monitoring well installations are included on the exploratory hole records presented in Appendix I.

The exploratory holes revealed that the site is underlain by a variable thickness of made ground over the Kempton Park Gravel member with the London Clay Formation at depth. This appears to confirm the stratigraphical succession described within the preliminary CSM and previous investigations.

For the purpose of discussion, the ground conditions encountered during the recent fieldworks are summarised in **Table 18** with the strata discussed in subsequent subsections.

Table 18 General succession of strata encountered (RSK 2022)

Stratum	Exploratory holes encountered	Depth to top of stratum m bgl	Proven thickness (m)
Made ground	BH01-22 to BH03-22, WS01-22 and WS05-22	0.00 (Ground Level)	0.50 to 1.70
Kempton Park Gravel Member	WS01-22 to WS05-22	0.50 to 1.10	Proven to the full depth of the investigation (3.60 m bgl)
	BH01-22 to BH03-22	1.20 to 1.70	4.30 to 5.80
London Clay Formation	BH01-22 – BH03-22	6.20 to 7.0	Proven to the full depth of the investigation (30 m bgl)

9.1.1 Made ground

The exploratory holes revealed a variable thickness of made ground ranging between 0.50 and 1.70 m. The Made Ground was heterogeneous in nature and reference should be made to the individual records. In general, it comprised an initial surface layer (asphalt/concrete) overlying a variable proportion of anthropogenic material in a granular matrix. Localised sandy clay with frequent inclusions of gravel sized brick fragments and brick cobbles was additionally noted.

9.1.2 Kempton Park Gravel

Soils recovered as the Kempton Park Gravel were encountered beneath the made ground, predominantly characterised by slightly clayey gravelly fine to coarse sand/sandy gravel. The gravel fraction consisted of subangular to rounded fine to coarse flint. A thin cohesive portion (between 0.20 and 0.40 m) was recorded locally above the granular horizon in WS01-22, WS03-22 and WS05-22, which typically comprised firm gravelly sandy clay.

A summary of the in-situ and laboratory test results recorded in the stratum are presented in **Table 19**.

Table 19 Summary of in-situ and laboratory test results (granular portion)

Soil parameters		Min. Value	Max. Value	Reference
SPT 'N' values (unfactored)		15	>50	Appendix I
Density term		Medium to Very Dense		Appendix I
Grading (%)	Silt/clay	0.4	20.6	Appendix M
	Sand	17.6	65.6	Appendix M
	Gravel	34.1	81.5	Appendix M

9.1.3 London Clay

The London Clay Formation was encountered beneath the Kempton Park Gravel and proven to a maximum depth of 30 m. The London Clay Formation typically comprised stiff high to very high strength closely fissured dark grey/grey silty clay with rare inclusions of phosphatic/calcareous nodules. Claystone band was recorded locally in BH01-22 (8.50 m and 24.30 m), BH02-22 (9.10 m and 27 m) and BH03-22 (9 m and 24.2 m).

A summary of the in-situ and laboratory test results recorded in the stratum are presented in **Table 20**.

Table 20 Summary of in-situ and laboratory test results for cohesive unit

Soil parameters	Min. Value	Max. Value	Reference
Moisture content (%)	20	27	Appendix M
Liquid limit (%)	70	87	Appendix M
Plasticity limit (%)	25	28	Appendix M
Plasticity index (%)	43	59	Appendix M
Plasticity term	Very High		Appendix M
Volume change potential	High		Appendix M
SPT 'N' values	28	<50	Appendix I
Undrained shear strength inferred from SPT 'N' values (kN/m^2)* based on a stroud factor of 5.7	182	>300[1)]	
Undrained shear strength measured by triaxial testing (kN/m^2)	111	197[2)]	Appendix M
Consistency Index	0.957	1.163	

Soil parameters	Min. Value	Max. Value	Reference
Consistency term from field description	Stiff	Very Stiff	Appendix I
Strength term (inferred from Triaxial testing)	High	Very High	

1) High 'N' was most likely contributed by the concretion nodules/claystone.
2) Undrained unconsolidated triaxial results relating to undisturbed samples U5 and U8 omitted due to unrepresentative confining pressures.

9.1.4 Visual/olfactory evidence of soil contamination

No visual or olfactory evidence of contamination was recorded during the course of the investigation.

On-site PID screening of disturbed samples indicated concentrations of volatile organic compounds (VOC) <1 ppm, indicating the absence of significant VOC within the samples.

9.2 Groundwater and surface water

9.2.1 Groundwater encountered during intrusive works

Groundwater was encountered during the intrusive investigation works as detailed on the logs in Appendix I. Groundwater strikes occurred at depths of 3.7 m bgl and 4.5 m bgl.

9.2.2 Groundwater encountered during monitoring

Rest groundwater levels recorded during the monitoring programme are summarised in **Table 21** based on the data provided in Appendix K. Field data measurements are also shown in Appendix K.

Table 21 Summary of groundwater monitoring results

Monitoring well	Response zone stratum	TOC elevation (m AOD)	Depth to water (mb TOC)	Product thickness (m)	Groundwater elevation (m AOD) – min.	Groundwater elevation (m AOD) – max.
BH01	3-8 m bgl	9.47	1.57 – 2.38	n/a	7.09	7.90
BH02	3-8 m bgl	9.29	1.44 – 2.13	n/a	7.16	7.85
BH03	3-8 m bgl	9.52	1.74 – 2.53	n/a	6.99	7.78

The findings reflect the groundwater table in the Kempton Park Gravel Member, which is at an elevation between 6.99 to 7.90 m AOD.

It should be noted that groundwater levels might fluctuate for a number of reasons including seasonal variations. On-going monitoring would be required to establish both the full range of conditions and any trends in groundwater levels.

The monitoring data have been used to construct a piezometric surface and this is presented in Figure 4. The data indicate groundwater flow in a northerly direction.

9.2.3 Visual/olfactory evidence of groundwater contamination

No visual or olfactory evidence of contamination in groundwater during well development, monitoring and sampling.

No visual or olfactory evidence of contamination in surface water, monitoring and sampling.

9.3 Chemical laboratory results

The soil and groundwater testing results are presented in Appendix L and Appendix N, respectively.

9.4 Geotechnical laboratory results

The results of the geotechnical testing are discussed in **Section 11** and presented in Appendix M.

9.5 Ground gas monitoring

The results of the ground gas monitoring and testing carried out are given in Appendix J and discussed in **Section 10**.

10 GEO-ENVIRONMENTAL ASSESSMENT

10.1 Refinement of initial CSM

Following the intrusive investigation ground conditions are the same as anticipated in the CSM with no significant changes. Made ground and natural strata were all of expected thickness with no obvious visual or olfactory evidence of contamination.

Groundwater depths were also in line with anticipated values, being present in the Kempton Park Gravel Member, at approximately 3.7 - 4.5 m bgl.

Linkages retained after the refinement of the initial CSM include:

- Future site users (residential) - exposure to potentially contaminative made ground on site
- Future site users (open/public spaces) - exposure to potentially contaminative made ground on site
- Current adjacent site users - exposure to potentially contaminative made ground from on site through migration of dust and/or groundwater
- Controlled water - leaching of made ground contaminants into controlled waters

10.1.1 Linkages added after refinement of the initial CSM

The presence of the made ground was confirmed beneath the site and therefore the following linkages were added into the assessment.

- Uptake of contaminants in vegetation potentially impacting plant growth and transferring contaminants to future users;
- Future site users (residential) – exposure to ground gases from the made ground on site.
- Organic contaminants permeating potable water supply pipes.

10.2 Linkages for assessment

As described in LCRM (Environment Agency, 2021), there are two stages of quantitative risk assessment (QRA), Tier 2 generic (GQRA) and Tier 3 detailed (DQRA). The GQRA comprises the comparison of soil, groundwater, soil gas and / or ground gas results with generic assessment criteria (GAC) that are appropriate to the linkage being assessed. This comparison can be undertaken directly against the laboratory results or following statistical analysis depending upon the sampling procedure that was adopted. This assessment relates to LCRM Stage 1, Tier 2 generic quantitative risk assessment.

Following the refinement of the CSM, the potentially complete contaminant linkages that require further assessment and the methodology of assessment are presented in **Table 22**.

Table 22 Linkages for GQRA

Potentially relevant contaminant linkage	Assessment method
Human health and phytotoxic-related linkages	
H1. Oral, dermal and inhalation exposure with impacted soil, soil vapour and dust by future residents	Human health GAC in Appendix O for a proposed residential end use with home-grown produce since the proposed end use includes residential gardens.
H2. Inhalation exposure of future residents to asbestos fibres.	Qualitative assessment based on the asbestos minerals present, their form, concentration, location and the nature of the proposed development.
H3. Uptake of contaminants by vegetation potentially impacting plant growth (phytotoxicity)	Comparison of soil data to GAC in Appendix P for phytotoxicity.
H4. Organic contaminants permeating potable water supply pipes	Comparison of soil data to GAC in Appendix Q for plastic water supply pipes using UKWIR (2010) guidance.
Controlled waters-related linkages	
W1. Migration of dissolved phase contaminants to wider principal aquifer and any associated potable abstractions	Comparison of groundwater data to relevant GAC based on Drinking Water Standards (DWS)/ Environmental Quality Standard (EQS)/ lowest of DWS and EQS in Table 1 of Appendix R.
W2. Migration of dissolved phase contaminants to surface waters (i.e. *River Crane*)	Comparison of groundwater data to relevant GAC based on freshwater Environmental Quality Standard (EQS) in Table 1 of Appendix R.
	Comparison of surface water data to relevant GAC based on freshwater EQS in Table 1 of Appendix R.
Ground gas-related linkages	
G1. Concentrations of methane and carbon dioxide in ground gas entering and accumulating in enclosed spaces or small rooms in new buildings, which could affect future site users. For methane this could create a potentially explosive atmosphere, while death by asphyxiation could result from carbon dioxide.	Borehole hazardous gas flow rates (Qhg) have been calculated using maximum (peak) methane and carbon dioxide concentrations and steady state flow rates in accordance with BS8485. This is subject to interpretation and use of professional judgement to designate the site or zones of the site characteristic situation by comparison to a Gas Screening Value (GSV) as appropriate and in line with the CSM. For applicable low-rise residential developments reference to NHBC guidance has also been considered.

10.3 Methodology and assessment of human health and phytotoxic-related linkages

10.3.1 H1. Oral, dermal and inhalation exposure with impacted soil by future occupants/site users

In order to assess the soil results against the appropriate GAC, the soil results have been split into appropriate data sets relevant to the oral, dermal and inhalation linkage.

The datasets being considered in the assessment are:

- Made Ground: WS01 – 0.2 m; WS01 – 0.8 m; WS02 – 0.3 m; WS02 – 0.8 m; WS03 – 0.3 m; WS03 – 1.0 m; WS04 – 0.3 m; WS05 – 0.2 m; WS05 – 1.3 m

As an initial assessment of the made ground dataset, all soil results have been directly compared against the GAC for residential with home-grown produce end use.

The ratio of soil contaminant concentrations of genotoxic PAHs (benz(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(ah)anthracene, indeno(123-cd)pyrene and benzo(ghi)perylene) against benzo(a)pyrene have been compared against lower and upper limits set out in C4SL project methodology (CL:AIRE, 2014). All genotoxic PAH ratios were within the upper and lower bounds of the underlying toxicological study. Therefore, and in accordance with HPA guidance (HPA, 2010), the assessment of genotoxic PAHs has been based on the use of benzo(a)pyrene as a surrogate marker. Therefore, a risk from genotoxic PAHs is only considered likely if the respective benzo(a)pyrene concentrations exceed the relevant GAC.

All made ground results have been compared with the GAC. Conservatively, a soil organic matter (SOM) of 1 % has been selected since laboratory results within the made ground range from 0.27 % and 15.74 %. The soil screening output spreadsheet is presented as Appendix S.

Assessment of the results indicates exceedances of the GAC for the contaminants shown in **Table 23**. These are highlighted in red on the screening output spreadsheet in Appendix S.

Table 23 Data summary table – Data set 1

Determinand	No. of samples tested	GAC (mg/kg)	No of exceedances	Maximum concentration (mg/kg)	
				Value	Location / depth (m bgl)
Lead	9	200	1	297	WS01 - 0.8 m
Asbestos – Chrysotile loose fibres	9	0.001	1	0.004	WS02 – 0.8 m

On the basis of the above assessment, it is considered that there are potential risks associated with the soil contamination and, as such, either additional risk assessment or remediation is required.

10.3.2 H2. Inhalation exposure of future occupants/site users to asbestos fibres

The laboratory screening for asbestos identified detectable asbestos fibres within one sample of made ground. These samples were then further analysed and the presence of fibres of chrysotile was confirmed, with a maximum of 0.004 % by weight present in the sample from WS02-0.8 m.

10.3.3 H3. Uptake of contaminants by vegetation potentially inhibiting plant growth (phytotoxicity)

The results have been compared with the GAC presented in Appendix P for this linkage. The soil screening output spreadsheet for this linkage is presented in Appendix S.

The results indicate that apart from the asbestos fibres there are no other contamination within the soils that exist associated with phytotoxic effects.

10.3.4 H4. Organic contaminants permeating potable water supply pipes

For initial assessment purposes, the results of the investigation have been compared with the GAC presented in Appendix Q for this linkage, which are reproduced from *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (UKWIR, 2010).

The results indicate that a relevant linkage is unlikely to exist associated with organic contaminants and therefore pollutant polyethylene (PE) and/or polyvinyl chloride (PVC) water supply pipes are expected to be suitable for use on the development unless remedial measures are implemented that mitigate the risk.

It should be noted that at the time of this investigation the future routes of water supply pipes had not been established, hence the investigation and sampling strategy may not be fully compliant with UKWIR recommendations. Consequently, a targeted investigation and specific sampling/analytical strategy may be required at a later date once the route(s) of the supply pipe(s) are known. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

10.4 Methodology and assessment of controlled waters-related linkages

10.4.1 W2. Migration of dissolved phase contaminants to wider principal aquifer and any associated potable abstractions

The groundwater results found to exceed the GAC presented in Appendix T are summarised in **Table 24**.

Table 24 Summary of groundwater GQRA and GAC exceedances

Determinand	GAC (µg/l) DWS	Exceedances (monitoring well and concentration µg/l)
Arsenic (dissolved)	10	BH03-22 / 10

The arsenic concentrations recorded within borehole BH03-22 equal the GAC and is likely to be representative of background concentrations. Within boreholes BH01 and BH02 the detected concentrations are 2 µg/l and 7 µg/l, respectively.

10.4.2 W3. Migration of dissolved phase contaminants to surface waters

The CSM has identified a potential linkage between groundwater and a nearby surface water body. Where groundwater is in connectivity to a nearby surface water body and the

groundwater was sampled as part of the site investigation, freshwater EQS have been used as GAC to assess data for groundwater samples.

The assessment sheet is included in Appendix T.

Some of the analytical results for groundwater are above the relevant GAC protective of surface water receptors (EQS) indicating contaminant linkages to surface waters associated with contaminants in the dissolved phase may be present. The exceedances are presented in **Table 25**.

Table 25 Summary of groundwater GQRA results with respect to surface waters

Determinand	GAC (µg/l) EQS	Groundwater exceedances (monitoring well and concentration µg/l)
Copper	1	88 (BH01-22)
Nickel	4	4 (BH02-22 and BH03-22)
Fluoranthene (w)	0.0063	0.01 (BH01-22)

Where these exceedances include copper, lead, nickel, zinc or manganese, and where direct sampling of the surface water receptor has taken place, further assessment has been undertaken using the UKTAG Metal Bioavailability Tool (M-BAT) approach Screening Tool. The tool(s) have been used to calculate the site-specific predicted no effect concentrations (PNEC) for these compounds.

Surface water samples from the watercourse the River Crane were analysed for pH, dissolved organic carbon (DOC) and calcium, these results are presented within Appendix N. The results have been input to the M-BAT tool to calculate the PNEC. Laboratory results have then been compared with the PNEC, and results are presented in **Table 26**.

Table 26 M-BAT tool results – groundwater samples

Determinand	Calculated Site Specific PNEC (µg/l)	Groundwater exceedances (monitoring well and concentration µg/l)
Copper	5.35	88

Groundwater sampling notes state the sample was ‘clear and odourless’ with no NAPL, as a result the possibility of sediment contamination affecting the sample result is unlikely.

There remains exceedance for copper in borehole BH01-22 compared to the PNEC, as summarised in **Table 26**.

Boreholes BH02-22and BH03-22 had concentrations in line with the previous GAC values of less than 4 µg/l, indicating only localised impact in the vicinity of borehole BH01-22. Furthermore, the groundwater flow beneath the site was calculated to be in northernly direction, away from the River Crane located 275 m to the south of the site; and therefore no direct pathway for contamination to travel from site to the River Crane is likely to be present. Furthermore, copper concentrations in the River Crane are less than 4 µg/l, which is less than the PNEC value, indicating no contamination. This suggests the potential

copper source on site is not having an effect on the copper concentrations in the River Crane.

Direct assessment of surface water feature

As a further line of evidence, due to the presence of River Crane in close proximity to the site, samples of the surface water have been collected to provide a direct assessment of the water quality.

Assessment of data for surface water samples against suitable EQS values indicates that:

The analytical results are below the relevant GAC protective of surface water receptors indicating no evidence of impact.

10.5 G1: Methodology and assessment of ground gas-related linkages

10.5.1 Appropriate guidance

The risks to development from ground gases have been assessed in accordance with BS8485:2015+A1:2019 (BS8485), which provides guidance on ground gas (methane and carbon dioxide) characterisation and hazard assessment, as well as providing a framework for the prescription of protection measures within new buildings.

The process involves characterising the gas hazard from combining the qualitative assessment of risk (using the CSM) with ground investigation data so that a 'characteristic situation' (CS) can be derived for the site or zones within the site. Characteristic situations range from CS1 to CS6, the higher the CS, the higher the hazard potential. Gas protection measures within new buildings can be prescribed using a point scoring system, taking into consideration the CS and the proposed building type.

BS8485 indicates that the gas hazard can be characterised using the following methods:

- an empirical semi-quantitative approach using gas monitoring data to determine the 'characteristic situation' of the site (or zones of the site) and subsequent protective measures (Wilson and Card approach).
- an empirical semi-quantitative approach using TOC data to determine the 'characteristic situation' of the site (or zones of the site) and subsequent protective measures (CL:AIRE RB17 approach)
- detailed quantitative assessment methodologies

For the purpose of this assessment, the empirical semi-quantitative using gas monitoring data approach above has been used to characterise the gas hazard and provide advice on the protective measures likely to be required within new buildings at the site.

For low rise residential developments an alternative assessment method can be adopted as per NHBC guidance (Boyle & Witherington, 2007) commonly known as the 'NHBC Traffic Light' guidance. The NHBC support the use of a standardised UK approach to demonstrate compliance with Building Regulations (NHBC, 2016). However, the NHBC state that the NHBC Traffic Light Guidance can still be used where development proposals are based on a 'typical house' comprising of up to three stories of <100 m^2 footprint and with a minimum 150 mm sub-floor ventilated void that achieves one air change per day.

As the proposed development meets these criteria, consideration with respect to NHBC guidance is provided in Section 9.5.4.

10.5.2 Summary of the refined CSM for ground gas

In the assessment of risks and selection of appropriate mitigation measures, BS8485 highlights the importance of the conceptual model. In summary, potential sources of ground gas within influencing distance of the site identified in **section 7.2** comprise:

- Made ground – TOC varied significantly between sample location and depth, at ~ 0.2 m bgl TOC ranged from 1.5%, 1.49% and 1.01% at a depth of 0.8 m bgl TOC was 9.13% and at 1.30 m bgl TOC was 0.16%. Made ground thickness across the site range from 0.5 m to 1.7 m with most values sitting at ~ 1 m.
- Infilled former pit (Twickenham Gravel Pit, 200 m to the SW infilled by 1915)

Pathways and receptors for ground gas were identified in **Section 7.2**. No building foundations designs are available at the current time.

This assessment has been undertaken to assess risks to building structures and proposed end users. The assessment has not taken into consideration the health and safety of construction workers. Risks may still be present to construction workers especially where works include the entry into excavations within the ground. Construction workers should undertake appropriate risk assessments and risks should be managed through health and safety procedures and safe systems of work.

The risk assessment has been undertaken based on the current understanding of the CSM.

10.5.3 Empirical semi-quantitative approach using borehole monitoring data (Wilson and Card approach, BS8485)

10.5.3.1 Background

The empirical semi quantitative approach using gas monitoring data requires the designation of a gas screening value (GSV) for the entire site or zones within the site, which informs the hazard potential and associated prescribed ground gas protection measures within new buildings (where necessary). BS8485 defines the GSV as the *'flow rate (l/hr) of a specific hazardous gas **representative of a site or zone**, derived from assessment of borehole concentration and flow rate measurements and taking account of all other influencing factors, in accordance with a conceptual site model'.*

BS8485 Section 6.3.1 outlines the process for developing a GSV for the site or a zone as follows:

- borehole hazardous gas flow rate (Q_{hg}) is calculated for each borehole standpipe for each monitoring event. The borehole hazardous gas flow rate is defined in BS8485 as the '*flow rate of a specific hazardous gas, either methane or carbon dioxide, from a borehole standpipe'*. The Q_{hg} is calculated from individual borehole measurements of total gas flow and the concentration of the specific hazardous gas. BS8485 states in Section 6.3.4 that the **maximum** gas concentration recorded during the monitoring event should be used, together with **steady-state** values of gas flows

- the reliability of the measured gas flow rates and concentrations are assessed taking into account borehole construction
- decisions are made about how to deal with any temporal or spatial shortages in the data
- judgements are made about what GSV to designate for use for design purposes taking all relevant information and the conceptual site model into account.

Once the Q_{hg} has been calculated for methane and carbon dioxide, individual borehole measurements are compared to the thresholds presented in Table 2 of BS8485 which inform the CS that directly relates to each individual measurement. Taking into account the site data (i.e. borehole gas concentration and flow rate to calculate the Q_{hg}) and all other influencing factors in accordance with the CSM, a decision can then be made regarding the GSV that is considered to be representative of the site or a zone within it.

Typical threshold concentrations of methane (1% v/v) and carbon dioxide (5% v/v), and flow rates (>70 l/h), are also considered when designating the GSV for the site or zone, which in turn dictates the hazard potential and CS. It is important to note that the site or zone characteristic GSV and maximum concentration or flow thresholds are guideline values and not absolute. The thresholds may be exceeded in certain circumstances, if the CSM indicates it is safe to do so.

10.5.3.2 Designation of a GSV for the site or zone

The results of the ground gas monitoring and testing undertaken, alongside site conditions at the time of monitoring, are given in Appendix J.

Consideration has been given to the presence of flooded or partially flooded response zones at the time of monitoring, with details of fully or partially flooded response zones detailed in Appendix J.

For the purposes of the current ground gas risk assessment, data from entirely flooded response zones has been included in the risk assessment.

A summary of the maximum recorded concentrations per borehole (or minimum for oxygen) is presented in **Table 27** overleaf. This table also presents details of the response zone, maximum recorded initial and steady state flow rates and minimum recorded depth to water across all monitoring rounds.

The range of atmospheric pressure over the 6 monitoring rounds completed was 998-1023 mbar and this was recorded to be falling at the time of 1 round.

Table 27 Summary of ground gas monitoring results – Maximum reported concentrations per borehole (minimum for oxygen)

Exploratory position ID	Response zone top (mbgl)	Response zone base (mbgl)	Response zone geological unit	No. of monitoring rounds	Peak CH_4 max. (%/vol)	Steady-state CH_4 max. (%/vol)	Peak CO_2 max. (%/vol)	Steady-state CO_2 max. (%/vol)	Oxygen min. (%/vol)	Peak gas flow max. (l/hr)	Steady-state gas flow max. (l/hr)	Depth to water min. (m)	Depth to water max. (m)	Atm. pressure min. (mb)	Atm pressure max. (mb)
WS02-22	1	1.4	Kempton Park Gravel	6	0.1	0.1	0.9	0.9	12	0	0	0.58	1.7	998	1023
WS04-22	1	1.8	Kempton Park Gravel	6	0.3	0.2	1.1	1.1	19.2	0	0	1.25	2.26	999	1023

10.5.3.3 *Summary of borehole hazardous gas flow rates*

Borehole hazardous gas flow rates (Q_{hg}) have been calculated for each borehole standpipe, for each monitoring round and are presented, alongside two 'worst case' checks in Appendix U comprising a probable 'worst case' and potential 'worst case' from the available monitoring data. Within this data gas concentrations exceeding the thresholds presented in Table 2 of BS8485 are identified, alongside the CS that could be associated with each individual borehole monitoring event.

Q_{hg} values for methane and carbon dioxide are zero across all monitoring rounds for both WS2 and WS4.

10.5.3.4 *Worst case check*

In accordance with BS8485, a 'worst case' Q_{hg} has been calculated per borehole by multiplying the maximum recorded flow from any monitoring round for that borehole by the maximum recorded methane or carbon dioxide concentration in that borehole. A further worst-case Q_{hg} check across all data collected is presented in Appendix U for the entire site (or zone), which has been calculated by multiplying the maximum recorded flow by the maximum recorded methane or carbon dioxide concentration.

10.5.3.5 *Consideration of negative flow rates*

No negative flow rates were measured at the either WS2 or WS4.

10.5.3.6 *Designation of site gas screening value (GSV)*

Considering the calculated Q_{hg}, the CSM, monitoring conditions and response zone construction, **Table 28** presents the GSVs designated for the site (or zone if applicable).

Table 28 Summary of ground gas monitoring results

Hazardous gas	GSV (l/h)	Justification for the GSV
Methane	< 0.07	Steady state gas flow was zero for all positions during all monitoring rounds
Carbon dioxide	< 0.07	Steady state gas flow was zero for all positions during all monitoring rounds

Based on the Q_{hg}, the maximum concentrations and flows recorded, the CSM and the method for determining the CS presented within Table 2 of BS8485, the site has been characterised as CS1.

10.5.3.7 *Data Limitations*

It should be noted that there are inherent limitations in ground gas monitoring including spatial adequacy of monitoring locations, changes in groundwater levels, variation in temporal or atmospheric conditions and whether these have been adequately characterised by the scope of monitoring undertaken.

The investigation undertaken to date has incorporated an appropriate number of ground gas monitoring visits, the data is considered reliable, and spatially representative of the site. It is also noted that 1 round(s) were completed during low and falling atmospheric

pressure (<1000 mb) indicating that possible worst-case conditions have been present during monitoring.

10.5.4 BS8485 recommended ground gas protection measures

Case 1: CS1 classification

Based on the current understanding of the conceptual site model and the assessment undertaken, the site has been classified as CS1. Considering the foregoing and in accordance with BS8485, ground gas protective measures are not considered necessary within proposed buildings.

10.5.5 Application of NHBC Guidance

The NHBC guidance (Boyle & & Witherington, 2007) provides alternative gas screening values based on calculated maximum gas concentrations within a 'typical house' allowing for potential hazardous gas dilution within a sub-floor void and accumulation within a small room for carbon dioxide and methane. The NHBC therefore derive separate GSV criteria for methane and carbon dioxide due to the different hazards posed by each gas.

The method for derivation of the GSV adopted by NHBC (2007) is based on the Wilson and Card Methodology and is subsequently broadly similar to that set out in BS8485 (BSI, 2015). However, for carbon dioxide the NHBC guidance recommend the use of a steady-state concentration due to the hazard posed by this substance. Therefore, the GSV for carbon dioxide has been adjusted based on a recorded maximum steady-state concentration of 0.2 %v/v.

The respective GSV and typical maximum concentrations as set out in NHBC Guidance is presented in **Table 29**.

Table 29 NHBC Traffic Light Classification System (as per NHBC, 2007)

Traffic Light Classification	Methane [1]		Carbon Dioxide [1]	
	Typical Maximum Concentration [3] (%v/v)	Gas Screening Value [2,4] (l/hr)	Typical Maximum Concentration [3] (%v/v)	Gas Screening Value [2,4] (l/hr)
Green	1	0.16	5	0.78
Amber 1	5	0.63	10	1.56
Amber 2	20	1.56	30	3.10
Red				

Notes:

1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated;
2. Gas Screening Value is the Borehole Gas Volume Flow Rate, in litres per hour, as defined in Wilson and Card (1999), which is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered;
3. The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so;
4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.

The derived GSV for carbon dioxide and methane and subsequent NHBC classification are as follows:

Methane: A GSV of <0.07 l/hr indicates a Green Classification. Based on the site data (0.3% v/v), the typical maximum concentration for methane of 1% v/v is not exceeded. Therefore, a traffic light classification of Green for low rise housing is considered appropriate.

Carbon Dioxide: A GSV of <0.07 l/hr indicates a Green Classification. Based on the site data (1.1% v/v), the typical maximum concentration for carbon dioxide of 5% v/v is not exceeded. Therefore, a traffic light classification of Green for low rise housing is considered appropriate.

Based on the overall NHBC Traffic Light classification of Green, recommendations for gas protection measures within low rise housing are as follows:

Green: No protection measures are required.

10.5.6 Implications of ground improvement or foundation design

As detailed in **section 11**, currently unknown ground improvement methods or foundation types are being considered for the development. Where such works may create preferential pathways for ground gas migration to the surface, this needs to be considered through the design process, such as through a foundation works risk assessment.

Should foundation solutions or building design change within the design process, then this gas risk assessment and mitigation should be reviewed and where applicable updated.

10.6 Uncertainties and implications in refined CSM and GQRA

In accordance with good practice, data gaps and uncertainties in the refined CSM have been identified at this stage. These are summarised in **Table 30** along with the likely implications.

Table 30 Data gaps and uncertainties

Data gap/ uncertainty	Details	Implications
The full extent of the potentially contaminative copper source in the groundwater has not been established.	Copper contamination was found in groundwater at one investigation location (BH1). Only one round of groundwater monitoring and sampling was undertaken. Copper GAC exceedances were not found in other groundwater samples or in soil samples collected from site.	The source may extend into an area not investigated and thus it could alter the report conclusions.
Areas inside existing school buildings were inaccessible for investigation.	The school is still an active site with buildings in use for education purposes. As such performing intrusive works in these areas was not viable.	There is a gap in coverage for soil and groundwater for this area.
Only one round of groundwater monitoring has been completed to date.	There may be seasonal variations in water levels that could affect the direction of groundwater flow or migration pathways. The groundwater copper exceedance seen may be an anomalous result.	Further groundwater monitoring and/or sampling may be needed over a longer time period to assess such effects

11 PRELIMINARY WASTE ASSESSMENT

In accordance with the definition provided in the Waste Framework Directive (WFD), materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded, by the holder'. Naturally occurring soils are not considered waste if reused on the site of origin for the purposes of development. Soils such as made ground that are not of clean and natural origin (irrespective of whether they are contaminated or not) and other materials such as recycled aggregate, do not become waste until the criteria above are met. Further background information is provided in Appendix H.

Excavation arisings from the development may therefore be classified as waste if surplus to requirements or unsuitable for reuse. The following assessments assume the material tested is classified subsequently as waste.

11.1 Hazardous waste assessment

Technical Guidance WM3 (EA, 2021) sets out in its Appendix D requirements for waste sampling. It is a legal requirement to correctly assess and classify waste. The level of sampling should be proportionate to the volume of waste and its heterogeneity. The preliminary assessment provided below is based only upon the available sample results and may not be sufficient to adequately classify the waste.

11.1.1 Chemical contaminants

Envirolab, an RSK company, has developed a waste soils characterisation assessment tool (HASWASTE), which follows the guidance within Technical Guidance WM3. The analytical results have been assessed using this tool to assess the hazardous properties to support potential off-site disposal of materials in the future. Note that it is ultimately for landfills to confirm what wastes they are able to accept within the constraints of their permit.

No samples were found to have hazardous properties based on this assessment. However, one samples of made ground tested positive for asbestos. The detected asbestos concentration was below the hazardous waste threshold of 0.1%, however, the made ground is unlikely to be accepted in the inert / standard non-hazardous landfill. The made ground soils are likely to be accepted in the non-hazardous landfill, which accepts low levels of asbestos.

11.2 WAC assessment

The sample Waste Arising was submitted for waste acceptance criteria (WAC) testing for the Hazwaste Envirolab testing minimum requirements suite, the results of which are presented in Appendix L.

The results of the WAC testing indicate that the leaching limit values and total content of organic parameters for inert waste have not been exceeded and therefore the waste is suitable for disposal at an inert landfill or a site that has a valid exemption from the Environmental Permitting (England and Wales) Regulations 2016 (as amended) registered with the EA.

RSK recommends that a Sampling Plan be prepared to support any waste classifications and hazardous waste assessments, prior to any material being excavated. Given the level of data obtained, scale of the development and heterogeneity of the site soils, the following assessment should be considered indicative and further assessment should be undertaken following the preparation of a waste sampling plan.

12 GEOTECHNICAL ASSESSMENT

12.1 Proposed development

The development scheme in Phase 2 is preliminary at this stage and consideration is being given to the following:

- Low rise terraced properties along the southern margins of the site;
- A residential apartment block (measuring up to 5 storeys in height); and
- Associated infrastructure and soft landscaping.

No specific information relating to the structural design or maximum imposed loads by the proposed building has been provided.

BS EN 1997-1 defines three different Geotechnical Categories that structures may fall into, which are summarised as follows:

- Category 1: Small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations; with negligible risk;
- Category 2: Conventional types of structure and foundation with no exceptional risk or difficult ground or loading conditions; and
- Category 3: Structures or part of structures, which fall outside limits of Geotechnical Categories 1 and 2. Examples include very large or unusual structures; structures involving abnormal risks, or unusual or exceptionally difficult ground or loading conditions; structures in highly seismic areas; structures in areas of probable site instability or persistent ground movements that require separate investigation or special measures.

Different regimes for each category are adopted for inspection of the construction works, quality control, checking the exposed ground and groundwater conditions and performance of the works in relation to the design assumptions.

Based on the information provided above on the proposed development and in view of the anticipated ground conditions, a Geotechnical Category of 2 has been assumed for the purposes of assessment. This should be reviewed at all stages of the investigation and revised where necessary.

For Categories 2, measurements of the ground properties should be conducted and additional ground investigations may be needed. Monitoring of performance in relation to the sequence of construction is required with measurements of displacements and appropriate ongoing analyses.

12.2 Key geotechnical hazards / development constraints

A summary of commonly occurring geotechnical hazards is given in **Table 31** together with an assessment of whether the site may be affected by each of the stated hazards.

Table 31 Summary of main potential geotechnical hazards that may affect site

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
Sudden lateral changes in ground conditions	✔	The variable composition and thickness of made ground and heterogeneity of the drift deposits (Kempton Park Gravel).		Likely to affect ground engineering and foundation design and construction
Shrinkable clay soils	✔	Associated with the cohesive portion of the Kempton Park Gravel and High Volume Change Potential associated with the London Clay Formation, although the latter is unlikely to have effect due to its depth.		Design to NHBC Standards Chapter 4 or similar
Highly compressible and low bearing capacity soils			✔	Likely to affect ground engineering and foundation design and construction
Silt-rich soils susceptible to loss of strength in wet conditions	✔	Variable silt content in the cohesive portion of the Kempton Park Gravel and inherent nature of the London Clay Formation.		Likely to affect ground engineering and foundation design and construction
Running sand at and below water table			✔ (assuming proposed shallow foundations above the groundwater level)	Likely to affect ground engineering and foundation design and construction
Rising groundwater table due to diminishing abstraction in urban area	Relevant to exceptional structures (CIRIA Special Publication 69). The site does not lie within critical areas in which foundations are at risk.			May affect deep foundations, basements and tunnels.
Existing sub-structures (e.g. tunnels, foundations, basements, and adjacent sub-structures)	✔	Foundations to existing structures.		Likely to affect ground engineering and foundation design and construction
Filled and made ground (including	✔	Made ground with variable thickness across the Site.		Likely to affect ground engineering and foundation design and construction

Hazard category (excluding contamination issues)	Hazard status based on investigation findings and proposed development			Engineering considerations if hazard affects site
	Found to be present on site	Could be present but not found	Unlikely to be present and/or affect site	
embankments, infilled ponds and quarries)				
Adverse ground chemistry (including expansive slags and weathering of sulphides to sulphates)	✔	Geological strata most likely to have substantial sulphate concentrations within the London Clay Formation. This is further discussed in the sub-sections below.		May affect ground engineering and foundation design and construction
Note: Seismicity is not included in the above table as this is not normally a design consideration in the UK.				

12.3 Foundations

12.3.1 Foundation options

The ground conditions beneath the footprints of the proposed blocks derived from the previous and current phases of investigative works reveal a variable depth of made ground, overlying interbedded superficial deposits of Kempton Park Gravel, typically characterised by a thin horizon of firm gravelly sandy clay over medium dense to very dense locally silty/clayey sandy gravel (locally gravelly sand). The solid geology comprised the London Clay Formation of stiff to very stiff dark grey/blueish grey silty clay. Groundwater levels recorded during the monitoring show resting levels within the Kempton Park Gravel, at a depth of between 1.44 and 2.53 m bgl (6.99 to 7.9 m AOD).

Given the presence of competent granular Kempton Park Gravel deposits at relatively shallow depths (1.0 m to 1.70 m below ground level) it is considered that traditional spread footings may be suitable to support the low-rise structures along the southern extent of the development area, provided the foundations are extended into the granular stratum. Foundation excavations will, however, be locally relatively deep and may require further deepening due to any ground disturbance caused during the removal of remnant sub structures associated with the existing buildings on-site. Therefore, whilst recommendations for the design and construction of spread foundation is provided in **Section 12.3.2**, it is recommended that further investigations be conducted to provide greater confidence that traditional spread foundations will prove viable given the likely requirement to locally deepen and support foundation excavations. Alternatively, prior treatment, such as vibro-compaction/replacement may prove a more cost-effective solution to enable the adoption of spread foundations or recourse to pile foundations. It is recommended that advice be sought from a ground improvement specialist to confirm suitability of the ground conditions for treatment and achievable bearing capacities.

With reference to five storey building, piles are deemed the most suitable foundation option given to the anticipated moderate to high structural loads. It has been assumed the development scheme will not include a basement level.

12.3.2 Spread foundations

It is envisaged that spread foundations founded within the Kempton Gravel Member (granular stratum) at a minimum depth of 1.00 m below the existing ground level or at least 0.2 m into the medium dense gravels may be appropriate for this option. Design Approach 1 - Combination 2 results are summarised in **Table 32**.

Table 32 Comparison of ULS design resistance and SLS design pressures

Foundation Dimensions				DA1-C2 Design Resistance (kN/m^2)	SLS (25 mm Settlement) (kN/m^2)
Width (m)	Length (m)	Depth (m)	Area (m^2)		
Strip/Trench Fill Foundations					
1.00	10.00	1.00	10.00	345	211
1.50	10.00		15.00	473	163
2.00	10.00		20.00	499	136
1.00	10.00	1.50	10.00	594	218
1.50	10.00		15.00	621	169
2.00	10.00		20.00	647	142
1.00	10.00	2.00	10.00	691	221
1.50	10.00		15.00	719	172
2.00	10.00		20.00	745	145
Notes: Depth refers to depth below ground level or m bgl					

Consideration may need to be given to some form of excavation stabilisation/support as pumping from open sumps in non-cohesive soils can result in instability and general loosening of the soils at the base of the excavation.

12.3.3 Piled foundations

Recommendations for the design and construction of pile foundations in relation to the ground conditions are set out in **Table 33**.

Table 33 Design and construction of piled foundations

Design/construction considerations	Design/construction recommendations	
Pile type	The construction of both bored and 'cfa' piles is considered technically feasible at this site	
Possible constraints on choice of pile type	Given the close proximity of the site to other properties, it is considered that the use of driven piles may not be acceptable due to the vibration, noise and heave associated with pile driving. Driven piles are also likely to reach premature set in the 'dense' portion of the sands and gravels of the Kempton Park Gravel.	
Temporary casing	Given the presence of groundwater within the Kempton Park Gravel, and the claystone bands in the London Clay Formation, bored piles will require temporary casing throughout their depth. Alternatively, the use of continuous-flight-auger (CFA) injected bored piles or driven piles usually overcomes this issue Groundwater adopted at 1.44 m bgl for preliminary design purposes	
Man-made obstructions	The presence of buried sub-structures or other obstructions within made ground may lead to some difficulty during piling. Where buried obstructions are encountered, it will be necessary to either relocate the pile(s) or make allowance for removing the obstruction	
Hard strata	An allowance should be made for the presence of 'rock' bands (claystone) within the London Clay Formation. Claystone bands were recorded locally within BH01-22 (8.50 m and 24.30 m), BH02-22 (9.10 m and 27 m) and BH03-22 (9 m and 24.20m).	
Limitations afforded by ground	For the purpose of assessing preliminary pile capacities the made ground/any cohesive layer (associated with the superficial deposits) have been presumed not to contribute to the load-carrying capacity for the piles for the first approximately 2 m bgl. At this time, no negative skin friction has been considered.	
Pile Design Parameters (bored piles)		
Kempton Park Gravel (granular)	Angle of internal friction (φ)	37 (between 2 and 5m) 33 (between 5 and 7m)
	Shaft friction factor ($k_s.\tan\delta$)	0.60 (between 2 and 5 m) 0.10 (between 5 and 7 m)
London Clay Formation	Undrained shear strength c_u (kN/m^2) for London Clay Formation	135 + 7.0z kN/m2 where z = depth
	Adhesion factor α	0.5
	End bearing factor (N_c)	9
General parameters	SLS check –factor on shaft friction	1.2
	Model factor (γ_{Rd})	1.4

Design/construction considerations	Design/construction recommendations	
	Maximum limiting shaft friction (kN/m^2)	140
Special precautions relating to bored pile shafts and bases	Bored pile concrete should be cast as soon after completion of boring as possible and in any event the same day as boring Prior to casting the base of the pile bore should be clean, otherwise a reduced safe working load will be required. Similarly, if the pile bore is left open the shaft walls may relax/soften, leading to a reduced safe working load	

The design resistance has been calculated in accordance with BS EN 1997-1 and the UK National Annex, using partial resistance factors for bored piles, given in **Table 34**.

Table 34 Partial resistance factors (γ_R)

Resistance	Set	
	DA1 C1	DA1 C2[1)]
Base - γ_b	1.0	2.0
Shaft (compression) - γ_s	1.0	1.6
Total (compression) - γ_t	1.0	2.0

[1)] no serviceability verification

The design procedure for piles varies considerably, depending on the proposed type of pile. However, for illustrative purposes **Table 35** gives likely working pile loads (in compression) for traditional bored, cast-in-situ concrete piles of various diameters and lengths, based on the design parameters given in **Table 33 and 34**.

Table 35 Illustration of typical compressive design resistances for bored cast-in-situ piles

Compression												
Typical Design resistance for DA1 – Combinations C1 & C2 (kN)												
Depth of toe below ground (mbgl)	Pile diameter											
	300 mm			450 mm			600 mm			750 mm		
	C1	C2	SLS	C1	C2	SLS	C1	C2	SLS	C1	C2	SLS
10	289	172	255	487	285	382	720	415	510	989	563	637
11	346	207	318	575	338	476	840	488	635	1143	656	794
12	405	244	383	666	394	574	965	564	766	1303	754	957
13	467	282	451	760	453	676	1094	644	902	1468	855	1127
14	531	321	522	858	513	782	1228	726	1043	1640	959	1304
15	597	362	595	960	576	893	1367	811	1190	1817	1068	1488
16	665	405	671	1065	641	1007	1510	899	1343	2000	1180	1678
17	736	448	750	1174	708	1126	1658	990	1501	2189	1295	1876
18	809	494	832	1286	777	1248	1811	1084	1664	2384	1415	2080
19	885	541	916	1402	848	1375	1968	1181	1833	2584	1538	2291

Compression												
Typical Design resistance for DA1 – Combinations C1 & C2 (kN)												
Depth of toe below ground (mbgl)	Pile diameter											
	300 mm			450 mm			600 mm			750 mm		
	C1	C2	SLS	C1	C2	SLS	C1	C2	SLS	C1	C2	SLS
20	963	589	1004	1521	922	1505	2130	1280	2007	2791	1664	2509
21	1043	639	1094	1644	998	1640	2297	1383	2187	3003	1795	2734
22	1126	690	1186	1770	1076	1779	2468	1488	2372	3222	1929	2965
23	1210	742	1282	1900	1156	1922	2645	1597	2563	3446	2066	3204
24	1298	797	1380	2033	1238	2069	2825	1708	2759	3676	2207	3449
25	1387	852	1480	2169	1323	2221	3011	1823	2961	3911	2352	3701

From the above, it can be seen that pile loads are limited by the Combination 2 design resistances or serviceability limit state and the smaller of the two adopted.

It should be stressed that the above capacities do not take into consideration limiting concrete stress (to be verified by a separate load case as defined in EC2) nor pile group effects, the latter of which is more pronounced for a large number of closely spaced piles.

Notwithstanding the above, it is recommended that the detailed advice of a specialist-piling contractor be sought as to the most suitable type of pile for the prevailing ground conditions and as to their lengths and diameters to support the required design loads.

It should be stressed that the above capacities do not take into consideration pile group of piled raft effects which is more pronounced for a large number of closely spaced piles.

12.3.4 Foundation works risk assessment

Given the hydrogeological and hydrological setting, it is not anticipated that a foundation works risk assessment be required for the development.

12.4 Floor slabs

The design loading for the proposed ground floor slab for the apartment building is not known at this stage. The sub-grade soil conditions beneath the footprint of the proposed buildings typically comprise variable made ground consisting of clayey sandy gravel/gravelly clay.

In view of the thickness of variable made ground encountered, it is recommended that ground floor slabs should be suspended. With respect to low rise terraced properties along the southern margins, it has been assumed that traditional ‘block and beam’ will be adopted.

12.5 Roads and hardstanding

In the 1 m to 1.5 m below the proposed finished ground level, the exploratory holes have revealed a soil profile comprising variable made ground over locally overlying firm gravelly silty clay and dense sandy gravel at depth (Kempton Park Gravel).

In pavement design terms, the groundwater conditions are anticipated to comprise a low water table, i.e. at least 1 m below the pavement formation level.

The estimated minimum, equilibrium soil-suction, California bearing ratio (CBR) value for the soils and groundwater conditions described above under a completed pavement is 2%, based upon Table C1 in TRRL (1984) Report LR1132.

Based on the variability of the made ground, a CBR value of 2% is recommended for design purposes. This value assumes that during construction the formation level will be carefully compacted and any soft spots removed and replaced with well-compacted granular fill.

The sub-grade soils can be regarded as non-frost-susceptible based upon the criteria given in Appendix 1 of TRRL (1970) Report Road Note 29.

12.6 Excavations for foundations and services

Man entry into any excavations should not be undertaken without provision of suitable shoring and support and dewatering or suitable regrading and battering of side slopes to safe angles. Confined spaces protocols for the Health and Safety of personnel should always be used where man entry into excavations is to be undertaken as low oxygen conditions may be present.

Groundwater was encountered in all the boreholes advanced. Dewatering may therefore be required to facilitate foundation excavation.

Pumping from open sumps in non-cohesive soils should be avoided as this can result in instability and general loosening of the soils at the base of the excavation. It is likely that dewatering in non-cohesive soils will require the use of well-pointing systems.

Excavation should be possible using conventional site plant. Breakers may be necessary to remove any concrete obstructions within the made ground.

12.7 Chemical attack on buried concrete

This assessment of the potential for chemical attack on buried concrete at the site is based on BRE Special Digest 1: Concrete in aggressive ground, which represents the most up-to-date guidance on this topic currently available in the UK.

The desk study and site reconnaissance indicate that, for the purposes of assessing the aggressive chemical environment of the site, the site should be considered as comprising brownfield ground likely to contain pyrite.

Based on testing results, **Table 36** gives the characteristic pH, water-soluble and total sulphate content values for soils from each of the geological units and groundwater encountered on-site.

Table 36 Characteristic pH, water soluble sulphate and total sulphate values

Stratum	pH	Water Soluble Sulphate (mg/l)	Total Potential Sulphate (mg/l)
Made ground	11.2	124	0.204
Kempton Park Gravel	7.5 - 8.1	30.3 – 198	0.03 – 0.141
London Clay Formation	8.4 – 10.3	185 - 881	0.183 – 1.47

Based on the results above and following the steps outlined in the BRE guidance, the Design Sulphate Classes and Aggressive Chemical Environment for Concrete classifications are summarised in **Table 37**, on the basis of water soluble sulphate and total potential sulphate, respectively.

Table 37 Concrete design class

Stratum	Ground water	Water Soluble Sulphate		Total Potential Sulphate	
		DS Class	AC Class	DS Class	AC Class
Made Ground	Mobile	DS-1	AC-1	DS-1	AC-1
Kempton Park Gravel	Mobile	DS-1	AC-1	DS-1	AC-1
London Clay Formation	Mobile	DS-2	AC-2	DS-4	AC-4

* based on mean of the highest two results

Assuming that disturbed ground will be minimised by the use of piled foundations, the recommended ACEC Classification is therefore;

- AC-2 with a Design Sulphate Class of DS-2 (London Clay).
- AC-1 with a Design Sulphate Class of DS-1 (Kempton Park Gravel Member)

However, if the proposals include the reuse of the London Clay, e.g. excavation and backfill arisings, the recommended ACEC Classification will increase to AC-4 with a Design Sulphate Class of DS-4.

12.8 Infiltration drainage

No infiltration testing was undertaken during this phase of works.

The EA should be contacted at the design stage in order to obtain a 'consent to discharge'. This may not be forthcoming where soakage will be into or just above the water table, particularly within groundwater protection zones. In addition, planning approval will have to be sought for their use.

13 CONCLUSIONS AND RECOMMENDATIONS

13.1 Geo-environmental assessment

Based on the results of the site investigation and GQRA, the contaminant linkages that have been identified to be potentially complete (relevant contaminant linkages) and to require further action are:

- Asbestos fibres within the made ground presenting an inhalation and ingestion risk to future site users.
- Inhalation of dust and direct contact with the made ground locally impacted with lead

Should unforeseen contamination be encountered during the development then specialist advice should be sought to determine the appropriate course of action. Imported material (e.g. topsoil, subsoil) should be validated before use on-site to confirm its suitability.

The preliminary waste assessment indicates the sample analysed did not exceed the leaching limit value and total content of organic parameters. However, considering the presence of detected asbestos fibres, at concentrations below the hazardous waste threshold, the made ground soils will likely to be accepted at non-hazardous landfills licensed to accept soils with low levels of asbestos.

13.2 Geotechnical assessment

The key findings of the initial geotechnical assessment are as follows:

- Piled foundations should be adopted for the high rise building (apartment blocks)
- Spread foundations may be considered for the low rise buildings along the southern extent of the development area, provided the foundations are extended into the granular stratum
- The variable thickness of made ground means suspended ground floor slabs should be adopted.
- It is assumed that the ground will not be disturbed by the use of piled foundations, the recommended ACEC Classification is therefore;
    - AC-2 with a Design Sulphate Class of DS 2 (London Clay).
    - AC-1 with a Design Sulphate Class of DS 1 (Kempton Park Gravel Member)

  However, if the proposals include the reuse of the London Clay, e.g. excavation and backfill arisings, the recommended ACEC Classification will increase to AC-4 with a Design Sulphate Class of DS-4.

13.3 Recommendations

The following recommendations are made for further assessment and remediation of the site to investigate the risks identified above and to address remaining uncertainties:

- A clean capping layer may be appropriate for areas of proposed soft landscaping and any private garden to break the pollutant linkage between the made ground and future site users.
- A barrier pipe would likely to be required where new drinking water supply pipes are constructed in the made ground soils.

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FIGURES

FIGURE 1 SITE LOCATION PLAN

Rev	Date	Amendment	Drawn	Chkd	Appd
C01	21.11.22	First Issue	AE	DE	DE

RSK GEOSCIENCES
18 Frogmore Road
Hemel Hempstead
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HP3 9RT
Tel: +44(0)1442 437500
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client: Clarion House

Project Name: Richmond Upon Thames College

Description: Site Location Plan

Dimension	Size	Scale	Geolocation	Project ID	Drawing no.	Rev	File name
m	A4	1:25,000	515403, 173745	1921744	11101	C01	1921744-HH-111-SS-D-C-11101-C01

FIGURE 2 SITE LAYOUT PLAN

N

Phase 1

Phase 2

PRELIMINARY REVISION
TO BE REVISED

LEGEND

2021 RSK Pier review report 1921744 R01(00) area.

Supplementary Investigation boundary

RSK GEOSCIENCES
18 Frogmore Road
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HP3 9RT
Tel: +44(0)1442 437500
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client: Clarion Housing Group

Project Name: Richmond College

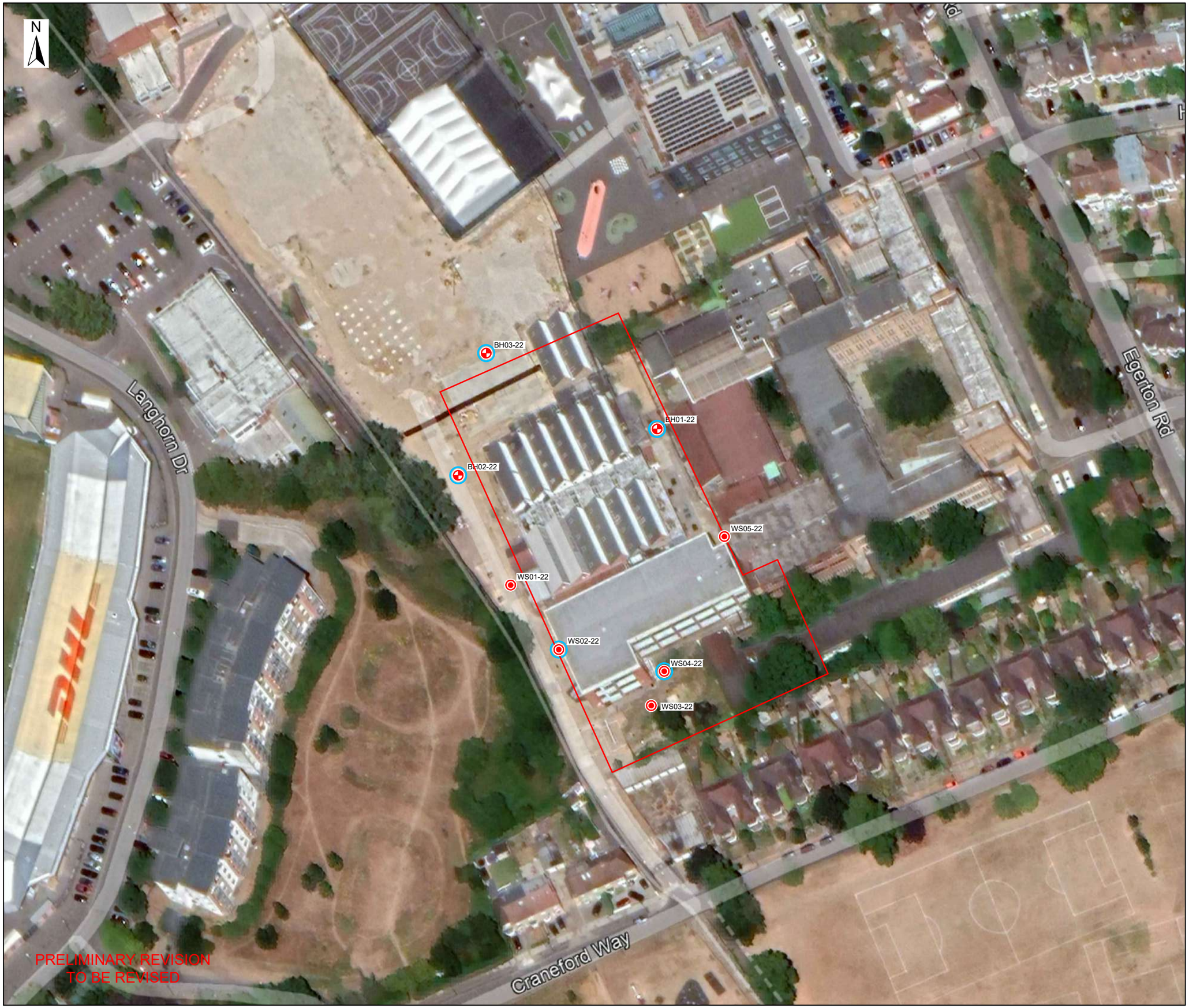
Description: Site Layout Plan and Boundaries

Rev	Date	Amendment	Drawn	Chkd	Appd
C01	09.01.2023	First Issue	BS	##	##

0 10 20 30 40 50m

Dimension	Scale	Size	Project ID	Drawing no.	Revision	File name
m	1:1000	A3	1921744	11203	P01	1921744-HH-112-SS-D-C-11203-P01

FIGURE 3 EXPLORATORY HOLE LOCATION PLAN



LEGEND

- Phase 2 site boundary
- Borehole location
- Window sample location
- Monitoring well location

Notes:

Contains google Earth © copyright and database right .

Rev	Date	Amendment	Drawn	Chkd	Appd
C01	09.01.23	First Issue	AS	##	##

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Web: www.rsk.co.uk

Client
Clarion Housing Group

Project Name
Phase 2 Area, Richmond Upon Thames College

Description
Exploratory Borehole Location Plan

Project ID	Drawing no.	Revision
1921744	22201	P03

File name
1921744-HH-222-SS-M-C-22201-P03

Dimensions	Scale	Size
m	1:1000	A3

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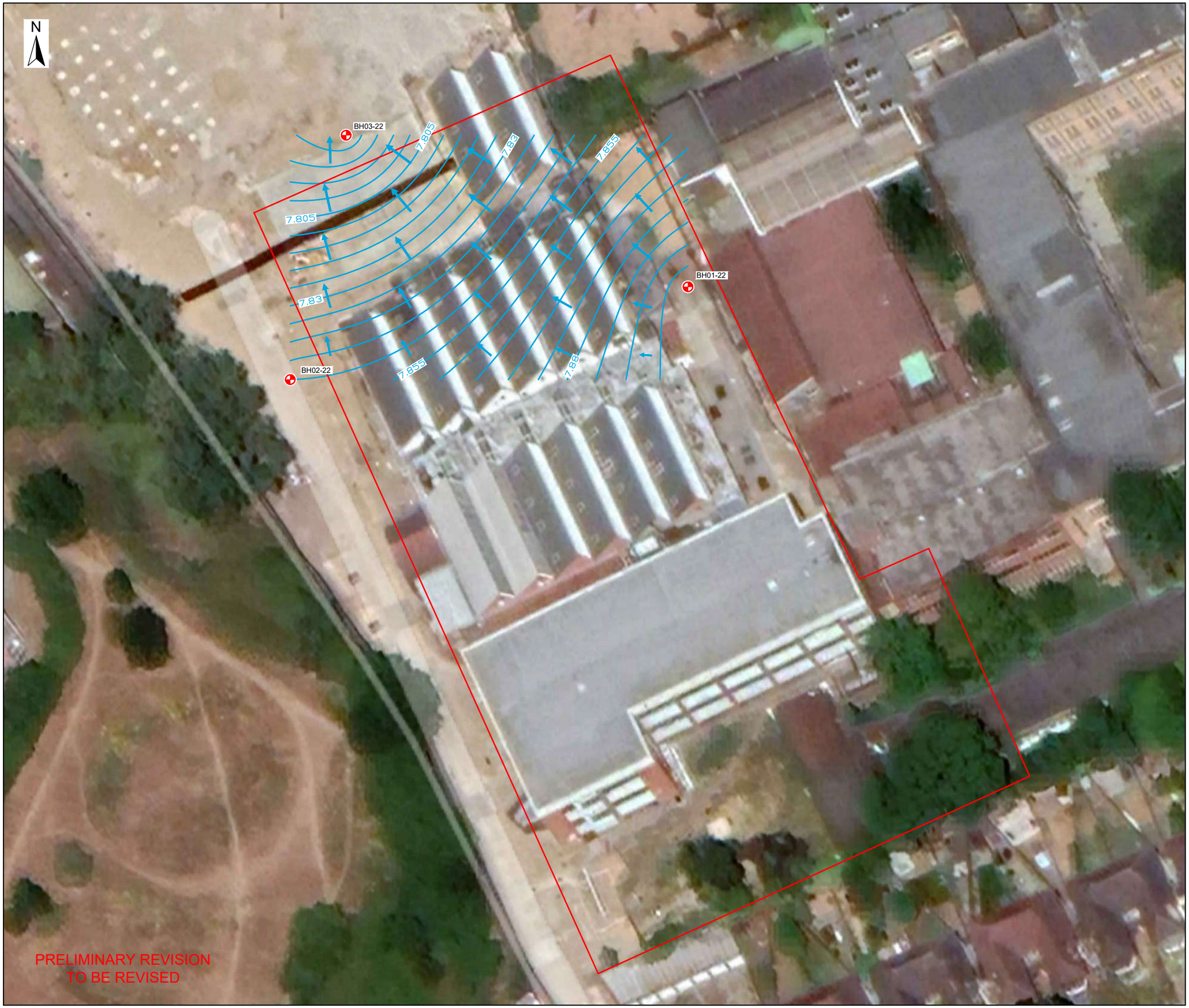
FIGURE 4 INITIAL SCHEMATIC CONCEPTUAL SITE MODEL



LEGEND

- Phase 2 site boundary
- Borehole location
- Groundwater contours
- 7.80 Groundwater level
- Assumed groundwater flow direction

Notes:

Rev	Date	Amendment	Drawn	Chkd	Appd
C01	09.01.23	First Issue	AS	##	##

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Tel: +44(0)1442 437500
Email: info@rsk.co.uk
Web: www.rsk.co.uk

Client: Clarion Housing Group

Project Name: Phase 2 Area, Richmond Upon Thames College

Description: Piezometric Plan

Project ID	Drawing no.	Revision
1921744	22701	P03

File name: 1921744-HH-227-SS-M-C-22701-P03

Dimensions	Scale	Size
m	1:500	A3

0 5 10 15 20 25m

APPENDICES

APPENDIX A
SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Clarion Housing Group (the "Client") in accordance with the terms of a contract [RSK Environment Standard Terms and Conditions] between RSK and the Client, dated July 2022. The Services were performed by RSK with the reasonable skill and care ordinarily exercised by an environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the Client.
2. Other than that, expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the Client. RSK is not aware of any interest of or reliance by any party other than the Client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK 's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the Client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the Client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off site of asbestos, invasive plants, electromagnetic fields, lead paint, heavy metals, radon gas, persistent, bioaccumulative or toxic chemicals (including PFAS/ PFOS) or other radioactive or hazardous materials, unless specifically identified in the Services.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a visual inspection of the site together with RSK's interpretation of information, including documentation, obtained from third parties and from the Client on the history and usage of the site, unless specifically identified in the Services or accreditation system (such as UKAS ISO 17020:2012 clause 7.1.6):
    a. The Services were based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely.

b. The Services were limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the visual inspection.

c. The Services did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services.

RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the Client and RSK.

8. The intrusive environmental site investigation aspects of the Services are a limited sampling of the site at pre-determined locations based on the known historic / operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the properties of the materials adjacent and local conditions, together with the position of any current structures and underground utilities and facilities, and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters (as stipulated in the scope between the client and RSK, based on an understanding of the available operational and historical information) and it should not be inferred that other chemical species are not present.

9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (intrusive and sample locations etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.

10. The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows, may vary from those reported due to seasonal, or other, effects and the limitations stated in the data should be recognised.

11. Asbestos is often observed to be present in soils in discrete areas. Whilst asbestos-containing materials may have been locally encountered during the fieldworks or supporting laboratory analysis, the history of brownfield and demolition sites indicates that asbestos fibres may be present more widely in soils and aggregates, which could be encountered during more extensive ground works.

12. Unless stated otherwise, only preliminary geotechnical recommendations are presented in this report and these should be verified in a Geotechnical Design Report, once proposed construction and structural design proposals are confirmed.

APPENDIX B
DEVELOPMENT DRAWINGS

Rev	Date	By	Amendment

LEGEND

- FOUL
- WATER
- HEATING
- GAS
- HOT WATER
- AC COOLANT
- ACETYLENE
- OXYGEN
- COMPRESSED AIR
- VENT PIPE
- UNKNOWN SERVICE

- UP THROUGH CEILING
- DOWN TO FLOOR
- UP AND DOWN
- VERTICAL PIPE
- DOWN CAPPED BEFORE FLOOR

- WATER TAP

- UNDER_FLOOR_FOUL
- UNDER_FLOOR_WATER
- UNDER_FLOOR_HEATING
- UNDER_FLOOR_GAS
- UNDER_FLOOR_HOT_WATER
- UNDER_FLOOR_UNKNOWN

SHEET LAYOUT

SHEET 1		SHEET 2
SHEET 3		SHEET 4

PLEASE NOTE:
INFORMATION HAS BEEN OVERLAID TO PLANS SUPPLIED BY RICHMOND UPON THAMES COLLEGE

CAUTIONARY NOTES:
INFORMATION HAS BEEN SHOWN IN DIAGRAMATIC FORMAT AND HAS BEEN SURVEYED UNINTRUSIVLEY WITH CONSIDERABLE EFFORT WHERE ACCESS ALLOWS
COMPLETENESS OF INFORMATION CANNOT BE GUARANTEED

3sixty measurement

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E-mail: info@3sixtymeasurement.co.uk
Website:www.3sixtymeasurement.co.uk

Client	RICHMOND UPON THAMES COLLEGE
Project	WATER SURVEY
Drawing	GROUND FLOOR SCHEMATIC SHEET 3
Date	SEPT 2013
Scale	A1@1:200
Drawn by	GFT
Checked by	RJT

Project No	Drawing No	Revision
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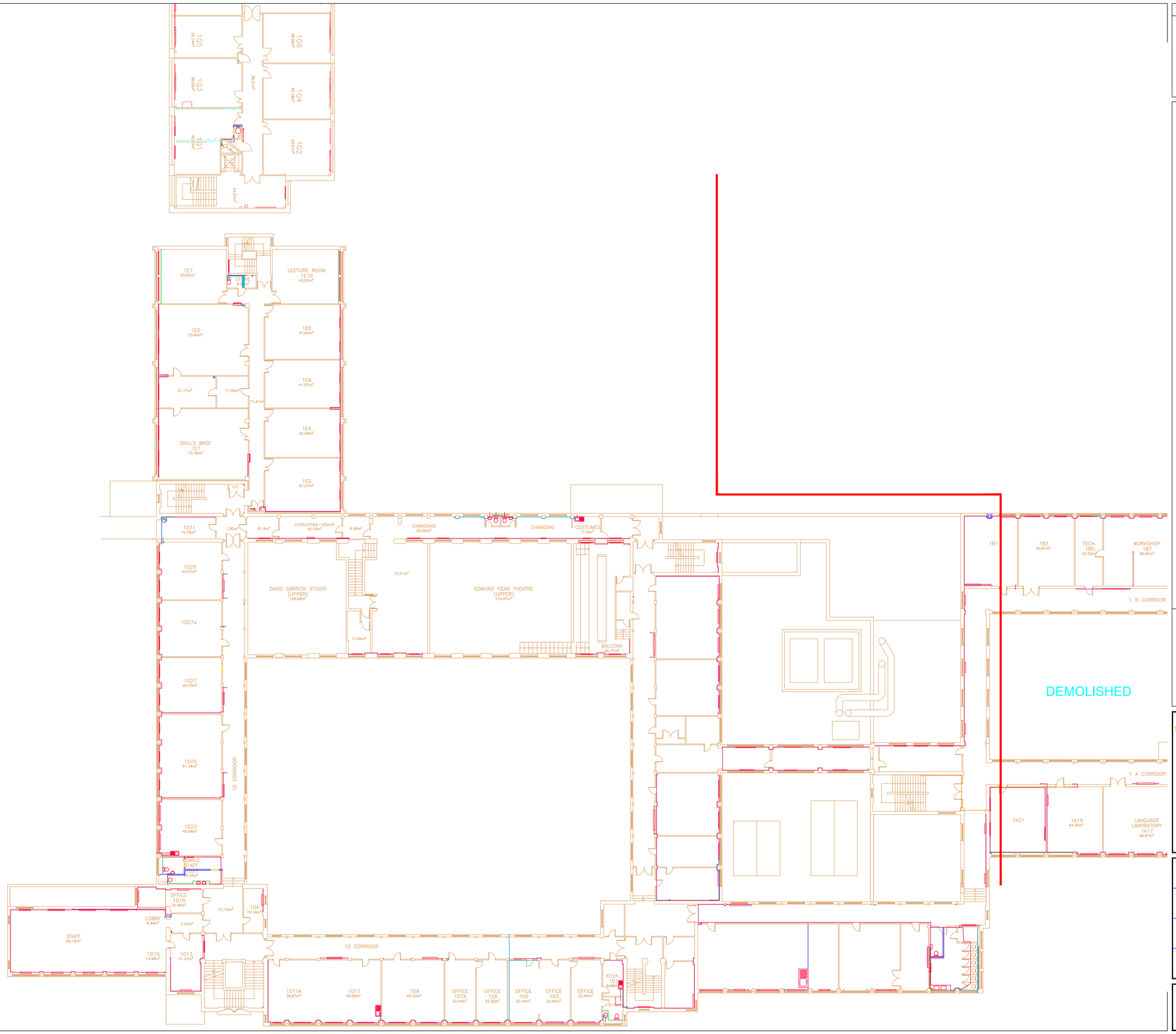

Rev	Date	By	Amendment

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WATER TAP

SHEET LAYOUT

SHEET 1		SHEET 2
SHEET 3		SHEET 4

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Client: RICHMOND UPON THAMES COLLEGE

Project: WATER SURVEY

Drawing: FIRST FLOOR SCHEMATIC
SHEET 3

Date	Scale	Drawn by	Checked by
SEPT 2013	A1@1:200	GFT	RJT

Project No	Drawing No	Revision
07404	-05	

Rev	Date	By	Amendment

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WATER TAP

SHEET LAYOUT

SHEET 1		SHEET 2
SHEET 3		SHEET 4

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Client: RICHMOND UPON THAMES COLLEGE

Project: WATER SURVEY

Drawing: SECOND FLOOR SCHEMATIC
SHEET 3

Date	Scale	Drawn by	Checked by
SEPT 2013	A1@1:200	GFT	RJT

Project No	Drawing No	Revision
07404	-06	

Rev	Date	By	Amendment

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- UP AND DOWN
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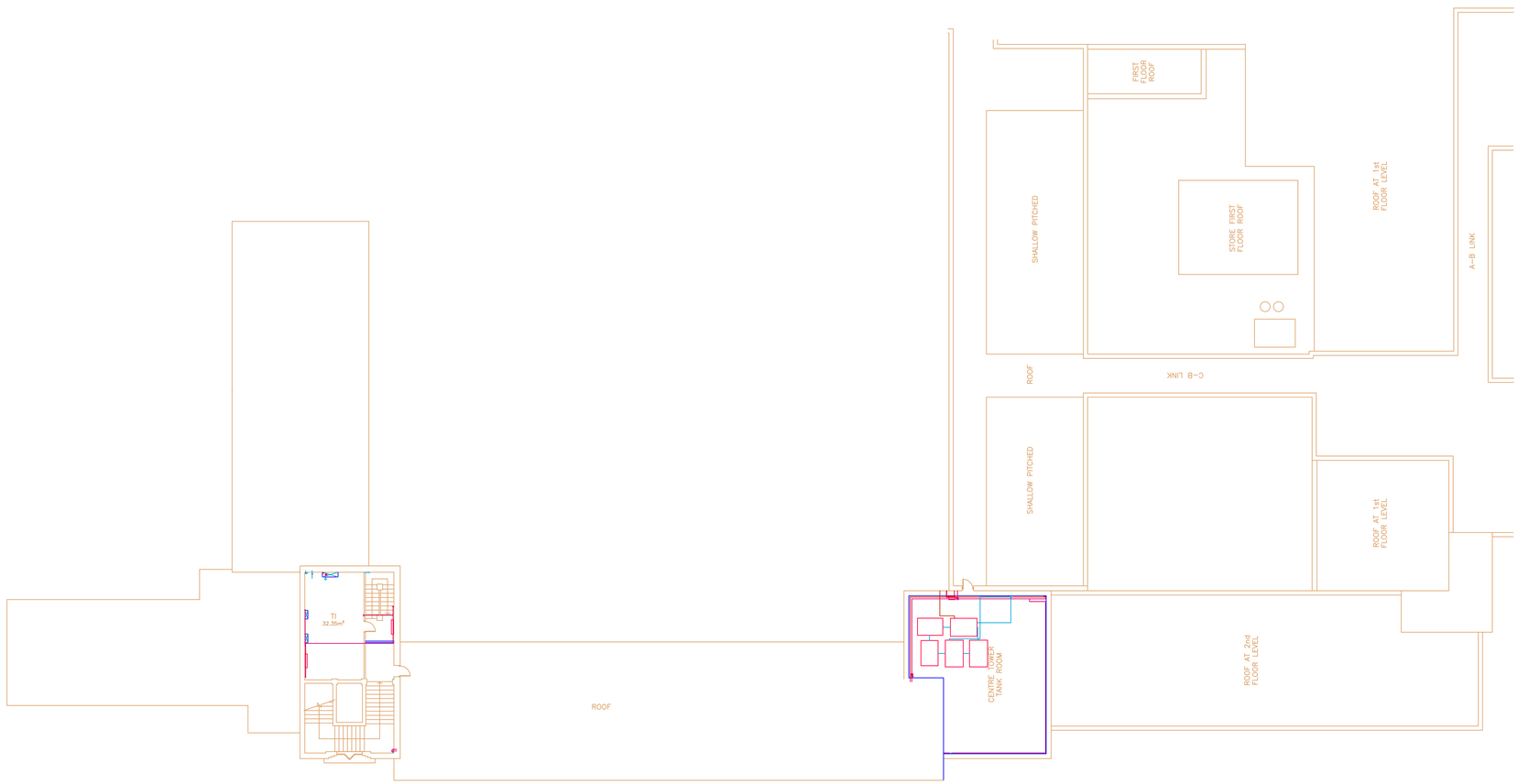
WATER TAP



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Client: RICHMOND UPON THAMES COLLEGE

Project: WATER SURVEY

Drawing: THIRD FLOOR SCHEMATIC

Date	Scale	Drawn by	Checked by
SEPT 2013	A1@1:200	GFT	RJT

Project No	Drawing No	Revision
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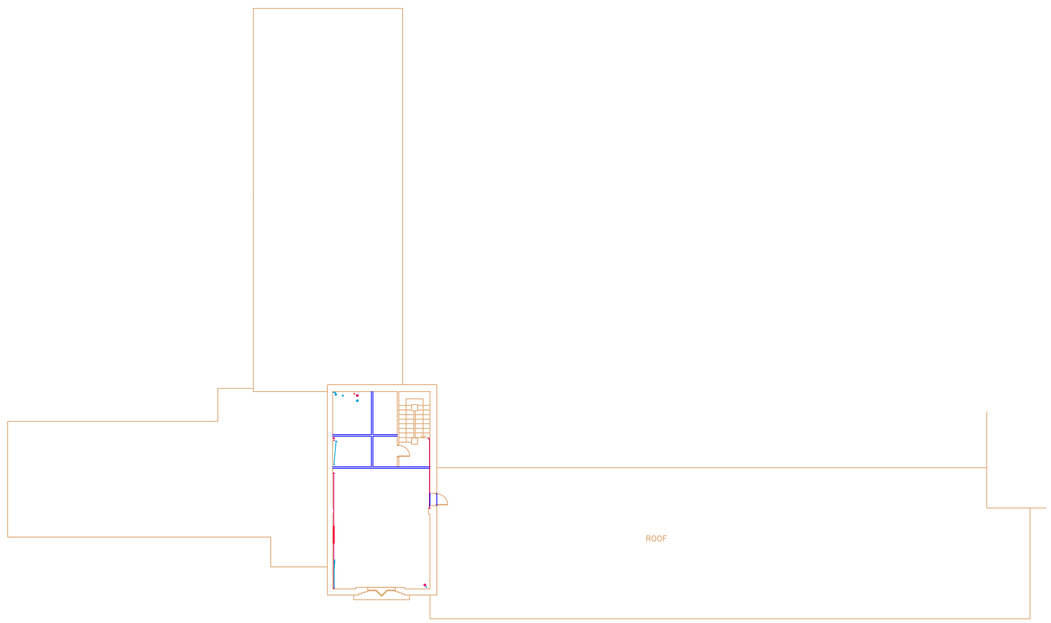

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Website:www.3sixtymeasurement.co.uk

Client: RICHMOND UPON THAMES COLLEGE

Project: WATER SURVEY

Drawing: LOW LEVEL TANK ROOM SCHEMATIC SHEET 1

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Project No	Drawing No	Revision
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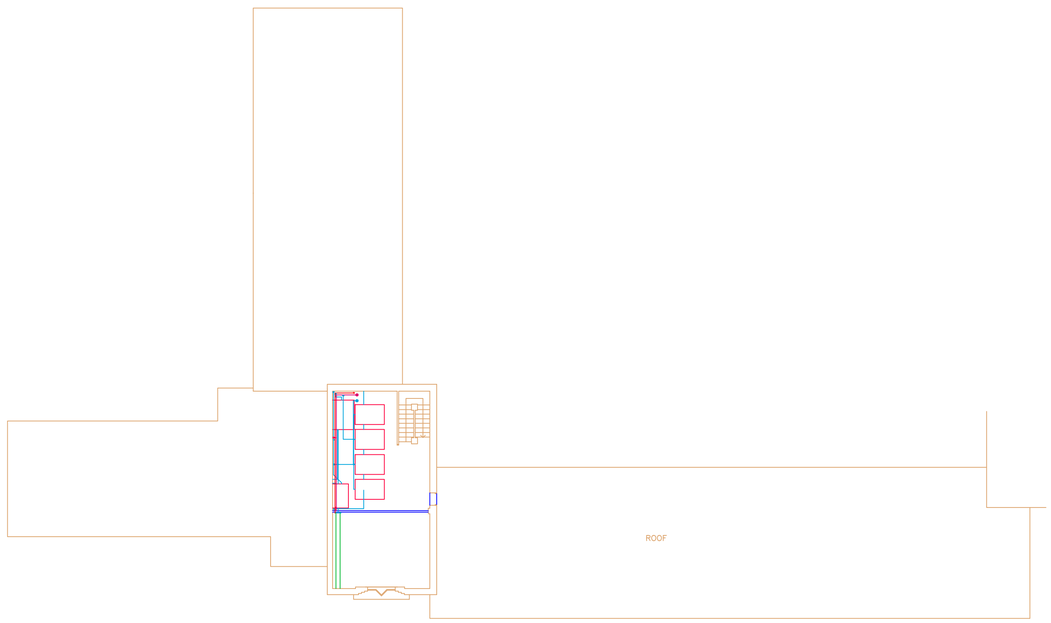

Rev	Date	By	Amendment

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Client: RICHMOND UPON THAMES COLLEGE

Project: WATER SURVEY

Drawing: HIGH LEVEL TANK ROOM SCHEMATIC SHEET 1

Date	Scale	Drawn by	Checked by
SEPT 2013	A1@1:200	GFT	RJT

Project No	Drawing No	Revision
07404	-09	

CLARION
HOUSING GROUP

Richmond College Site, Egerton Road, Twickenham

Development Brief

05/11/2020

RICHMOND COLLEGE

DEVELOPMENT BRIEF

Version History

Revision	Description of Updates	Author	Date
V1.0		Cerys Tudge	02/11/2020

Document Review

Each major revision must be approved by the following functions prior to external issue.

Role	Name	Job Title	1.0	2.0	3.0	Etc
Development Director	Nick Wood	Development Director				

Document Endorsement

DLT Member	Name	Version 1.0
Development Director	Nick Wood	Gateway 4 approved 02.11.2020
Partnerships	Iain Taylor	Gateway 4 approved 02.11.2020
Project Management & Commercial Director	Nigel Tenwick	Gateway 4 approved 02.11.2020
Sales & Marketing Director	Tim Seward	Gateway 4 approved 02.11.2020
Finance Director	Steve Wild	Gateway 4 approved 02.11.2020
Customer Experience Director	Gemma Conlon	Gateway 4 approved 02.11.2020
Design & Technical Director	Ayo Allu	Gateway 4 approved 02.11.2020

RICHMOND COLLEGE

DEVELOPMENT BRIEF

Table of Contents

DEVELOPMENT BRIEF

Executive Summary

Document Purpose

This Development Brief has been prepared to support the proposed redevelopment of the Richmond College Site, Egerton Road, Twickenham. Clarion recognises an opportunity to deliver an enhanced residential product in a key London Borough where affordable housing for local residents is in high demand.

The purpose of the Development Brief (DB) is to set out the:

- Vision and objectives for the project;
- site details;
- commitment to safety & sustainability;
- residential product brief;
- key programme milestones;,
- risks & opportunities of the site.

The Development Brief will be circulated to both Clarion Team members and the external Project Team. This is a 'live' document and will be developed and updated as appropriate during the design journey before being fixed at the end of RIBA Stage 2.

Project Overview

In 2018 Clarion Housing Association entered into an agreement to purchase two parcels of land from Richmond College.

The site forms the residential phase of a wider mixed use redevelopment (to include 180 homes), which benefits from Outline planning permission (REF: DC/JEF/15/3038/OUT/OUT dated 16.08.16) (see Appendix 1: Outline Planning Permission).

Reserved Matters planning permission (REF: 18/4157/RES dated 02.08.19) was granted for the delivery of 180 homes within the residential phase (see Appendix 2: Reserved Matters Planning Permission), to be delivered in two phases with the S106 affordable delivered in Phase 1. This scheme was designed for Clarion by BPTW for delivery as a fully affordable scheme.

The approved scheme is no longer being pursued by the business, with this Development Brief to inform a revised mixed tenure (50% affordable housing) scheme incorporating zero-operational carbon design.

Site & Context

The site is located at:

Richmond Upon Thames College, Egerton Road, Twickenham, TW2 7SJ

The site extends to 1.94 hectares and is located approximately eight minutes-walk from Twickenham railway station and high street. The land was previously owned by Richmond Upon Thames College ("RUTC") and Clarion are in the process of purchasing the site in two parcels. Phase 1 has been purchased and has been leased back to RUTC for 18 months. The Phase 2 acquisition is due to be completed imminently.

DEVELOPMENT BRIEF

The site forms part of the wider Richmond College redevelopment site, which is bound by the Chertsey Road to the North and the Harlequins Stoop Stadium to the West (see Figures 1 & 2). Within the wider development it forms the southern edge, with new college buildings and a secondary school to the north, and residential neighbours to the East and South (see Figures 1 & 2).

Figure 1: Site location

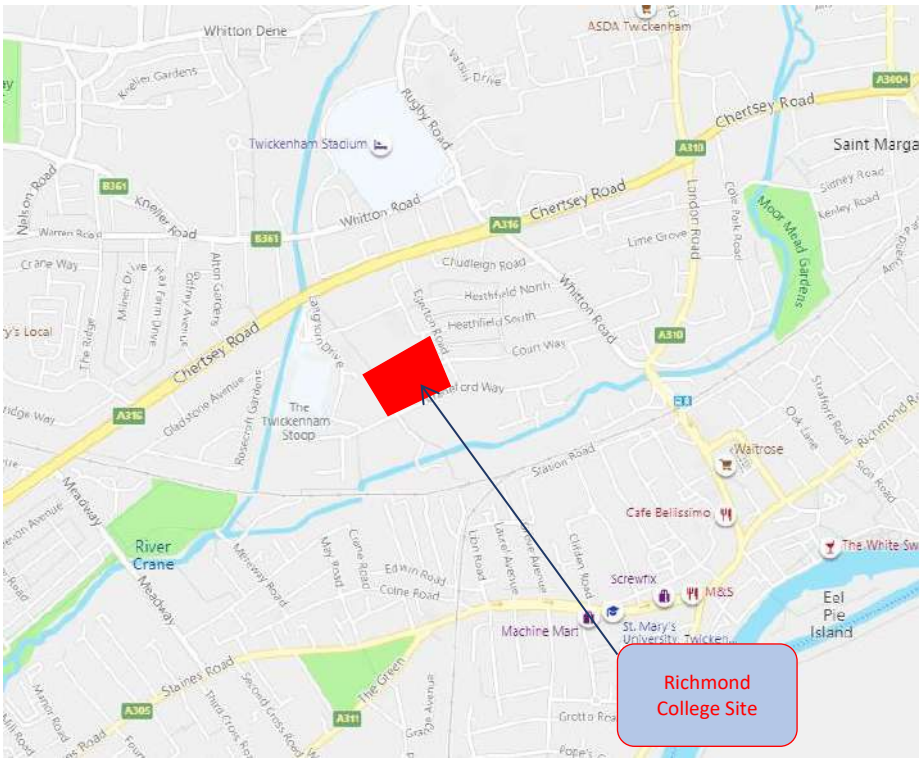


Figure 2: Site location

Figure 3: Indicative redline site boundary

Figure 4: Indicative redline site boundary in surrounding context.

DEVELOPMENT BRIEF

Introduction

Document Hierarchy

This document forms part of the core briefing tools that manage the design outputs across our residential projects:

- Initial Project Brief
- The Development Brief
- Project Execution Plan (PEP)
- Clarion Housing Group Employer's Requirements, ERI and BIM Execution Plan.

These documents establish the principles that govern all Clarion activities.

For the purposes of assessing site opportunities, the 'Initial Project Brief' should contain all relevant information for the development of feasibility study and design.

As the scope of instruction progresses into later RIBA design stages, this Development Brief will be provided and supplemented with further detail including Clarion's full Employer's Requirements as well as ERI and BIM Execution Plan.

Clarion Housing Group

Clarion Housing Group comprises the country's largest housing association, Clarion Housing, with 125,000 homes nationwide. We are also a leading developer, with an aim to build 50,000 homes over ten years, and a business for social purpose, with our charitable foundation Clarion Futures. We use our strength and scale to create opportunities that change people's lives.

We have a major role to play in fixing the broken housing market. We are using our experience, scale and financial strength to deliver new homes and communities across the country. These are at a range of price points and tenures from private sale to social rent. Any profits generated are invested in our social purpose.

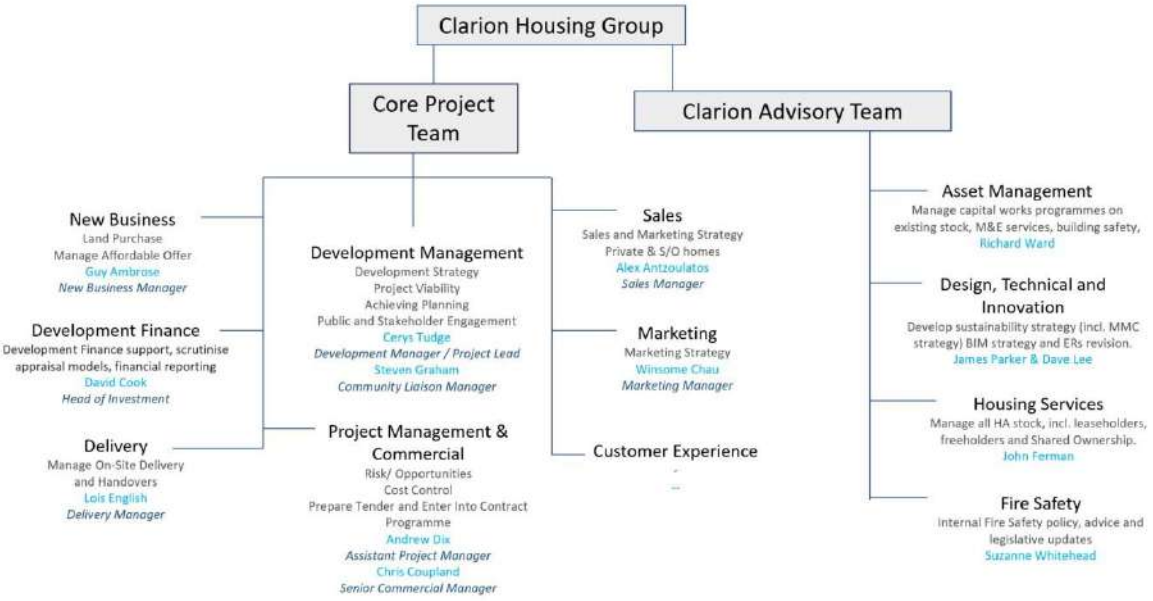
We offer high quality, innovative regeneration skills, an excellent understanding of community issues and needs, together with a proven track record in delivering successful schemes. We recognise the need for good quality engagement with existing residents and the local community and our dedicated liaison team lead on this.

Clarion Housing Group's Strategic Priorities

- Be the housing and service provider of choice
- Build a successful respected and influential national business
- Build new homes and successful communities
- Be a great place to work
- Maintain our financial resilience
- Exploit new technology and innovation

DEVELOPMENT BRIEF

Group Structure



Clarion Housing Group's Vision, Mission and Values

VISION
Building homes, developing futures

MISSION
Our Mission is to provide good quality, affordable, homes and neighbourhoods to people inadequately served by the market

VALUES
The Clarion Way is positioned to ensure that we put our customers at the heart of everything we do and is enabled by three other principles which focus on the individual, the organisation and our leadership: • Shared Purpose • Clear Leadership • Personally Responsible

Health, Safety & Wellbeing

Clarion Housing Group sets high standards for safety and takes our legal responsibility to ensure the health and welfare of our employees, customers and other people we impact very seriously. The health, safety and well-being of our employees and stakeholders are central to everything we do, and is integral to the success of our business.

Clarion recognises the risks to health and safety associated with construction and building maintenance tasks and is committed to eliminating or at least reducing these risks so far as is reasonably practicable by having clearly defined roles, responsibilities and procedures.

Clarion will implement 'Safety in Design' as a formal process from the beginning of a design, in order to mitigate or reduce potential risks to a building, facility, or structure in accordance with industry best practices, technical standards, legislative and local requirements. This will involve hazard analysis at the beginning and end of each design stage. The Design Team is also encouraged to proactively identify any potential hazards and preventive measures to mitigate these throughout design development.

Sustainability

As a business with 125,000 homes, 3,500 employees and a significant development programme we recognise that we have a substantial direct environmental footprint and larger indirect footprint.

Our strategy is based on a clear business case that recognises the opportunity to make our business resilient to the risks associated with sustainability issues. This, in turn, can improve the wellbeing of communities we work with, increase customer satisfaction, improve employee engagement as well as delivering more efficient, 'value for money' services.

Sustainability underpins our long-term strategic objectives and will contribute towards our success.

Our sustainability objectives, linked to the Clarion vision Building Homes, Developing Futures, are:

- To develop sustainable and affordable homes across all tenures.
- To promote biodiversity, green living and working.
- To enable the health and wellbeing of our communities.

Through our Sustainable Housing Finance Framework, we are the UK's first housing association to adopt the Certified Sustainable Housing Label. This incorporates 30 social and green indicators and mirrors the principles developed by the UN that have become the benchmark for impact investing.

Contractors and suppliers are a key part of our indirect environmental footprint. We will therefore work with them to address sustainability issues and impacts to reduce our indirect environmental footprint.

Diversity and Inclusion Statement

At Clarion Housing Group we believe it is important to reflect the communities that we serve, and we know that diversity in the workforce improves problem solving, innovation and dynamism.

Research also confirms that organisations that allow staff to be themselves are more productive, as their workforce are likely to be more authentic, effective and happier.

We are embedding diversity and inclusion (D&I) into everything we do at Clarion Housing Group from the way we develop our staff, to the way we recruit and communicate. This holistic approach will help us to fulfil our goal of being an inclusive landlord and employer that understands the needs of colleagues and customers.

We provide training for all staff on D&I to ensure we meet the requirements of the Equality Act 2010 and the Public Sector Equality Duty. We actively promote inclusivity and ensure that everyone is treated with dignity and respect and we expect the same from our wider consultant team.

Setting the Scene

Title Plans

The two phases are covered by different titles, Phase 1 Title Number: TGL525882 has already been registered to Clarion. Phase 2 is still owned by the college.

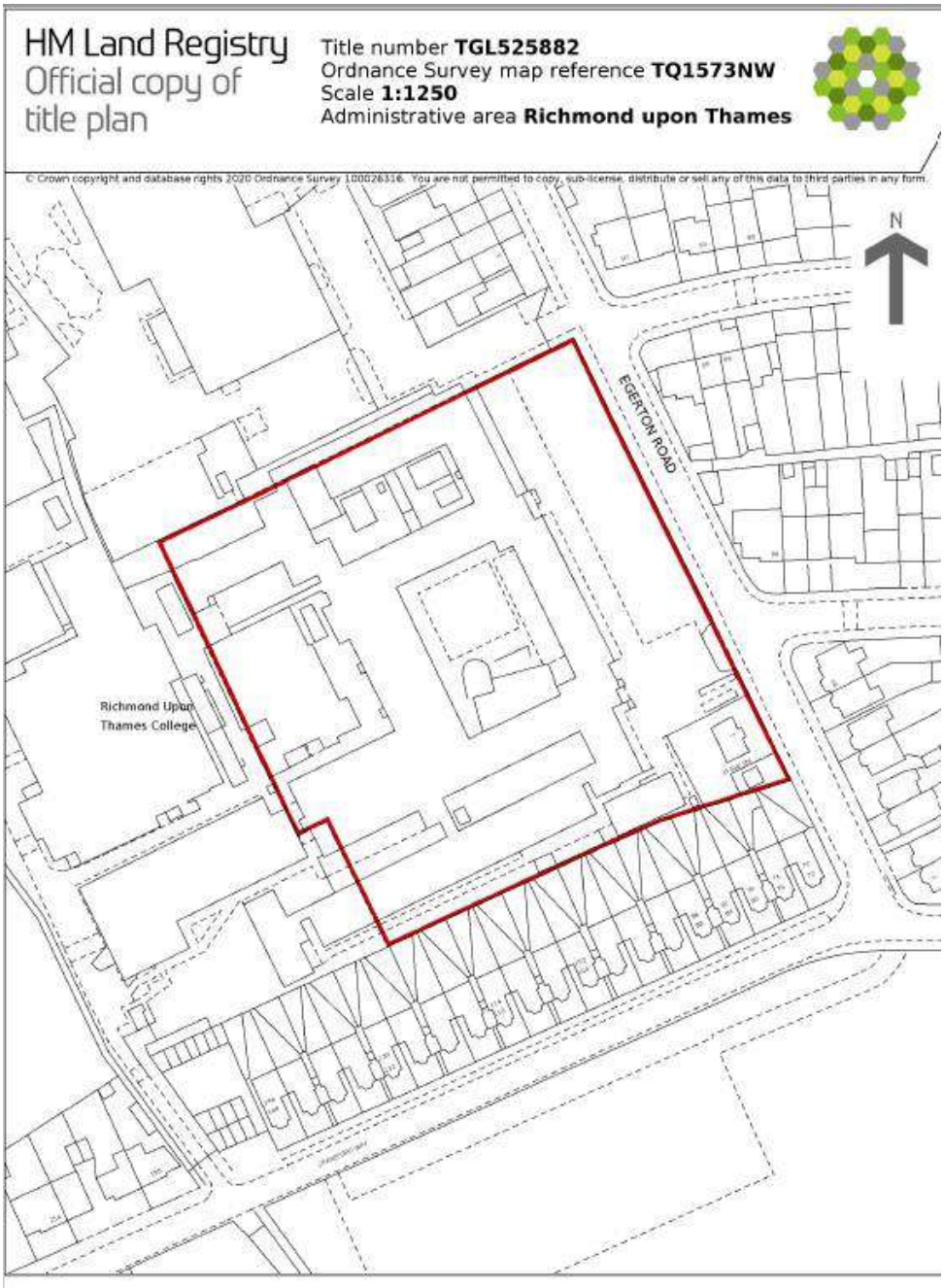


Figure 5: Title plan of Phase 1

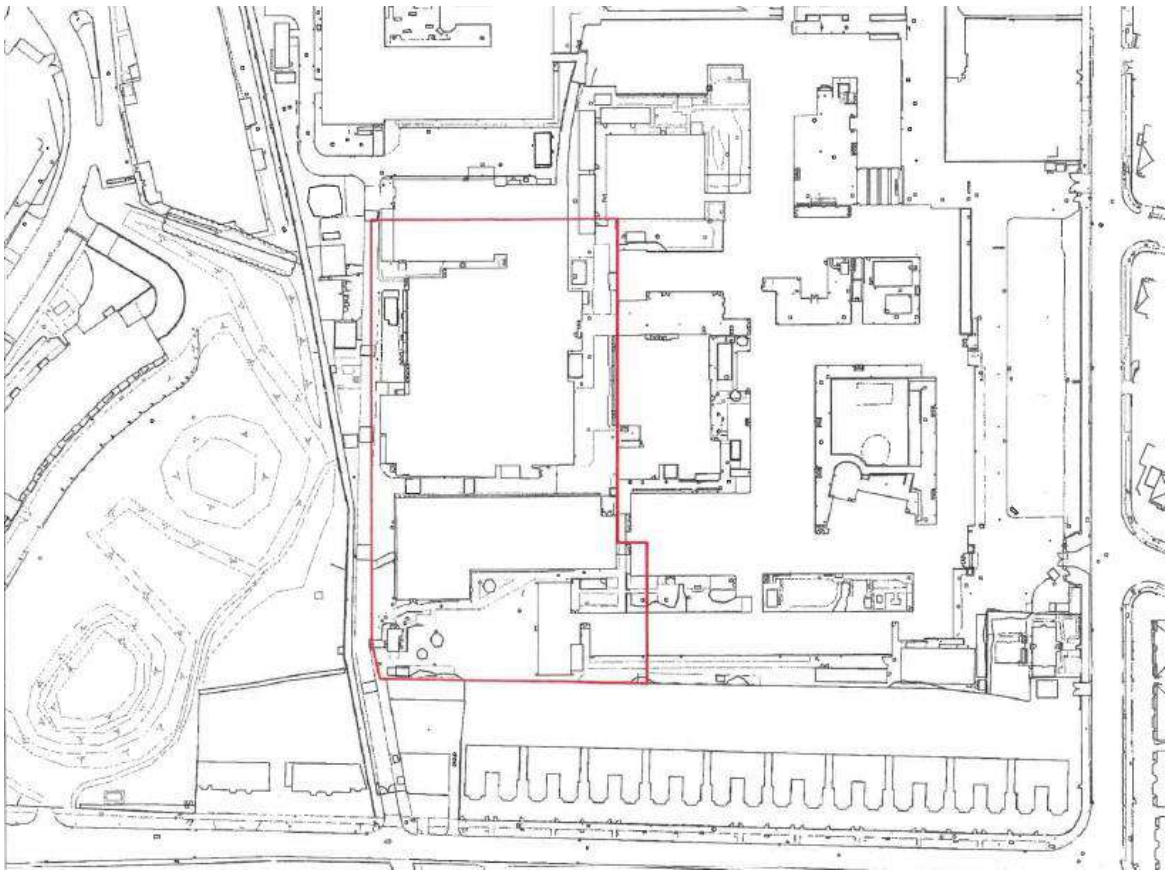


Figure 6: Indicative red line plan of Phase 2

Site History

Outline Planning Permission

RUTC secured Outline Planning Permission for the wider college site (REF: DC/JEF/15/3038/OUT/OUT dated 16.08.16). This requires 6 reserved matters approvals as follows; 1) a new secondary school building 2) new College Main Building 3) Residential Phase 1, Sports and STEM buildings (split into 3 individual sub applications) 4) Playing fields 5) Phase 2 residential and 6) a new Technical Hub. Figure 7 sets out the structure of the outline consent and key stakeholders. Figure 8 shows how these buildings relate to one another as the overall masterplan.

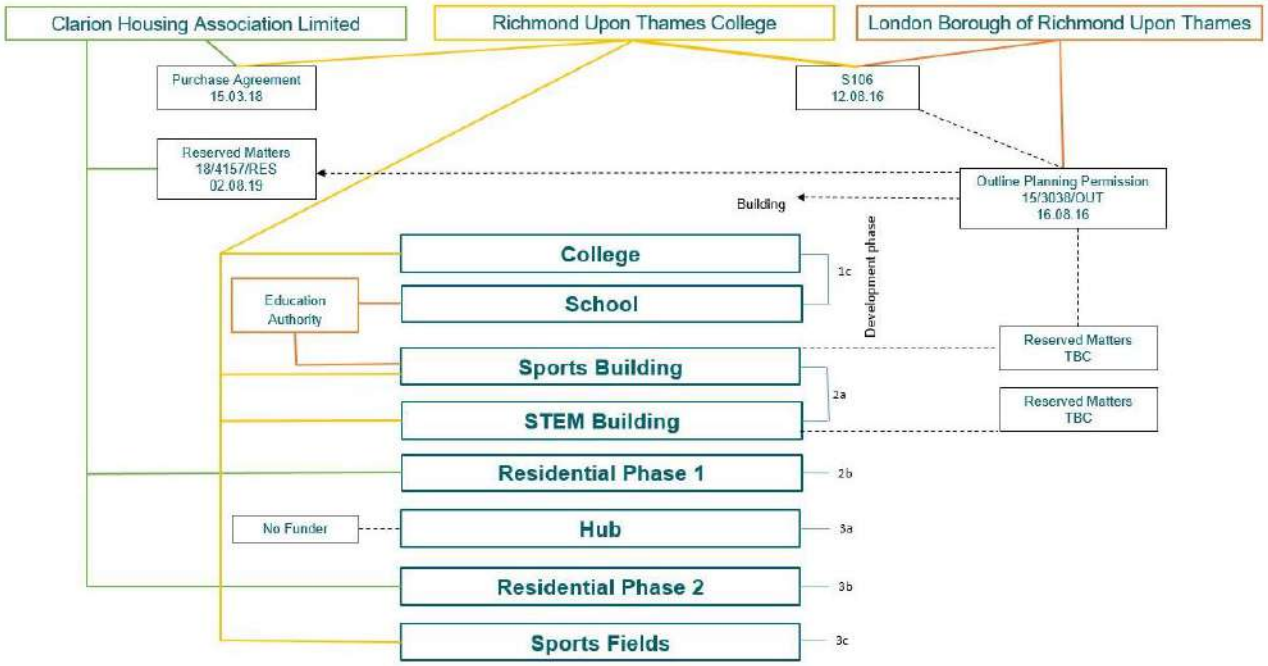


Figure 7: Structure of the Outline Planning Permission

Figure 8: Outline Masterplan

Clarion has purchased the residential zone which was designated within the masterplan for 180 residential units to be built in two phases.

The outline planning permission clearly set out parameters relating to height, massing and building extents for the residential zones.

Existing Reserved Matters

Reserved Matters permission was granted to Clarion in August 2019 for 180 units (REF: 18/4157/RES dated 02.08.19) which were proposed to provide as all affordable (although only 34 were required by the S106). The 180 units would be delivered in two phases as detailed in the outline consent with a single point of vehicular entry via the college site and Longhorn Drive for both residential and construction traffic. The approved scheme has several significant design and delivery challenges which combine to make the scheme undeliverable in its approved form.

Key issues with the approved scheme are:

- The number of high value homes (£1m+) is considered to be a sales risk.
- The affordability of the high value homes as a Shared Ownership product is in doubt.
- The layout of the terraced townhouses was not considered to be appropriate for the price point.
- A single point of access to the development limits deliverability and impacts build sequence.
- Residents had to access site via a hoarded off construction route – impacting on their experience of site, sales values reflected this.
- The assumed sales rates for the 154 SO units are considered high.

Constraints and Opportunities

Constraints	Opportunities
Building Levels, which will be dictated by the flood risk assessment	Placemaking and creation of good amenity space
4m ecological corridor on the northern boundary with school.	Opportunity to improve efficiency by reducing the number of cores.
Building massing has ben detailed in outline consent.	Opportunity to create more efficient, useable and saleable apartment layouts.
Proximity to arterial road routes to and through London	“Opportunity to increase efficiency through stacking / repeated floor plans and standardisation of unit types.
Existing planning consents and the rationale for these, which may restrict development	Develop a meanwhile use strategy for the site to mitigate costs of vacant existing college building ahead of demolition.
Adjacency to School and College poses safeguarding concerns around window placement.	To connect and/or collaborate with existing local amenities such as the Harlequins Rugby Club and Richmond College.
Current access is only from Langhorn Drive/ Chertsey Road	To improve the permeability across the site, with new road connection.

Market Overview

The scheme is in a desirable London location – one of London's wealthiest boroughs – making it highly desirable for young professionals and families. The site location benefits from strong transport links, being only 0.6 miles to Twickenham station, with trains directly to London Waterloo in under half an hour. The location also benefits from Proximity to the Harlequins Rugby Club, a large variety of local shops and amenities close by in Twickenham as well as public parks at Kneller Gardens, Marble Hill Park, Ham Lands and Richmond Park, which will appeal to families who are our target market for the larger 3 and 4 bed units.

The overall price point of the one, two and three-bed apartments in this location will exceed the typical first time buyer market, but we are confident based on sales in the area (specifically at Brewery Wharf by Berkeley), that demand for the product is present and will be driven due to the location, place making and standard of the units.

There are limited developments within close proximity. We have looked at the two closest comparables:

Twickenham Gateway - Solum

The closest and main comparable, is Twickenham Gateway, which comprises 115, one, two and three bed private apartments, set around a new public piazza and next to the River Thames. The site is just one minute to Twickenham Station and according to Molior as of Jul-20, 20 units have sold and final completions are set for Q2'20 – Q1'21.

We are pitching ourselves at a similar average price level to Twickenham Gateway on the one and two bed apartments as we will be a new site and we deem ourselves a more well-known brand than Solum, who only have 1 live site throughout Greater London. Twickenham Gateway delivers no houses and therefore their three-bed average unit sizes are considerably smaller and are marketed at a lower price point than us on the average prices for these.

Brewery Wharf - Berkeley

The site sold out in Q3 2018, but is highly comparable in mix. The development compiles of 99 private units with 1 and 2 bed apartments and a total of 28 gated 3, 4 and 5 bed houses. It is a riverside development and within one minute of Twickenham Station. It was launched in Molior as of Jun-14, selling out in Sep-18 with build completions finalised in Q1-18.

The values achieved, specifically on the four bed-houses make it clear that our current cap values are in line and achievable within the market – they are higher than us but this is to be expected with the larger sized units they have and the place-making/brand aspect of their scheme.

Key Project Objectives

This Development Brief proposes the following key changes from the most recent Reserved Matters planning permission:

Home mix adjusted in order to:

- Reduce the number of high value homes and the associated sales risk;
- Increase the number of lower value homes on site;
- Adjust the tenure mix to achieve a 50:50 affordable : private split based on hab rooms (Note: minimum 26x affordable rent homes).

Layouts:

- Layouts of the remaining town houses and all apartments to be improved to reflect a better private sale offer, support the target capital values and to reduce the sales risk;
- Review apartment layouts to optimise efficiencies and reduce the number of different apartment types;
- Avoid any oversized apartments (delivering within 5% variance from LHDG requirements).

Construction Phasing:

- Improve construction efficiencies by targeting a single phase build programme rather than the two phase plan previously detailed.

Access:

- Retain Chertsey Road access for construction. Identify and deliver 2x permanent points of access and egress from Egerton Road in order to:
  - Improve relationship with surrounding residential area
  - Improve experience for purchasers
  - Separate construction traffic from residential traffic

Sustainability:

- Deliver part of the development as Net Zero Carbon (NZC) in operation;
- Achieve NZC for 1x Terrace of Townhouses and 1x block of Affordable Rent apartments in order to:
  - Deliver highly sustainable homes and learn lessons we can roll out on other projects.
  - Enable learning across different home types and construction methods which will be applicable to a wider range of Clarion sites / projects in the future;
  - Test the market demand, sales & marketing strategy and branding of a NZC product on private sale homes;
  - Develop an understanding of the benefits of NZC design to residents in affordable accommodation and the risks & opportunities of the

management and maintenance of the homes. Capture lessons learnt to feed back into the business.

- Deliver a truly sustainable scheme which offers environmental, social and economic benefits to our new residents and the wider community.;

Governance

Clarion is required to achieve internal approval at Development Gateways prior to key project milestones, such as planning submission and Start on Site. Development Gateway meetings are held on Tuesdays, weekly, and papers must be submitted 1 week in advance.

The current project milestone target dates, including the internal Development Gateways, are outlined below.

Bi weekly Design Team Meetings will be held with a monthly design pause at which the cost plan will be updated to reflect changes within the period.

Project Milestones

Activity	Start Date
Appoint Design Team	October 2020
Develop Design & Planning Application	October 2020
Gateway 5 - Planning Submission	March 2021
Planning Committee	July 2021
Gateway 5.1 – S106 Approval	September 2021
Sign S106	September 2021
Gateway 6 – Sales Signoff	January 2022
Gateway 7- Construction Contract	March 2022
Gateway 8 – Start on Site	June 2022
Gateway 9 – Practical Completion	October 2024

Vision

Our project team's purpose is to create and deliver a great place to live in Twickenham. We will do this by considering four main objectives:

Education

- Drawing on the sites previous use as an educational facility to offer education and training opportunities during the construction and where possible incorporated into the final development.
- To have links to the neighbouring educational facilities.
- To learn from the experience of delivering net zero carbon homes so that we can develop and improve as a housing provider

Legacy

- Deliver tenure blind affordable and market housing
- Developing well considered layouts, making the best use of space, delivering efficient buildings that are enjoyable to live in.

Sustainability

- Deliver Net Zero Carbon homes in operation.
- Encourage biodiversity and support ecological habitats to support wildlife
- Create opportunities for social interactions amongst the wider community including the immediate neighbours of the college and school and help combat social isolation;
- Encourage sustainable transport

Health and Wellbeing

- Creating a safe and secure environment for visitors and residents
- Encourage active travel making it easier for residents to walk or cycle
- Embed Health and Safety in Design and Incident and Injury Free culture in the project
- Design public areas and spaces that families and other groups will want to use and socialise in, and which are inclusive for everyone.

The project vision will be further developed following a Vision Workshop event attended by the wider project team.

Target Metrics

Phasing and Drawdown

The land is being acquired in two phases with the Phase 1 purchase complete, currently rented back to the college and VP predicted for late-November 2020. The Phase 2 acquisition is dependent on a number of conditions that the college must meet and is currently anticipated to be achieved in December 2020. The college will then enter into a lease to occupy the building for a maximum of 30 months. Full VP of the site is anticipated after 18 months in the summer of 2021.

The demolition of Phase 1 will start in advance of VP of Phase 2, however it is intended for the build to be delivered in a single phase.

Planning

An Initial Pre Application consultation has been held with London Borough of Richmond upon Thames (LBR) who advised that the proposal would require an application for detailed planning permission. Generally they appeared supportive of the proposed changes but held reservations about the revised access strategy, which will need to be addressed in detail and through public consultation. It is therefore proposed to submit a new planning application but tie it back into the existing Section 106 agreement through a Deed of Variation.

Aspects of the existing permitted scheme will serve as a reference and precedent for the revised scheme. Where possible footprint and massing should follow the parameters established in the Outline Planning Permission, however, the clear instruction is to identify opportunities for re-design and enhancement that might otherwise not have been possible had the original design process have continued. The planning approach of a full stand-alone application does facilitate starting from a clean slate should this be justifiable.

The scheme must also comply with the wider development planning obligations as set out under the S.106 attached to the original Outline Planning Permission.

The design team will be expected to present design development proposals to Richmond's Design Review Panel, in order to gain written feedback on design quality from the independent built environment practitioners.

Section 106

The S.106 Agreement associated with the outline planning permission was entered into by the college and LBR and covers the whole site [dated: 12.08.2016]. This requires the provision of 26 Affordable Rent and 8 Shared Ownership homes within Phase 1 of the residential development. The S.106 includes details of the whole site phasing plan and some obligations are tied to triggers relating to these phases.

CIL

Due to the size of the building to be demolished, the quantum of affordable homes being provided, and the quantum of private sale homes, currently no CIL is chargeable. However, this relies on obtaining CIL relief post planning permission and pre-demolition of the existing buildings. CIL liability must be reassessed if floor area increases over the existing proposal.

Stakeholder Engagement

Statutory consultations related to the planning application will be fronted by the design team alongside the project team. Resident and stakeholder engagement will be facilitated by Barton Wilmore. Under the current circumstances, all engagement will need to be done remotely.

Although this is a new planning application, Councillors and the public are very well aware of the site and the previous planning applications, so we believe the engagement strategy can focus on the key changes and the most contentious issues i.e. access from Egerton Road. Proposals should consider what the development can offer the wider community to encourage acceptance of the new entrance.

Clarion has obtained pre-application advice from LBR and will continue to do so via a PPA. This is expected to provide an understanding of how the Council's policies will be applied to the development, provide input from relevant departments/teams where considered necessary, and provide an opportunity to respond to any issues or concerns prior to submitting the formal application.

A series of pre-application meetings will be held with the Council's Planning and Design Officers, and should they be required topic based meetings will be held to discuss technical issues. The need for topic based meetings will be borne out of the discussions with the Council's Planning Officers. Our initial thoughts are that, topic based discussions will be held in relation to the following topic areas:

- Design and Townscape Analysis;
- Transport, Highways, Public Realm:

The consultant team will be encouraged to engage with Council Officers as required

A full programme of community engagement will be undertaken, this will include:

- Digital engagement activities, including taking part in Zoom (or equivalent) based events
- Similar events for other stakeholders (including the college, Harlequins, The school, Friends of the River Crain)
- Written information distributed to all homes business in adjoin neighbourhoods
- Face to face meetings with ward members and the areas MP should they be required and COVID dependent

A full engagement strategy will be developed and presented in due course.

Place-making

Research has shown that often the features that homeowners value most about their home are not necessarily associated with the merits of the building itself but rather the environment. High quality public realm and access to open, green spaces and neighbourhood amenities need to considered as much as if not more than designing attractive buildings.

To achieve the Project Vision, the following project objectives have been set:

- Create a safe and secure environment with passive surveillance. Activation should consider daytime and night-time uses.
- Consider the ten principles set out in the National Design Guide –

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/843468/National_Design_Guide.pdf

- The development should follow the principles of Building for a Healthy life https://www.designforhomes.org/project/building-for-life/ /https://www.udg.org.uk/publications/othermanuals/building-healthy-life
- Follow Sport England active design principles where applicable https://www.sportengland.org/how-we-can-help/facilities-and-planning/design-and-cost-guidance/active-design
- Build on principles from Building with Nature (certification should be further investigated) https://www.buildingwithnature.org.uk/how-it-works

Meanwhile Use

A meanwhile use is being actively pursued. Current uses being considered are:

- Renting the existing building out for use for media productions
- Use by London Fire Brigade as a training facility

Sustainability

This project seeks to target some homes as Zero Carbon in operation. The Zero Carbon element is discussed in detail further on. All other homes will achieve requirements to meet the current London Plan through a fabric first approach. Ideally all homes will be able to be upgraded to zero carbon at a later date through the introduction of technologies and other upgradable elements.

There are a range of other initiatives that our development can potentially contribute to, from tree planting to improved pedestrian routes. The design team should develop the scheme so sustainability is embedded within it. Residents who choose to live here should find it easy to live sustainable lives.

Aspects of the scheme that will be focussed on include:

- promotion of active travel, cycling and walking with the associated health benefits
- low embodied carbon, long life, low maintenance materials
- highly efficient building envelope
- clean energy
- Efficient use of potable water
- homeworking facilities, future proofing changing society behaviours
- community spaces
- electric vehicle charging and car club
- using local labour and supply chain
- providing training opportunities
- delivering apprenticeships
- implementing community engagement plans
- Provision of healthy environments
- Delivery of improvements to biodiversity

Ventilation / Overheating

To comply with Clarion's ERs, apartments and common parts with communal heating should be carefully designed to avoid overheating without reliance on Mechanical Ventilation Heat Recovery (MVHR) inside units and with either natural or mechanical ventilation to common parts.

Designers should complete the Good Homes Alliance (GHA) Overheating in New Homes Tool at early RIBA Stage 2 (Concept Design). The review of the completed overheating risk assessment will result in feedback as to the likely overheating risks, any studies required to understand the risk more accurately and potential solutions to avoid or reduce the risk.

Zero Carbon

In order to realise the target of Zero Carbon on 1.no terrace of housing and 1.no. block of apartments (the affordable rent) the following should be carefully considered:

- Construction methodology
- Sustainable heating technologies including opex vs capex costs, maintenance,
- How renewable energy can be distributed and benefit residents
- Reduction in residents' energy bills
- How the remainder of the site can be upgraded to NZC at a later date.
- Build Cost

Infrastructure

Utilities

Heating and power will form one of the central considerations in achieving NZC. Consideration should be given to the removal of gas from the site.

Road / Highway adoption

All internal roads will be delivered to an adoptable standard, to facilitate a conversation with the local authority for their adoption. Adoption will be further investigated at the end of Stage 2 design subject to access being gained from Egerton Road.

Space Standards

All homes should comply with the Nationally Described Space Standards (NDSS), and within London the London Housing Design Guide Dwelling Space Standards (LHDG), or such other subsequently adopted space standards.

Target Building Metrics and Efficiencies

(Items marked with a * relate to apartments only)

Building Metrics, Efficiencies & Standardisation	
Build cost	Target: £37.2m
Gross External Area (GEA) : Gross Internal Area (GIA)	92% - 95%
Total Net Internal Area (NIA) : GIA	76%
Typical residential floor plate NIA : GIA *	80%
Space Standards – Apartments	All apartments to comply with NDSS / LHDG
Apartments per core *	8
External wall to Floor (GIA) ratio	55%
Residential external wall glazing allowance	30% - 35%
Slab-to-slab height	target 3m
Ceiling heights within units	2.5m (2.4m acceptable to bathrooms)
Ceiling heights to communal corridors *	2.4m
Floorplan Layouts – very important to stack services *	One floor plate from 1st floor upwards
En-suites	Include in 2 Bedroom and larger for both Private and S/O.
Built in wardrobes	1 Bedroom Apts – 1 no. 2 Bedroom Apts – 1 no. 3 Bedroom Apts/ Houses – 1 no. 4 Bed Houses – 2 no.
Lifts per core *	1 (subject to blocks remaining 4 stories or less and location of WC units)
Slab thickness – concrete flat slabs *	Target - 225mm
Structural grid *	Yes

Standardisation Targets

Standardisation Targets	
Apartment variations:	10
Bathroom types	2 (I adaptable, 1 accessible)
WC types	2 (1 adaptable, 1 accessible)
En-suite types	1
Utility Cupboard types	1
Balcony types	2 (100% Bolt on)
Kitchen types	1 per unit type
Window Types	4

The design team should produce a standardisation schedule at the end of each design stage to show the number of different apartment and component types.

Build Method

The construction method will be determined through ongoing work identifying the most appropriate NZC strategy.

Pod Elements

It is not anticipated that his scheme will incorporate Pod elements, however Clarion is open to exploring the potential should there be demonstrable cost, quality and/or programme benefits.

Financials

Target build cost

A target build cost of £37.2m is considered suitable for this development opportunity.

Design Brief - Residential Product

Target Apartment Mix,

Tenure Mix

1. Home type	AR	SO	PFS
1B2P	30%	40%	30%
2B3P	10%	10%	20%
2B4P	50%	40%	20%
3B5P	10%	10%	

3B5P (H)			20%
4B7P (H)			10%
Target tenure split (hab rooms)	14%	36%	50%

The above is the current tenure proposal. Clarion housing will consider variation from this if it can be justified from a design and financial position.

Apartment Sizes

All homes to comply with the NDSS. 1:50 plan drawings should include the minimum suggested furniture requirements, room areas and key dims. Units should not be oversized and stay within a 5% variance from LHDG.

2B3P homes to be sized to accommodate a double bed in the second bedroom. Target second bedroom size 10sqm.

3B5P homes to be sized to accommodate a third double bed rather than a single bed. Target third bedroom size 10sqm.

Floor-to-Ceiling height to be 2.5m throughout all homes (can reduce to 2.4m in communal corridors).

Apartment layouts should follow our Residential Design Principles which can be found in Appendix 1

Affordable Housing

Tenure distribution so that Affordable Rent tenure is served by a separate entrance & core to the private and shared ownership homes.

Affordable Rent housing should not be open plan.

Wheelchair Accessible Housing

In line with GLA requirements, 90 percent of new dwellings are 'accessible and adaptable dwellings' and ensuring that 10% are wheelchair user dwellings. Wheelchair user dwellings should be located on the lower floors, ideally ground floor. Balconies should not just be accessible but actually functional for disabled users, consider door and furniture placement to allow for navigation and use.

Maisonettes / Duplex

Duplex units are typically less valuable per sqft (£ / ft²) than the single storey equivalent unity type.

Duplex homes should be limited to street level and used only where expressly necessary to create front doors onto streetscapes and activate the ground floors.

Open Plan Product

Clarion is encouraging of the incorporation of open plan apartment layouts, where the fire strategy allows.

North Facing Apartments

The design should reflect a predominance of homes with two or more aspects. Therefore 50%+ of all homes to be designed as dual aspect homes. Single aspect north facing homes should be avoided.

Back of House Facilities:

Area	Requirement
Resident's Lobby & concierge facility*	More details on concierge facility can be found below.
Property Management Facility	Small lockup facility to provide area to store personal items, microwave and to include a toilet. [size: 8 sqm – can be combined with cleaners cupboard in this core]
Cleaners cupboard	To include a Belfast sink, source of hot & cold water & storage for cleaning equipment (hover / mop / bucket etc). 1x required per core. [Size: 2sqm]

Specification & Standard Detail

Fit-Out Specifications

Private and Shared ownership homes to be Silver specification with some amendments agreed with Sales at IC as follows:

	Standard Silver Spec	Proposed uplift for all private and Shared ownership homes
Kitchen	• Laminate worktop • 50mm upstand / splashback • Bosch appliances • Stainless steel sink (over mounted)	**Apartments & Houses:** • Composite stone or silestone worktop • Back painted glass splash back • Bosch appliances • Stainless steel sink (under mounted) 1.5 bowl **Houses:** • Integrated Microwave oven
Flooring	• Engineered hardwood	**Houses** - Engineered hardwood (30 nr. units) (keep engineered hardwood flooring)
		Apartments - Amtico flooring
Heating	Radiators	**Houses** – underfloor heating

The specification will be further developed by the appointed Interior Designer who will also develop a specification for communal areas.

Apartment Window Strategy

The number of window types and fenestration should be optimised so as to contribute to attractive design, whilst representing an efficient, cost effective solution.

Apartment Heating Strategy

Heating and power to apartments to form part of the NZC strategy. The site will be fossil fuel free.

Residents' Amenities

External amenity spaces to be provided in line with:

- Prevailing policy
- Active Buildings principle from Sports England Active Design,
- Building for Healthy Living
- Building with Nature

Public Realm

The public realm design should work together with the building architecture to create a well-integrated, high quality and welcoming sense of place, and the design should meet the following key principles:

- The public realm frontage to the street is important and should be visually open;
- Promote wellbeing of residents through the use of light to create a sense of place after dark and create focal points;
- The public realm should be design to last, be part of the wider community, look good and be low maintenance to ensure estate management charges are minimised; and
- The public realm should be accessible to all, providing level access to all areas.
- Estate roads and pavements should be designed to an adoptable standard.

Concierge

We are exploring the possibility (subject to service charge) to provide a basic 18h concierge to be on the main private block. Adequate space for a reception desk. Post room for storage of parcels. Accessible toilet for staff / customers.

Balconies

Every home should have access to private external amenity space, either a garden, balcony or terrace. For balconies, preliminary minimum dimensions for balconies are set out below. The architect should review the local market to establish any prevailing sizes for balconies.

Balcony designs should include a furniture layout by the architect to demonstrate how they can be used. Primary access to private amenity from a living space and not from bedrooms.

Max. useable depth of 1.5m

Protruding bolt-on or slide-on construction and standardised sizes.

Car Parking

Target to meet existing approval. 135 spaces. Provide Electric Vehicle Charging actively to 20% of total parking provision with remainder to have infrastructure in place for future installation.

Car Club

To be provided in line with the S.106 requirements.

Cycle Parking

Cycle Storage to be provided in line with current GLA requirements.

- Long-stay - 1 space per studio and 1 bedroom home, 2 spaces per all other dwellings.
- Short-stay – 1 space per 40 homes.
- Additionally, provision to be made for a 12 bay Brompton bike dock externally.

Facilities Management

Servicing and Delivery Strategy

Management Strategy

The development will be managed by either Grange or a third party management company. A full management strategy will be developed in due course.

Target Service Charge

The design team should be mindful of service charge and reserve fund implications during design development. It is therefore expected that design proposals consider lifecycle costs. That is, operation, maintenance, repair and replacement costs, not just initial capital costs.

Clarion has an internal Service Charge team who can provide draft budget services charge costs based on design proposals.

The design process should include a review of the design by the Service Charge Team during RIBA Stage 2 and/or RIBA Stage 3. The purpose of this will be to check that the developing design remains within the target service charge rate, and to identify any elements of the design that are at risk of exceeding the overall target.

Window Cleaning Strategy

All apartment windows should be safe to clean by a resident standing in their apartment or on their balcony.

Windows in common parts should be cleanable from the ground using a pole. If the windows are higher than a pole reach they should be capable of cleaning by an operative standing inside the building.

Waste Storage & Recycling

The following should be provided as part of the resident's waste and recycling facilities:

- Easily accessible communal waste / recycling at ground level for residents drop off
- Waste should be collected within 10m of public highway so that collection is completed by the Council's waste contractor. Waste collection should not rely on management.
- Stores should accommodate separate facilities for waste and recycling, space for bulky collection and sufficient capacity to accommodate standard Local Authority collections
- Residents will carry their own waste to the refuse stores. Management requirements should be kept to a minimum
- Refuse stores should be located within 10m drag distance from refuse vehicle stopping point

Procurement and Construction

Procurement

The current procurement strategy is based upon the procurement of a demo contract for Phase 1, followed by a single phased, construction contract which includes the demo of Phase 2. The logic of procuring these two contracts separately is to allow maximum flexibility around when Phase 1 is demolished.

Main Works Contract

Due to the nature of the project as having an element of Zero Carbon, the process by which the building will be procured is yet to be determined. Ideally a single main contractor will be employed for the whole site based on stage 3+ (with the scope of the '+' yet to de agreed) information. The scope of this package will include the sub-structure, superstructure, MEP, external envelope, fit-out works, and external landscaping. This will be a single stage tendered design and building procurement route for the main contract works run through the DPS.

Outline Sales and Marketing Strategy

Target Market

Local city professionals, young couples and families, first time buyers, investors.

Key Target Dates

- Potential to take overseas 18 months before PC to start the sales programme early.
- Domestic launch event in the UK 12 months before PC for Private and 6 months for S/O Shared Ownership values have been calculated against todays HTB scheme. This is due to expire before these homes are completed.
- Provision of Show House & Flat and Marketing suite 12 months before handovers begin on private units
- Provision of SO show flat 6 months before handovers.

Sales and Marketing Suite/ Show Homes

A 2 storey marketing suite is proposed on Egerton Road opposite Court Way. The existing care takers house which is currently located there will be demolished to make way for an (approx) 72sqm purpose built marketing suite with provision for 6 parking spaces. The downstairs of the marketing suite will be a meet and greet area for visitors, desk space for sales staff, a meeting room and soft seating and bathroom facilities. Upstairs will feature sample kitchen, bathroom and spec finishes including flooring.

The back door of the marketing suite should lead directly to the entrance to a 3 and 4 bedroom show home which needs to be available at launch.

In addition to the 2 show houses, a 1 and 2 bedroom apartment should be available up to 18 months before handover.

Signage will be required along Egerton Drive and Longhorn Drive (where possible).

Appendix 1

Residential Design Principles

APPENDIX C
SUMMARY OF LEGISLATION AND POLICY RELATING TO LAND CONTAMINATION

Part IIA of the Environmental Protection Act 1990

Part IIA of the Environmental Protection Act 1990 (Part IIA) and its associated Contaminated Land Regulations 2000 (SI 2000/227), which came into force in England on 1 April 2000, formed the basis for the current regulatory framework and the statutory regime for the identification and remediation of contaminated land. Part IIA of the EPA 1990 defines contaminated land as 'any land which appears to the Local Authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that significant harm is being caused, or that there is significant possibility of significant harm being caused, or that pollution of controlled waters is being or is likely to be caused'. Controlled waters are considered to include all groundwater, inland waters and estuaries.

In August 2006, the Contaminated Land (England) Regulations 2006 (SI 2006/1380) were implemented, which extended the statutory regime to include Part IIA of the EPA as originally introduced on 1 April 2000, together with changes intended chiefly to address land that is contaminated by virtue of radioactivity. These have been replaced subsequently by the Contaminated Land (England) (Amendment) Regulations 2012, which now exclude land that is contaminated by virtue of radioactivity.

The intention of Part IIA is to deal with contaminated land issues that are considered to cause significant harm on land that is not undergoing development (see Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, April 2012). This document replaces Annex III of Defra Circular 01/2006, published in September 2006 (the remainder of this document is now obsolete).

Planning Policy

Land contamination is often addressed via the planning process during redevelopment of sites. This approach was documented in Planning Policy Statement: Planning and Pollution Control PPS23, which states that it remains the responsibility of the landowner and developer to identify land affected by contamination and carry out sufficient remediation to render the land suitable for use. PPS23 was withdrawn early in 2012 and has been replaced by much reduced guidance within the National Planning Policy Framework (NPPF), reference ISBN: 978-1-5286-1033-9, July 2021. For sites in Wales, reference should be made to Planning Policy Wales (Welsh Government. Edition 11, February 2021).

The new framework has limited guidance on contaminated land, as follows:

Chapter 11. Making effective use of land

117 Planning policies and decisions should promote an effective use of land in meeting the need for homes and other uses, while safeguarding and improving the environment and ensuring safe and healthy living conditions. Strategic policies should set out a clear strategy for accommodating objectively assessed needs, in a way that makes as much use as possible of previously-developed or 'brownfield' land.

118. Planning policies and decisions should:

c) give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land.

Chapter 15. Conserving and enhancing the natural environment

170. Planning policies and decisions should contribute to and enhance the natural and local environment by:

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and

f) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.

Ground conditions and pollution

178. Planning policies and decisions should ensure that:

a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);

b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990; and

c) adequate site investigation information, prepared by a competent person, is available to inform these assessments.

179. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

Water Resources Act (WRA)

The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009 updated the Water Resources Act 1991, which introduced the offence of causing or knowingly permitting pollution of controlled waters. The Act provides the Environment Agency with powers to implement remediation necessary to protect controlled waters and recover all reasonable costs of doing so.

Water Framework Directive (WFD)

The Water Framework Directive 2000/60/EC is designed to:

- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands that depend on the aquatic ecosystems
- promote the sustainable use of water
- reduce pollution of water, especially by ‘priority’ and ‘priority hazardous’ substances
- ensure progressive reduction of groundwater pollution.

The WFD requires a management plan for each river basin be developed every six years.

Groundwater Directive (GWD)

The 1980 Groundwater Directive 80/68/EEC and the 2006 Groundwater Daughter Directive 2006/118/EC of the WFD are the main European legislation in place to protect groundwater. The 1980 Directive is due to be repealed in December 2013. The European legislation has been transposed into national legislation by regulations and directions to the Environment Agency.

Priority Substances Directive (PSD)

The Priority Substances Directive 2008/105/EC is a 'Daughter' Directive of the WFD, which sets out a priority list of substances posing a threat to or via the aquatic environment. The PSD establishes environmental quality standards for priority substances, which have been set at concentrations that are safe for the aquatic environment and for human health. In addition, there is a further aim of reducing (or eliminating) pollution of surface water (rivers, lakes, estuaries and coastal waters) by pollutants on the list. The WFD requires that countries establish a list of dangerous substances that are being discharged and EQS for them. In England and Wales, this list is provided in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. In order to achieve the objectives of the WFD, classification schemes are used to describe where the water environment is of good quality and where it may require improvement.

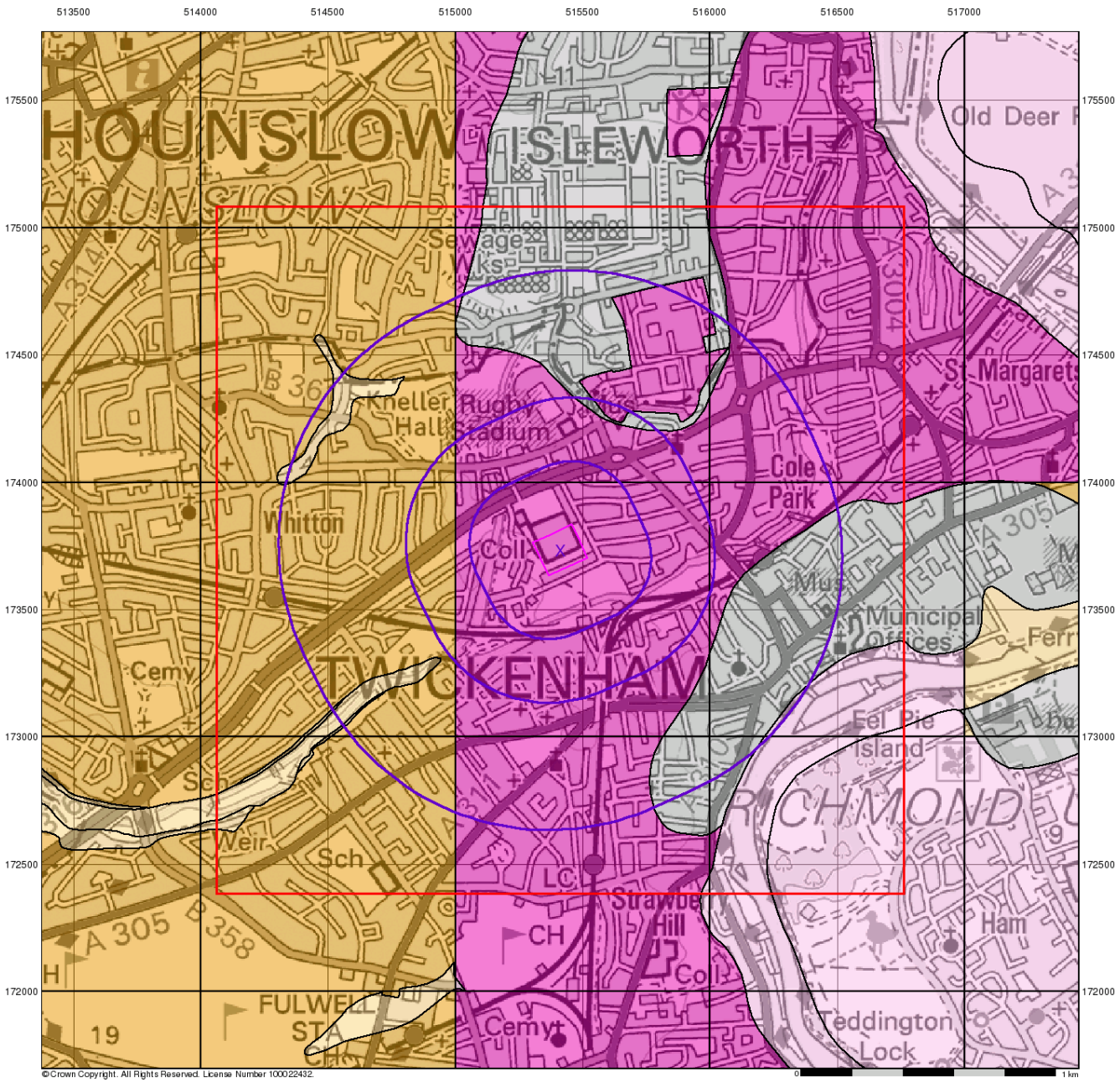
Environmental Permitting Regulations (EPR)

The Environmental Permitting (England and Wales) Regulations 2016 (as amended) provide a single regulatory framework that streamlines and integrates waste management licensing, pollution prevention and control, water discharge consenting, groundwater authorisations, and radioactive substances regulation. Schedule 22, paragraph 6 of EPR 2016 states: 'the regulator must, in exercising its relevant functions, take all necessary measures - (a) to prevent the input of any hazardous substance to groundwater; and (b) to limit the input of non-hazardous pollutants to groundwater so as to ensure that such inputs do not cause pollution of groundwater.'

Notes:

1. *The above information is provided for background but does not constitute site-specific advice*
2. *The above summary applies to England only. Variations exist within other countries of the United Kingdom*

APPENDIX D
ENVIRONMENTAL DATABASE REPORT



Groundwater Vulnerability

General

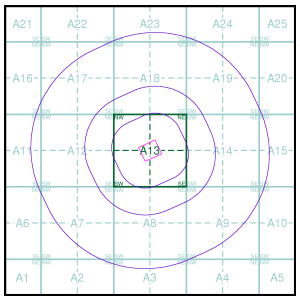
Specified Site | Specified Buffer(s) | Bearing Reference Point
Slice | Map ID

Agency and Hydrological

Bedrock Aquifers	Superficial Aquifers
High Vulnerability, Principal Aquifer	High Vulnerability, Principal Aquifer
High Vulnerability, Secondary Aquifer	High Vulnerability, Secondary Aquifer
Medium Vulnerability, Principal Aquifer	Medium Vulnerability, Principal Aquifer
Medium Vulnerability, Secondary Aquifer	Medium Vulnerability, Secondary Aquifer
Low Vulnerability, Principal Aquifer	Low Vulnerability, Principal Aquifer
Low Vulnerability, Secondary Aquifer	Low Vulnerability, Secondary Aquifer

Unproductive Aquifer
Soluble Rock

Site Sensitivity Context Map - Slice A



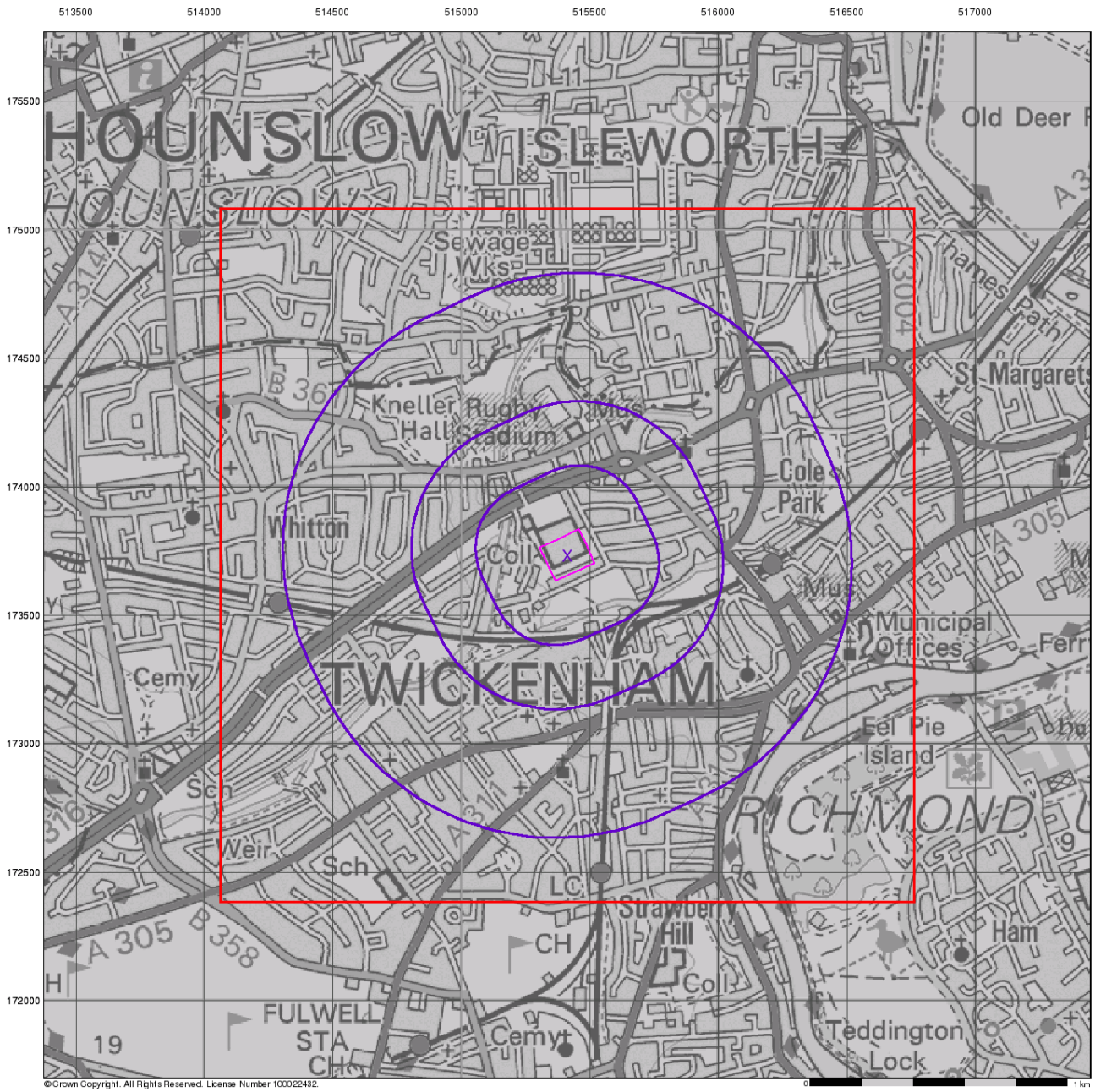
Order Details

Order Number:	300390822_1_1
Customer Ref:	1921744
National Grid Reference:	515410, 173730
Slice:	A
Site Area (Ha):	2.41
Search Buffer (m):	1000

Site Details

Richmond Upon Thames College, Langhorn Drive, TWICKENHAM, TW2 7SJ

Landmark INFORMATION GROUP
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



Bedrock Aquifer Designation

General

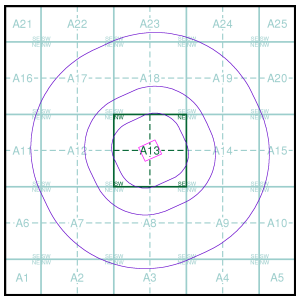
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A



Order Details

Order Number:	300390822_1_1
Customer Ref:	1921744
National Grid Reference:	515410, 173730
Slice:	A
Site Area (Ha):	2.41
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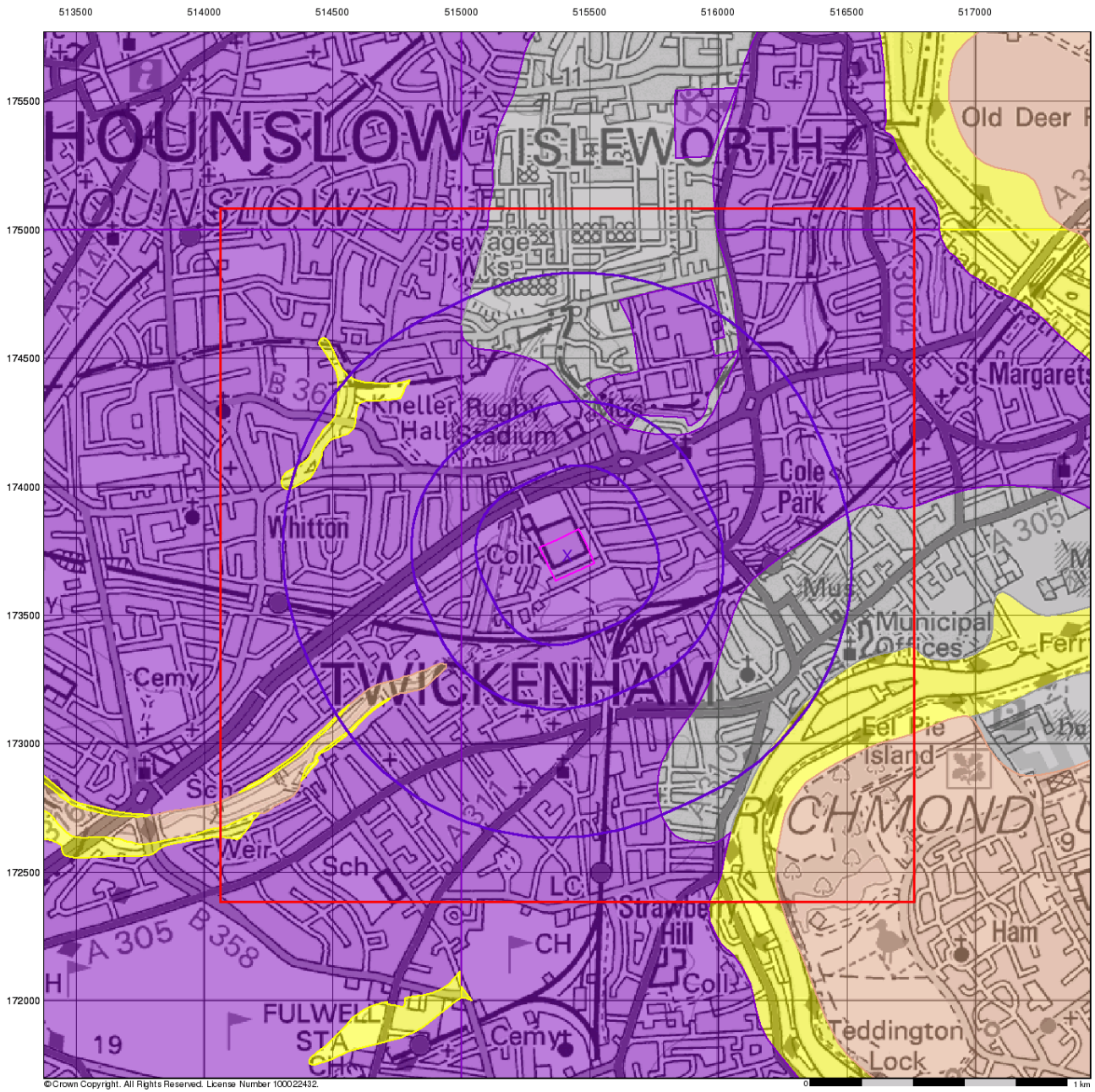


RSK

Superficial Aquifer Designation

General

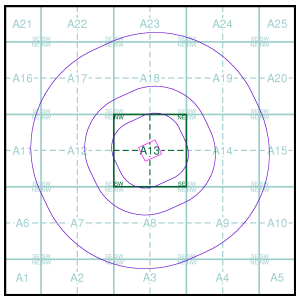
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A



Order Details

Order Number:	300390822_1_1
Customer Ref:	1921744
National Grid Reference:	515410, 173730
Slice:	A
Site Area (Ha):	2.41
Search Buffer (m):	1000

Site Details

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