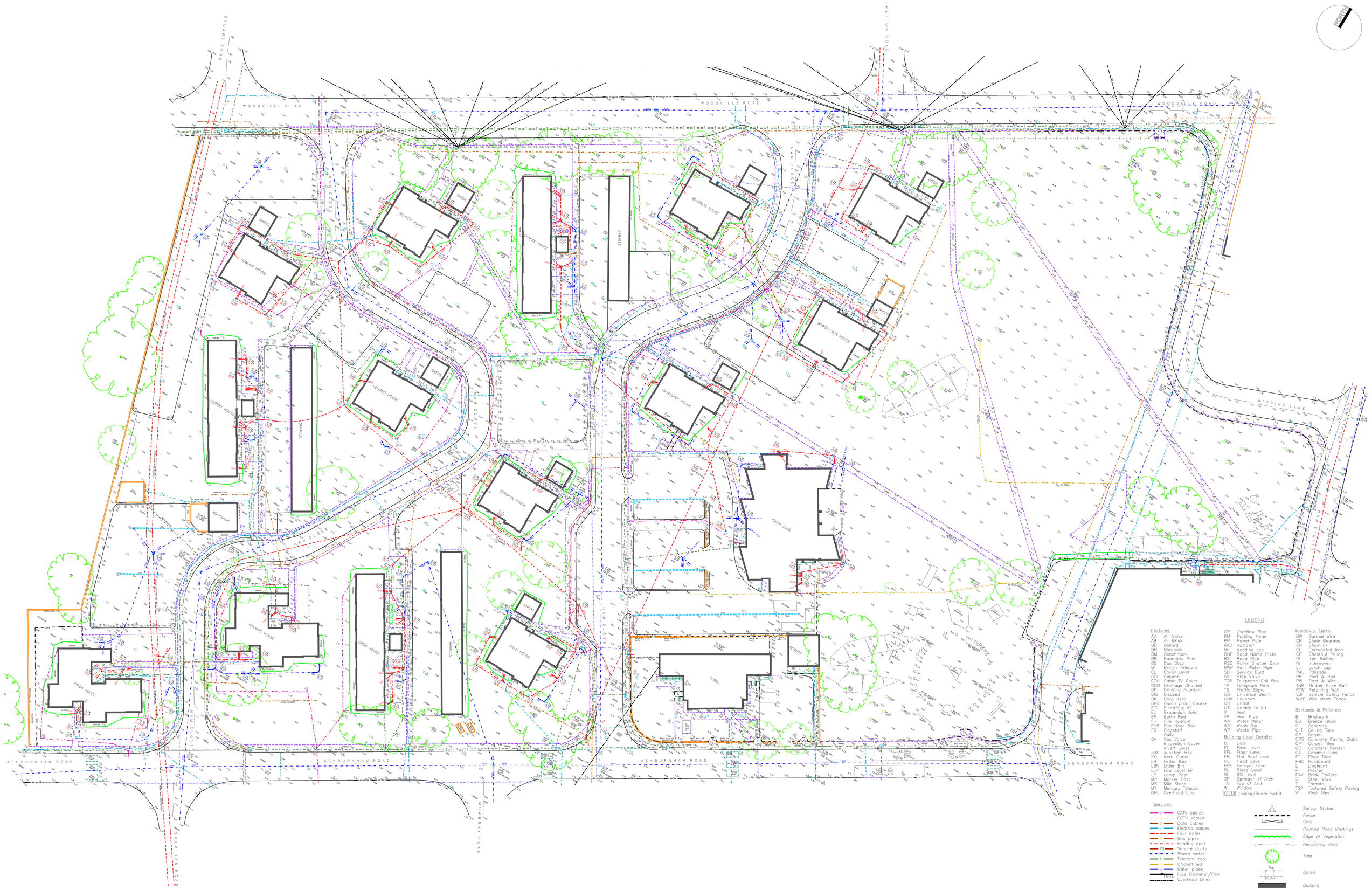
Appendix B: Topographical Survey



LEGEND

Features:

AV	Air Valve
AB	Air Brick
BD	Bollard
BH	Borehole
BM	Benchmark
BP	Boundary Post
BS	Bus Stop
BT	British Telecom
CL	Cover Level
COL	Column
CTV	Cable TV Cover
DCH	Drainage Channel
DF	Drinking Fountain
DIS	Disused
DK	Drop Kerb
DPC	Damp proof Course
EIC	Electricity IC
EJ	Expansion Joint
ER	Earth Rod
FH	Fire Hydrant
FHR	Fire Hose Reel
FS	Flagstaff
GV	Gully Gas Valve
	Inspection Cover
	Invert Level
JBX	Junction Box
KO	Kerb Outlet
LB	Letter Box
LBN	Litter Bin
LLP	Low Level LP
LP	Lamp Post
MP	Marker Post
MS	Mile Stone
MT	Mercury Telecom
OHL	Overhead Line
OP	Overflow Pipe
PM	Parking Meter
PP	Power Pole
RAD	Radiator
RE	Rodding Eye
RNP	Road Name Plate
RS	Road Sign
RSD	Roller Shutter Door
RWP	Rain Water Pipe
SD	Service Duct
SV	Stop Valve
TCB	Telephone Call Box
TP	Telegraph Pole
TS	Traffic Signal
UB	Universal Beam
UNK	Unknown
UR	Urinal
UTL	Unable to lift
V	Vent
VP	Vent Pipe
WM	Water Meter
WO	Wash Out
WP	Waste Pipe

Building Level Details:

D	Door
EL	Eave Level
FFL	Floor Level
FRL	Flat Roof Level
HL	Head Level
PPL	Parapet Level
RL	Ridge Level
SL	Sill Level
SP	Springer of Arch
TA	Top of Arch
W	Window
12.34	Ceiling/Beam Soffit

Boundary Types:

BW	Barbed Wire
CB	Close Boarded
CH	Chainlink
CI	Corrugated Iron
CP	Chestnut Paling
IR	Iron Railing
IW	Interwoven
LL	Larch Lap
PAL	Palisade
PR	Post & Rail
PW	Post & Wire
TNR	Timber Knee Rail
RTW	Retaining Wall
VSF	Vehicle Safety Fence
WMF	Wire Mesh Fence

Surfaces & Finishes:

B	Brickwork
BB	Breeze Block
C	Concrete
CLT	Ceiling Tiles
CP	Carpet
CPS	Concrete Paving Slabs
CPT	Carpet Tiles
CR	Concrete Render
CT	Ceramic Tiles
FT	Floor Tiles
HBD	Hardboard
L	Linoleum
P	Plaster
PAV	Brick Paviors
S	Steel work
T	Tarmac
TSP	Textured Safety Paving
VT	Vinyl Tiles

Services:

C	CATV cables
C	CCTV cables
D	Data cables
E	Electric cables
FW	Foul water
G	Gas pipes
H	Heating duct
SD	Service ducts
SW	Storm water
T	Telecom cab.
U	Unidentified
W	Water pipes
75x50	Pipe Diameter/Flow
	Overhead Lines

Survey Station
Fence
Gate
Painted Road Markings
Edge of Vegetation
Kerb/Drop Kerb
Tree
Top / Bottom
Banks
Building
Overhead Building Detail
Wall

Notes:

Do not scale. All dimensions to be checked on site. This drawing is copyright of bptw partnership.

Topographical information on this drawing was produced for RHP by EDI.

Notes:

Revisions:

Rev		Date	Drwn	Chkd
*	First Issue	21.01.2019	CD	CB

Revisions:

Rev		Date	Drwn	Chkd

Revisions:

Rev		Date	Drwn	Chkd

Revisions:

Rev		Date	Drwn	Chkd

FOR COMMENTS ONLY

Date: JAN 2019	Client: RHP		
Drawn: CD	Project: Ham Close - Further Appraisal		
Check: CB	Title: Topographical Survey		
Scale: 1:300 @ A0	Dwgno: J17.114 / SK3000	Revision: *	

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Appendix C: Soil Investigation Report

enzygo
geo environmental

Geo-Environmental Report

Ashburnham Rd, Richmond, TW10 7PB
for:

Hill Partnerships Ltd

'Experience and expertise working in union'

enzygo.com

Association of Geotechnical & Geoenvironmental Specialists

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Geo-Environmental Report

Project:	Ashburnham Rd, Richmond, TW10 7PB
For:	Hill Partnerships Ltd
Ref:	CRM.1027.087.GE.R.002.
Status:	Revision A
Date:	August 2021
Author:	Steve Rhodes **Director**
Reviewer:	Richard Hamilton **Director of Geoenvironmental**

Executive Summary

Proposed Development

The site is to be re-developed for a mixture of residential houses with domestic gardens and apartments with communal open space.

Investigation

Site investigation, desk study and monitoring visits were undertaken by Enzygo Geoenvironmental Ltd.

Ground Conditions

Ground Conditions comprise Made Ground over firm clay and loose becoming dense with depth sand and gravel. Shallow groundwater was not encountered.

Contamination

Elevated PAH, Lead and Arsenic was encountered together with asbestos. Remediation and management procedures are proposed.

Foundations

Spread foundations should be suitable for domestic houses but piled foundations are likely to be required for apartments.

Pavement Design

An equilibrium CBR of 3% is recommended. Soils are not considered to be frost susceptible.

Buried Concrete

It is recommended that Class AC-1s conditions of Special Digest 1 are used.

Ground Gas and Radon

No radon risk has been identified. No significant ground gas has been measured.

TABLE OF CONTENTS

1.0 INTRODUCTION

Background

1.1 Enzygo Geoenvironmental Limited has been commissioned to prepare a Geo-Environmental Report for a site at Ashburnham Rd, Richmond, TW10 7PB.

Proposed Development

1.2 Hill Partnership Ltd are seeking to re-develop the site for a mixture of residential apartments and domestic houses with associated infrastructure.

Objectives

1.3 The objectives of the study are to:

- Review an existing Phase I desk study, a copy of which is included in Appendix A;
- Undertake a ground investigation;
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors; and
- Provide a factual and interpretative report relating to the desk study and site investigations. Provide a revised conceptual model and recommendations on any potential development issues and mitigation measures, where appropriate.
- Provide geotechnical recommendations in relation to foundations and infrastructure.

Risk Classification

1.4 Enzygo Geoenvironmental has utilised the available information, together with our experience to assess the likely risks to development from land quality issues. Definitions of the risk terms used are provided on the following table.

Risk	Description
Negligible	No contamination risk has been identified which is likely to affect development.
Low	No significant contaminated land risks have been encountered affecting development and a low risk that remediation will be required.
Low-Moderate	There are unlikely to be significant contaminated land issue associated with the site which will adversely affect its re-development. However, minor or localised contamination may be present requiring remediation. Remediation should be possible under a discovery strategy and with a call out service.
Moderate	Some potential contaminated land risks have been encountered or identified which may affect re- development. The risks identified are unlikely to affect the entire site or preclude development. Remediation is considered feasible as part of the development process and no further investigation is considered necessary.
Moderate-High	Some potentially significant contaminated land risks have been identified at the property that requires remediation. It is recommended that a separate remedial methodology is prepared supported by a site-specific risk assessment
High	Significant potential contaminated land risks have been identified and remediation is required supported by further intrusive ground investigation, risk assessment and remedial design.

1.5 Where adverse risks from ground instability are identified these are discussed within the report.

2.0 SITE SETTING

Site Description

Item	Description
Site Address	Ashburnham Rd, Richmond, TW10 7PB
National Grid Reference	517160 172360
Site Area	4.58 Ha

Current Site Description

2.1 The following site description has been compiled from the site inspection undertaken by Enzygo Geoenvironmental staff, together with current maps, aerial photographs and a topographical survey.

2.2 At the time of the site investigation the site was occupied by residential apartment blocks with communal grassed areas and occasional trees across the central and western area of the site.

2.3 Internal roadways, parking areas and lock-up garages were present between the apartment blocks.

2.4 Within the southern area of the site an amenity hall, clinic and police station are present with associated parking.

2.5 The eastern area of the site is open land vegetated with grass and including footpaths.

2.6 An electricity sub station is present on the western boundary. This appears to be of modern construction with no evidence of leakage. The sub-station is not considered a significant risk.

Surrounding Area

2.7 The surrounding land uses are summarised as follows:

Direction	Land Use
South	Ashburnham Road with residential development beyond.
East	Wiggins Lan with residential development beyond.
West	School and open space.
North	Woodville Road with residential development beyond.

2.8 No significant sources of potential contamination were noted on or adjacent to the site.

3.0 SITE HISTORY

3.1 A review of historical Ordnance Survey maps and information pertinent to the site obtained from the existing desk study report is summarised below:

3.2 The site is shown as open land prior to construction of a farm in the eastern part of the site by 1868.

3.3 The site was redeveloped for residential use by 1947. A ruin is shown in the eastern part of the site by 1959 which is likely to be from bomb damage.

3.4 The current residential development is shown by 1983 and with open space in the east.

3.5 There is the potential for Made Ground associated with historic buildings, demolished prior to the current development. No other significant potential sources identified on or near to the site.

3.6 No significant off-site contamination sources are identified.

3.7 A low Unexploded Ordnance Risk was identified in relation to ground investigation works.

4.0 ENVIRONMENTAL SETTING

Ground Conditions

4.1 The British Geological Survey (BGS) indicates that the site is underlain by the following geological sequence:

Geological Unit	Type	Description	Aquifer Classification
Drift	Kempton Park Gravels	Sand and Gravel	Secondary A
Solid	London Clay	Clay	Unproductive

4.2 There are no records of Made Ground below the site. Made Ground is shown 41m south west. Given the distance from the site this is not considered a significant risk.

4.3 There are no records of landslips on the site.

4.4 BGS borehole records on site show 0.6m of Made ground over gravel and with London Clay encountered at depths of 6m.

Groundwater

4.5 The Desk Study Report shows that the site is not within a Source Protection Zone.

4.6 BGS records show that the site is at potential risk of groundwater flooding. This is only considered a significant risk where basements are proposed.

Coal Mining

4.7 No historical or current coal mining extraction has been identified within 1000m of the site.

Non Coal Mining

4.8 No other mining activity has been identified within 1000m of the site.

Cavities

4.9 No natural cavities or solution features are identified on site.

Hydrology

4.10 There are no water courses on the site.

4.11 Environment Agency records show that the site is not within an Environment Agency Flood Zone.

Radon Risk Potential

4.12 The Groundsure GeoInsight Report indicates that the site is not within a Radon Affected Area. No radon protective measures are necessary in the construction of new dwellings.

Natural Hazards Finding

4.13 BGS information presented within the Groundsure Geoinsight report identifies the following:

Hazard	Risk Designation (Groundsure)
Coal Mining.	None Identified.
Collapsible Ground.	Very Low.
Compressible Ground.	Very Low.
Ground Dissolution.	Very Low.
Landslide.	Very Low.
Running Sand.	Very Low.
Swelling / Shrinking Clay.	Very Low.

4.14 No significant geotechnical risks are identified.

Sensitive Land Uses

4.15 There are no sites of special interest on or surrounding the site.

4.16 English Heritage has not identified any listed buildings or scheduled ancient monuments on or close to the site. No sensitive geology has been identified at the site.

Environmental Sensitivity

4.17 Overall the site is currently considered to be of low/moderate sensitivity due to the following:

- The underlying stratum is classified as a Secondary A Aquifer;
- Not within a source protection zone;
- No surface water courses on or adjacent to the site; and
- No sensitive ecology is noted adjacent to or on the site.

4.18 The proposed end use of the site is residential and as such future sensitivity will be high for end users.

Industrial Land Uses

4.19 No significant current industrial activities are identified on or adjacent to the site.

Landfill Sites and Waste Treatment Sites

4.20 There are no active or historic landfills within 250m of the site.

Planning Records

4.21 A review of London Borough of Richmond's planning history shows no relevant information for the site.

5.0 PREVIOUS REPORTS

5.1 No previous ground investigation reports were provided.

6.0 PRELIMINARY CONCEPTUAL MODEL

6.1 Based on the desk study information the following Preliminary Conceptual Model has been prepared:

Source	Location	Exposure Pathway	Potential Receptor	Probability of Exposure	Details
Human Health					
Asbestos, Hydrocarbon and metals.	Unforeseen Contamination.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	Normal site management practices and PPE will address risk.
			Site users.	Negligible.	No source identified.
Asbestos, Hydrocarbon and metals.	Made Ground.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	Normal PPE will address risk.
			Site users.	Very Low.	If present can easily be addressed through development.
Hydrocarbon and metals.	Potential migration from off-site source.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	No significant off site sources identified.
			Site users.		
Ground Gas.	Historic Landfill.	Inhalation & Explosive.	Construction Workers.	Dismissed.	No source identified.
			Site users.		
	Potential Made Ground.	Inhalation & Explosive.	Construction Workers.	Dismissed.	No significant source identified.
			Site users.		
Groundwater					
Hydrocarbon and metals.	Potential spillage on site.	Vertical Migration.	Groundwater.	Dismissed.	No source identified.
Surface Water					
Hydrocarbon and metals.	Potential spillage on site.	Horizontal Migration.	River Network.	Dismissed.	No source or credible receptor.
Environmental Receptors					
On site contaminants		Ingestion dermal and inhalation.	Ecology.	Dismissed.	No sensitive ecology designation.
		Direct.	Archaeology.	Dismissed.	None present.
		Direct.	Geology.	Dismissed.	No sensitive receptor present.
		Phytotoxic.	Woodland.	Dismissed.	None present.
		Phytotoxic.	Crops.	Dismissed.	No source identified.
		Ingestion dermal and inhalation.	Livestock.	Dismissed.	No source identified.
Building Services					
On site contaminants		Direct.	Historic Buildings.	Dismissed.	None present.
		Direct.	Proposed Buildings.	Dismissed.	No source identified.
		Permeate into pipework.	Water Pipes.	Dismissed.	No significant source identified.

6.2 There is a very low risk from Made Ground, including former buildings which will be investigated. Should contamination be present this can easily be addressed through development. No other significant risks are identified.

7.0 SITE INVESTIGATION

General

7.1 A ground investigation was undertaken based on the findings of the desk study. The locations of the exploratory holes are shown on Drawing CRM.1027.087.GE.D.001.

Site Works

7.2 The site investigation works comprised window sampler holes (WS1 to WS18) advanced between 27th and 29th April 2021 and six deep boreholes (BH1 to BH6) advanced between 16th and 19th August 2021.

7.3 Exploratory hole locations were determined to provide general coverage of the site within areas where access was permitted by the land owner. The investigation works are summarised in the table below:

Rational	Exploratory Holes	Notes
Site Coverage.	WS1 to WS18.	Across site.
Monitoring.	WS5 WS6 WS7 WS9 WS14 WS16 & WS18.	Installations.
Deep foundations.	BH1 to BH6.	Deep boreholes.

7.4 Strength of soils were assessed using Standard Penetration Tests (SPT). The results of which are included on the borehole logs presented in Appendix B.

7.5 Representative soil samples were collected for chemical and geotechnical testing. Soil samples destined for chemical analysis were collected in appropriate containers provided by the analytical laboratory. Samples were stored in cool boxes prior to dispatch to the laboratory for analysis. All samples were collected using appropriate sampling equipment that was cleaned at each sampling location.

7.6 Generally samples were collected from Made Ground, which may contain potential inclusions of contaminating materials and materials displaying evidence of potential contamination.

7.7 In the absence of any evidence of contamination samples were collected near surface as this material is more likely to be contaminated by surface spillages and also will potentially be in contact with future residents.

Monitoring

7.8 Return visits to monitor groundwater levels were undertaken and during these visits ground gas was also measured.

Laboratory Testing

7.9 Samples for geotechnical testing were sent to the laboratories of I2, which is UKAS accredited, for the following analysis:

- California Bearing Ratio(CBR) tests undertaken on re-compacted samples
- Atterberg Limits Determinations;
- Moisture Content; and
- Soluble sulphate and pH.

7.10 Samples for chemical analysis were sent to the laboratories of The I2 Ltd who are UKAS and MCERTS accredited. Samples were tested for the CLEA metal suite, pH, sulphate, cyanide, phenols, speciated Polycyclic Aromatic Hydrocarbons (PAH), organic carbon, banded Total Petroleum Hydrocarbon (TPH), asbestos quantification, and two stage WAC tests.

8.0 GROUND AND GROUNDWATER CONDITIONS

Summary of Ground and Groundwater Conditions

8.1 The investigations undertaken by Enzygo Geoenvironmental Ltd identify the following strata:

Strata	Summary Description	Thickness (m)
Made Ground	Brown and grey clayey fine sand and flint gravel with fragments of brick concrete and ash.	0.4 to 1.2
Kempton Park Gravels	Firm and stiff brown clay and gravelly clay.	0 to 0.9
	Loose becoming medium dense and dense with depth brown sand and flint gravel.	3.8 to 5.3
London Clay	Stiff grey brown silty clay with occasional claystone gravel.	>20
Groundwater	Seepages	2.2m to 4.3 bgl.

8.2 Details of the ground and groundwater conditions encountered are given on the exploratory hole records included in Appendix B and are summarised in the sections below:

Made Ground

8.3 Made Ground was encountered across the site comprising brown and grey clayey fine sand and flint gravel with fragments of brick concrete and ash.

8.4 This material is consistent with typical Made Ground comprising natural soils with anthropegenic inclusions associated with demolition and removal of historic buildings

Kempton Park Gravels

8.5 The Kempton Park Gravels were encountered at depths of between 0.4m and 1.2m below ground level (bgl). The upper horizon of the Kempton Park Gravels generally comprised firm and stiff brown clay and gravelly clay.

8.6 The clay layer was underlain by loose becoming medium dense and dense with depth brown sand and flint gravel. The granular Kempton Park Gravels were encountered at depths of between 0.4m and 1.5m bgl.

London Clay

The London Clay was only encountered in deep boreholes and comprised stiff grey brown silty clay with occasional claystone gravel.

Visual and Olfactory Evidence of Contamination

8.7 Potential asbestos fragments were encountered in Window Sampler boreholes WS6 and WS8. No other visual or olfactory evidence of contamination was encountered during the site works. Samples of potential asbestos were collected for laboratory testing and this is discussed in Section 9.

Soil Strength

8.8 Undrained shear strength of cohesive Kempton Park Gravels were calculated using the correlations of Stroud and Butler. These show the undrained shear strength values to vary from 45kN/m^2 to 100kN/m^2 at 1m bgl. Granular soils ere noted to be loose medium dense and dense with depth. SPT values increasing 7 at 1m bgl to over 50 at 4m bgl being recorded.

8.9 London Clay was noted to have undrained shear strength values increasing from 60kN/m^2 at 6m to 170kN/m^2 at 25m bgl.

Groundwater

8.10 Groundwater was encountered as a seepages at depths of between 2.2m to 4.3 bgl from within the Kempton Park Gravels. The depth to groundwater measured during the monitoring visit is summarised on the table below:

Exploratory Hole	Depth m(bgl)					
	12.5.21	19.5.21	2.6.21	16.6.21	30.6.21	14.7.21
WS5	Dry	Dry	Dry	Dry	Dry	Dry
WS6	Dry	Dry	Dry	Dry	Dry	Dry
WS7	Dry	Dry	Dry	Dry	Dry	Dry
WS9	Dry	Dry	Dry	Dry	Dry	Dry
WS14	Dry	Dry	Dry	Dry	Dry	Dry
WS16	Dry	Dry	Dry	Dry	Dry	Dry
WS18	Dry	Dry	Dry	Dry	Dry	Dry

Ground Gas

8.11 Ground gas was monitored during the return visit to monitor groundwater levels and the results are summarised on the table below:

Exploratory Hole	Atmos pressure (Mb)	Flow (l/hr)	CH4		CO2		O2
			Concentration (%)	GSV (l/hr)	Concentration (%)	GSV (l/hr)	Concentration (%)
12.5.21							
WS5	997	<0.1	<0.1	<0.0001	1.8	<0.0018	19.5
WS6	997	<0.1	<0.1	<0.0001	1.8	<0.0018	19.4
WS7	997	<0.1	<0.1	<0.0001	1.5	<0.0015	19.1
WS9	997	<0.1	<0.1	<0.0001	1.2	<0.0012	19.3

WS14	997	<0.1	<0.1	<0.0001	1.6	<0.0016	18.9
WS16	997	<0.1	<0.1	<0.0001	0.8	<0.0008	18.8
19.5.21							
WS5	1017	<0.1	<0.1	<0.0001	1.9	<0.0019	18.1
WS6	1017	<0.1	<0.1	<0.0001	1.1	<0.0011	18.8
WS7	1017	<0.1	<0.1	<0.0001	2.0	<0.0020	18.0
WS9	1017	<0.1	<0.1	<0.0001	1.3	<0.0013	19.6
WS14	1017	<0.1	<0.1	<0.0001	1.7	<0.0017	18.2
WS16	1017	<0.1	<0.1	<0.0001	1.4	<0.0014	18.9
WS18	1017	<0.1	<0.1	<0.0001	1.1	<0.0011	19.6
2.6.21							
WS5	1014	<0.1	<0.1	<0.0001	2.1	<0.0021	18.2
WS6	1014	<0.1	<0.1	<0.0001	1.2	<0.0012	18.6
WS7	1014	<0.1	<0.1	<0.0001	1.7	<0.0017	18.5
WS9	1014	<0.1	<0.1	<0.0001	1.2	<0.0012	19.1
WS14	1014	<0.1	<0.1	<0.0001	1.6	<0.0016	18.8
WS16	1014	<0.1	<0.1	<0.0001	1.5	<0.0015	18.7
WS18	1014	<0.1	<0.1	<0.0001	1.0	<0.0010	19.7
16.6.21							
WS5	1009	<0.1	<0.1	<0.0001	2.1	<0.0023	18.3
WS6	1009	<0.1	<0.1	<0.0001	1.4	<0.0014	18.7
WS7	1009	<0.1	<0.1	<0.0001	1.5	<0.0015	18.8
WS9	1009	<0.1	<0.1	<0.0001	1.3	<0.0013	19.2
WS14	1009	<0.1	<0.1	<0.0001	1.6	<0.0016	18.9
WS16	1009	<0.1	<0.1	<0.0001	1.7	<0.0017	18.5
WS18	1009	<0.1	<0.1	<0.0001	0.7	<0.0007	19.9
30.6.21							
WS5	1015	<0.1	<0.1	<0.0001	1.8	<0.0018	18.2
WS6	1015	<0.1	<0.1	<0.0001	1.3	<0.0013	18.9
WS7	1015	<0.1	<0.1	<0.0001	1.6	<0.0016	18.7
WS9	1015	<0.1	<0.1	<0.0001	1.4	<0.0014	18.9
WS14	1015	<0.1	<0.1	<0.0001	1.5	<0.0015	19.0
WS16	1015	<0.1	<0.1	<0.0001	1.6	<0.0016	18.8
WS18	1015	<0.1	<0.1	<0.0001	1.0	<0.0010	19.2
14.7.21							
WS5	1017	<0.1	<0.1	<0.0001	1.9	<0.0019	18.3
WS6	1017	<0.1	<0.1	<0.0001	1.5	<0.0015	18.9
WS7	1017	<0.1	<0.1	<0.0001	1.6	<0.0016	18.7
WS9	1017	<0.1	<0.1	<0.0001	1.2	<0.0012	18.7
WS14	1017	<0.1	<0.1	<0.0001	1.7	<0.0017	18.8
WS16	1017	<0.1	<0.1	<0.0001	0.9	<0.0009	19.3
WS18	1017	<0.1	<0.1	<0.0001	0.8	<0.008	19.5

8.12 No significant ground gas has been measured.

9.0 CONTAMINATION ASSESSMENT

General

9.1 A Tier I risk assessment has been undertaken using available and current screening values for human health and where appropriate controlled waters. The risk assessment is undertaken based on the findings of the preliminary conceptual model presented in Section 6. Based on the contamination testing and Tier I assessment a revised Conceptual Model has been prepared, which is presented later in this section.

9.2 Where significant risks are identified remedial measures are recommended.

Human Health

9.3 Assessment of the risks to human health has been undertaken by comparing the soil quality data with reference values obtained from the Contaminated Land Exposure Assessment (CLEA), Soil Guideline Values (SGV) and General Acceptance Criteria (GAC) published by LQM and derived in consultation with the Chartered Institute of Environmental Health. The LQM/CIEH S4ULs values are used and summary tables of the reference values are included in Appendix C.

9.4 Where an exceedance is identified the risk is assessed by considering the sensitivity of the proposed development and the potential pathway. The proposed development comprises conventional residential houses with domestic gardens.

9.5 The GAC values for residential use with plant uptake are used as the development includes domestic properties.

9.6 The soil quality shows exceedances of the GAC values for the following contaminants.

Exploratory Hole	Determinant	Concentration (mg/kg)	
		GAC	Soil
WS2 0.2m	Asbestos	Absent	0.006%
	Arsenic	37	40
WS6 0.4m	Asbestos	Absent	<0.001%
WS8 0.4m	Asbestos	Absent	3.127%
	Benzo(b)fluoranthene	2.6	3.4
	Benzo(a)pyrene	2.2	2.6
	Dibenz(a,h)anthracene	0.24	0.53
	Lead	200	320
WS1 0.4m	Benzo(b)fluoranthene	2.6	8.1
	Benzo(a)pyrene	2.2	7.0
	Dibenz(a,h)anthracene	0.24	1.1
	Lead	200	310
WS10 0.4m	Lead	200	250

9.7 No other exceedances were recorded.

Controlled Waters

9.8 Risk to groundwater resources is dismissed due to the absence of any significant source of mobile contamination.

9.9 The risk to surface waters risk has been dismissed within the Initial Conceptual Model. No new risks are identified.

Ground Gas

9.10 Following the guidance provided in Section 3 of CIRIA C665 an initial assessment is undertaken to determine if there are any significant sources of potential ground gas. Such sources include landfills, organic clays and made ground incorporating putrescible materials such as rags, paper and wood. Where no significant source is identified no further assessment is necessary.

9.11 This approach is further supported by supplementary guidance given in RB17, published by CL:AIRE which confirms that gas monitoring is not generally required on sites where Made Ground is less than 5m thick and with low organic matter content or on natural soils such as alluvial clays and Chalk as the ground gas sources are not considered significant. The supplementary guidance given in RB17 also takes account of the current requirements for sealing of floor slabs and substructures to meet air tightness requirements under Part L of the Building Regulations which were not considered in CIRIA C665. The advice given in RB17 is consistent with CIRIA C665 and the Local Authority Guide to Ground Gas published by CIEH.

9.12 Where significant potential risk from ground gas is identified from the Initial Conceptual Model and the intrusive ground investigation works ground gas monitoring is undertaken and the results of the monitoring are compared against the Gas Screening Values given in CIRIA Report 665. From this the Characteristic Situation is identified and remedial measures proposed.

9.13 When assessing the risk and type of remedial measures appropriate consideration is given to the likely construction of the development, the nature of the gas posing a risk and the nature of the likely source. The use of engineering judgement when determining risk from ground gas is consistent with the recommendations given in CIRIA C665 using a pollutant linkage model.

9.14 Gas monitoring was undertaken during return visits which has not recorded elevated concentrations of Methane and no flow. Based on the gas monitoring undertake the Gas Screening Value is less than 0.07l/hr and therefore falls within Characteristic Situation 1 (CS1).

9.15 Additional monitoring is being undertaken.

Revised Conceptual Model

9.16 The Initial Conceptual Model presented in Section 6 has been revised based on the findings of the ground investigation and the revised Conceptual Model is presented below:

Source	Location	Exposure Pathway	Potential Receptor	Probability of Exposure	Details
Human Health					
Asbestos, Hydrocarbon and metals.	Potential Made Ground.	Ingestion dermal and inhalation.	Construction Workers.	Low	Management procedures proposed.
			Site users.	Low	Remediation proposed.
Asbestos, Hydrocarbon and metals.	Unforeseen Contamination.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	Normal PPE will address risk.
			Site users.	Negligible.	No source identified.
Hydrocarbon and metals.	Potential migration from off-site source.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	No source and no exceedance of GAC.
			Site users.		
Ground Gas.	Historic Landfill.	Inhalation & Explosive.	Construction Workers.	Dismissed.	No significant source identified and no significant ground gas measured.
			Site users.		
	Potential Made Ground.	Inhalation & Explosive.	Construction Workers.		
			Site users.		
Groundwater					
Hydrocarbon and metals.	Potential spillage on site	Vertical Migration.	Groundwater	Dismissed.	No mobile source identified.
Surface Water					
Hydrocarbon and metals.	Potential spillage on site	Horizontal Migration.	River Network	Dismissed.	No source or credible receptor.
Environmental Receptors					
On site contaminants		Ingestion dermal and inhalation.	Ecology.	Dismissed.	No sensitive ecology designation.
		Direct.	Archaeology.	Dismissed.	None present.
		Direct.	Geology.	Dismissed.	No sensitive receptor present.
		Phytotoxic.	Woodland.	Dismissed.	None present.
		Phytotoxic.	Crops.	Dismissed.	No source identified.
		Ingestion dermal and inhalation.	Livestock.	Dismissed.	No source identified.
Building Services					
On site contaminants		Direct.	Historic Buildings.	Dismissed.	None present.
		Direct.	Proposed Buildings.	Dismissed.	No source identified.
		Permeate into pipework.	Water Pipes.	Dismissed.	No significant source identified.

9.17 Elevated Lead, Arsenic and PAH have been identified and it is recommended that remediation is undertaken.

9.18 Within areas of buildings and pavements the use of hardstanding will provide remediation by breaking the potential pollutant linkage. Within proposed soft landscape areas it is

recommended that clean cover soils are provided comprising 600mm in domestic garden areas and 400mm in communal areas over a geotextile no dig layer. Validation of the cover soils should be undertaken using hand pits with testing of cover soils.

9.19 Asbestos contaminated material has been identified during the ground investigation and it is possible that further material could be encountered during construction works. The use of clean cover soils discussed above will provide remediation to protect future site users. Measures should to be incorporated in to the Contractors Construction Stage Health and Safety Plan and asbestos management plan as required under the Construction Design and Management (CDM) Regulations to mitigate risk to construction works. Measures may include:

- Designing temporary works to minimise disturbance of the Back fill material;
- Separating material and disposal of soils containing asbestos;
- Wetting down during excavation;
- Sheeting of stockpiles where asbestos is suspected;
- Testing of soils and off-site disposal of any soils found or suspected of containing asbestos;
- Preventing access to the construction site by members of the public;
- Use of good hygiene measures, including washing down of plant; and
- Use of appropriate PPE, including face masks..

9.20 If unforeseen contamination is encountered during construction works such as localised spillage outside the areas investigated an Environmental consultant will be available on a 'call out' basis to undertake an assessment of risk. If 'unforeseen contamination' is encountered such as hydrocarbon contamination or solvent odours the discovery strategy will be to remove the source as it is likely to be very limited in extent or encapsulate it on site as appropriate and the Local Planning Authority advised.

9.21 As part of this discovery strategy it is recommended that additional investigation by trial pits is undertaken in areas of existing hardstanding where access can not currently be obtained to identify potential areas of contamination. This supplementary investigation is best undertaken following demolition works where safe access can be gained.

Waste Classification

9.22 Two part WAC test has been undertaken, the results of which are included in Appendix C. These show no exceedances above the inert threshold values PAH, TPH or TOC. Exceedance above leachable thresholds for Inert Waste by Antimony and Lead were recorded. In addition, asbestos above 0.1% has been recorded.

9.23 The Waste Management paper 2 has been updated to version 3 which states that sites which previously could be considered 'uncontaminated land' surplus soils if they did not exceed the GAC values now requires the landfill to make an appropriate assessment of the waste classification. As such final assessment, will be undertaken by the receiving landfill based on the requirements of their permit.

9.24 Based on the results received it is considered that Made Ground is likely to be classified as Stable Non Reactive Waste.

10.0 GEOTECHNICAL ASSESSMENT

Proposed Development

10.1 The proposed development comprises a mixture of residential houses with domestic gardens and apartment blocks. Structural loadings are not known but assumed to be 75kN/m wall run for houses.

10.2 It is considered that the scheme meets the criteria of Geotechnical Category 1 of Eurocode 7.

Ground Conditions

10.3 Ground Conditions comprise Made Ground over firm clay and loose becoming dense with depth sand and gravel. This is underlain by London Clay comprising stiff clay.

10.4 Groundwater was encountered at depths of between 2.2m to 4.3 bgl.

Site Preparation

10.5 The site should be cleared and any vegetation below areas of proposed development stripped in accordance with Series 200 of the Specification for Highway Works. This should include:

- Any redundant services should be sealed off and grubbed out and replaced with suitable compacted engineered fill; and
- Any tree roots should be grubbed out.

Foundations

10.6 It is considered that conventional strip foundations should be suitable for low rise buildings with wall loadings of 75kN/m or les assuming an allowable bearing capacity of 100kN/m^2 for natural soils at depths of 1.5m bgl. Within the natural firm clay or medium dense sand and gravel. An assessment of likely settlements has been undertaken and these are estimated to be less than 25mm.

10.7 Foundations may need to be stepped down locally where Made Ground is deeper. Foundations may also need to be deepened in accordance with NHBC requirements for building near trees. Foundations should be designed assuming soils of moderate shrinkage potential. It is recommended that foundations are reinforced to allow them to span both clay and granular soils.

10.8 No evidence of desiccation was noted.

10.9 It is likely that apartment blocks and structures with wall loadings above 75kN per m will require piled foundations.

10.10 For preliminary purposes and an initial pile assessment has been undertaken using the following assumptions:

- Upper 1.5m is ignored.
- Soil properties have been taken from the ground investigation and laboratory testing.
- A global factor of safety of 2.5 has been used, together with factors of 1.5 on shaft resistance and 3 on base resistance.

10.11 The following preliminary pile working loads have been calculated:

Pile depth (m bgl)	Working Load kN					
	200mm	250mm	300mm	350mm	450mm	600mm
10	80	100	125	150	200	300
15	150	180	235	280	370	530
20	220	290	350	420	560	770
25	320	400	500	590	780	1080

10.12 Final design should be undertaken by a specialist piling contractor who ca use case studies to negotiate more economic pile designs.

Ground Floor Slab

10.13 Based on thickness of Made Ground suspended floor slabs are recommended.

Pavement Construction

10.14 An assessment of the likely California Bearing Ratio (CBR) has been assessed from the following sources:

- Description of the materials encountered in the exploratory holes; and
- Guidance given in HD25/94.

10.15 Based on the above it is considered that an equilibrium CBR of 3% is suitable.

10.16 It is recommended that the sub-formation is proof rolled with any soft materials being excavated and replaced with suitable compacted capping.

10.17 Soils are not considered to be frost susceptible.

Drainage

10.18 Soakaway drainage maybe feasiable. If soil infiltration is to be used as part of a SuDS train then BRE 365 soakaway tests should be undertaken. Given the public access to the site it is recommended that any soakaway testing is undertaken once possession has been taken.

10.19 Chemical results should be provided to the water authority to confirm the design of potable water supply pipes.

Buried Concrete

10.20 Results of the sulphate and pH testing indicate that shallow soils have soluble sulphate concentrations are generally less than 0.5 g/l consistent with DS1 Conditions. Samples from the London Clay below 6m bgl recorded a concentration above 0.5 g/l within the London Clay at 25m bgl but the soils have a neutral pH. Taking account of pH and sulphate concentrations it is considered that shallow buried concrete can be deigned to Class AC1-s.

Excavation and Materials Re-Use

10.21 Site observations indicated that excavations should be feasible in the near surface. Where access is required the excavations should be designed in accordance with CIRIA RR97.

10.22 Significant dewatering of excavations is not likely to be required.

0 10 20 30 40 60 80 100m

Scale 1:1000@A3

Key

- Site Boundary
- Window Sampler Locations (WS)
- Borehole Locations (BH) (BH1 - BH6)

enzygo environmental consultants

Samuel House, 5 Fox Valley Way, Stocksbridge, Sheffield, S36 2AA

CLIENT: Hill Partnership

SCALE: 1:1000@A3

PROJECT REF: CRM.1027.087

DRAWN: MG

CHECKED: SR

DATE: Aug 2021

PROJECT: Richmond

TITLE: Site Plan

DRAWING NO: CRM.1027.087.GE.D.001.A

Executive Summary

Proposed Development

The site is to be re-developed for a mixture of residential houses with domestic gardens and apartments with communal open space.

Investigation

Site investigation, desk study and monitoring visits were undertaken by Enzygo Geoenvironmental Ltd.

Ground Conditions

Ground Conditions comprise Made Ground over firm clay and loose becoming dense with depth sand and gravel. Shallow groundwater was not encountered.

Contamination

Elevated PAH, Lead and Arsenic was encountered together with asbestos. Remediation and management procedures are proposed.

Foundations

Spread foundations should be suitable for domestic houses but piled foundations are likely to be required for apartments.

Pavement Design

An equilibrium CBR of 3% is recommended. Soils are not considered to be frost susceptible.

Buried Concrete

It is recommended that Class AC-1s conditions of Special Digest 1 are used.

Ground Gas and Radon

No radon risk has been identified. No significant ground gas has been measured.

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1.0 INTRODUCTION

Background

1.1 Enzygo Geoenvironmental Limited has been commissioned to prepare a Geo-Environmental Report for a site at Ashburnham Rd, Richmond, TW10 7PB.

Proposed Development

1.2 Hill Partnership Ltd are seeking to re-develop the site for a mixture of residential apartments and domestic houses with associated infrastructure.

Objectives

1.3 The objectives of the study are to:

- Review an existing Phase I desk study, a copy of which is included in Appendix A;
- Undertake a ground investigation;
- Assess the implications of any potential environmental risks, liabilities and development constraints associated with the site in relation to the future use of the site and in relation to off-site receptors; and
- Provide a factual and interpretative report relating to the desk study and site investigations. Provide a revised conceptual model and recommendations on any potential development issues and mitigation measures, where appropriate.
- Provide geotechnical recommendations in relation to foundations and infrastructure.

Risk Classification

1.4 Enzygo Geoenvironmental has utilised the available information, together with our experience to assess the likely risks to development from land quality issues. Definitions of the risk terms used are provided on the following table.

Risk	Description
Negligible	No contamination risk has been identified which is likely to affect development.
Low	No significant contaminated land risks have been encountered affecting development and a low risk that remediation will be required.
Low-Moderate	There are unlikely to be significant contaminated land issue associated with the site which will adversely affect its re-development. However, minor or localised contamination may be present requiring remediation. Remediation should be possible under a discovery strategy and with a call out service.
Moderate	Some potential contaminated land risks have been encountered or identified which may affect re- development. The risks identified are unlikely to affect the entire site or preclude development. Remediation is considered feasible as part of the development process and no further investigation is considered necessary.
Moderate-High	Some potentially significant contaminated land risks have been identified at the property that requires remediation. It is recommended that a separate remedial methodology is prepared supported by a site-specific risk assessment
High	Significant potential contaminated land risks have been identified and remediation is required supported by further intrusive ground investigation, risk assessment and remedial design.

1.5 Where adverse risks from ground instability are identified these are discussed within the report.

2.0 SITE SETTING

Site Description

Item	Description
Site Address	Ashburnham Rd, Richmond, TW10 7PB
National Grid Reference	517160 172360
Site Area	4.58 Ha

Current Site Description

2.1 The following site description has been compiled from the site inspection undertaken by Enzygo Geoenvironmental staff, together with current maps, aerial photographs and a topographical survey.

2.2 At the time of the site investigation the site was occupied by residential apartment blocks with communal grassed areas and occasional trees across the central and western area of the site.

2.3 Internal roadways, parking areas and lock-up garages were present between the apartment blocks.

2.4 Within the southern area of the site an amenity hall, clinic and police station are present with associated parking.

2.5 The eastern area of the site is open land vegetated with grass and including footpaths.

2.6 An electricity sub station is present on the western boundary. This appears to be of modern construction with no evidence of leakage. The sub-station is not considered a significant risk.

Surrounding Area

2.7 The surrounding land uses are summarised as follows:

Direction	Land Use
South	Ashburnham Road with residential development beyond.
East	Wiggins Lan with residential development beyond.
West	School and open space.
North	Woodville Road with residential development beyond.

2.8 No significant sources of potential contamination were noted on or adjacent to the site.

3.0 SITE HISTORY

3.1 A review of historical Ordnance Survey maps and information pertinent to the site obtained from the existing desk study report is summarised below:

3.2 The site is shown as open land prior to construction of a farm in the eastern part of the site by 1868.

3.3 The site was redeveloped for residential use by 1947. A ruin is shown in the eastern part of the site by 1959 which is likely to be from bomb damage.

3.4 The current residential development is shown by 1983 and with open space in the east.

3.5 There is the potential for Made Ground associated with historic buildings, demolished prior to the current development. No other significant potential sources identified on or near to the site.

3.6 No significant off-site contamination sources are identified.

3.7 A low Unexploded Ordnance Risk was identified in relation to ground investigation works.

4.0 ENVIRONMENTAL SETTING

Ground Conditions

4.1 The British Geological Survey (BGS) indicates that the site is underlain by the following geological sequence:

Geological Unit	Type	Description	Aquifer Classification
Drift	Kempton Park Gravels	Sand and Gravel	Secondary A
Solid	London Clay	Clay	Unproductive

4.2 There are no records of Made Ground below the site. Made Ground is shown 41m south west. Given the distance from the site this is not considered a significant risk.

4.3 There are no records of landslips on the site.

4.4 BGS borehole records on site show 0.6m of Made ground over gravel and with London Clay encountered at depths of 6m.

Groundwater

4.5 The Desk Study Report shows that the site is not within a Source Protection Zone.

4.6 BGS records show that the site is at potential risk of groundwater flooding. This is only considered a significant risk where basements are proposed.

Coal Mining

4.7 No historical or current coal mining extraction has been identified within 1000m of the site.

Non Coal Mining

4.8 No other mining activity has been identified within 1000m of the site.

Cavities

4.9 No natural cavities or solution features are identified on site.

Hydrology

4.10 There are no water courses on the site.

4.11 Environment Agency records show that the site is not within an Environment Agency Flood Zone.

Radon Risk Potential

4.12 The Groundsure GeoInsight Report indicates that the site is not within a Radon Affected Area. No radon protective measures are necessary in the construction of new dwellings.

Natural Hazards Finding

4.13 BGS information presented within the Groundsure Geoinsight report identifies the following:

Hazard	Risk Designation (Groundsure)
Coal Mining.	None Identified.
Collapsible Ground.	Very Low.
Compressible Ground.	Very Low.
Ground Dissolution.	Very Low.
Landslide.	Very Low.
Running Sand.	Very Low.
Swelling / Shrinking Clay.	Very Low.

4.14 No significant geotechnical risks are identified.

Sensitive Land Uses

4.15 There are no sites of special interest on or surrounding the site.

4.16 English Heritage has not identified any listed buildings or scheduled ancient monuments on or close to the site. No sensitive geology has been identified at the site.

Environmental Sensitivity

4.17 Overall the site is currently considered to be of low/moderate sensitivity due to the following:

- The underlying stratum is classified as a Secondary A Aquifer;
- Not within a source protection zone;
- No surface water courses on or adjacent to the site; and
- No sensitive ecology is noted adjacent to or on the site.

4.18 The proposed end use of the site is residential and as such future sensitivity will be high for end users.

Industrial Land Uses

4.19 No significant current industrial activities are identified on or adjacent to the site.

Landfill Sites and Waste Treatment Sites

4.20 There are no active or historic landfills within 250m of the site.

Planning Records

4.21 A review of London Borough of Richmond's planning history shows no relevant information for the site.

5.0 PREVIOUS REPORTS

5.1 No previous ground investigation reports were provided.

6.0 PRELIMINARY CONCEPTUAL MODEL

6.1 Based on the desk study information the following Preliminary Conceptual Model has been prepared:

Source	Location	Exposure Pathway	Potential Receptor	Probability of Exposure	Details
Human Health					
Asbestos, Hydrocarbon and metals.	Unforeseen Contamination.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	Normal site management practices and PPE will address risk.
			Site users.	Negligible.	No source identified.
Asbestos, Hydrocarbon and metals.	Made Ground.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	Normal PPE will address risk.
			Site users.	Very Low.	If present can easily be addressed through development.
Hydrocarbon and metals.	Potential migration from off-site source.	Ingestion dermal and inhalation.	Construction Workers.	Dismissed.	No significant off site sources identified.
			Site users.		
Ground Gas.	Historic Landfill.	Inhalation & Explosive.	Construction Workers.	Dismissed.	No source identified.
			Site users.		
	Potential Made Ground.	Inhalation & Explosive.	Construction Workers.	Dismissed.	No significant source identified.
			Site users.		
Groundwater					
Hydrocarbon and metals.	Potential spillage on site.	Vertical Migration.	Groundwater.	Dismissed.	No source identified.
Surface Water					
Hydrocarbon and metals.	Potential spillage on site.	Horizontal Migration.	River Network.	Dismissed.	No source or credible receptor.
Environmental Receptors					
On site contaminants		Ingestion dermal and inhalation.	Ecology.	Dismissed.	No sensitive ecology designation.
		Direct.	Archaeology.	Dismissed.	None present.
		Direct.	Geology.	Dismissed.	No sensitive receptor present.
		Phytotoxic.	Woodland.	Dismissed.	None present.
		Phytotoxic.	Crops.	Dismissed.	No source identified.
		Ingestion dermal and inhalation.	Livestock.	Dismissed.	No source identified.
Building Services					
On site contaminants		Direct.	Historic Buildings.	Dismissed.	None present.
		Direct.	Proposed Buildings.	Dismissed.	No source identified.
		Permeate into pipework.	Water Pipes.	Dismissed.	No significant source identified.

6.2 There is a very low risk from Made Ground, including former buildings which will be investigated. Should contamination be present this can easily be addressed through development. No other significant risks are identified.

7.0 SITE INVESTIGATION

General

7.1 A ground investigation was undertaken based on the findings of the desk study. The locations of the exploratory holes are shown on Drawing CRM.1027.087.GE.D.001.

Site Works

7.2 The site investigation works comprised window sampler holes (WS1 to WS18) advanced between 27th and 29th April 2021 and six deep boreholes (BH1 to BH6) advanced between 16th and 19th August 2021.

7.3 Exploratory hole locations were determined to provide general coverage of the site within areas where access was permitted by the land owner. The investigation works are summarised in the table below:

Rational	Exploratory Holes	Notes
Site Coverage.	WS1 to WS18.	Across site.
Monitoring.	WS5 WS6 WS7 WS9 WS14 WS16 & WS18.	Installations.
Deep foundations.	BH1 to BH6.	Deep boreholes.

7.4 Strength of soils were assessed using Standard Penetration Tests (SPT). The results of which are included on the borehole logs presented in Appendix B.

7.5 Representative soil samples were collected for chemical and geotechnical testing. Soil samples destined for chemical analysis were collected in appropriate containers provided by the analytical laboratory. Samples were stored in cool boxes prior to dispatch to the laboratory for analysis. All samples were collected using appropriate sampling equipment that was cleaned at each sampling location.

7.6 Generally samples were collected from Made Ground, which may contain potential inclusions of contaminating materials and materials displaying evidence of potential contamination.

7.7 In the absence of any evidence of contamination samples were collected near surface as this material is more likely to be contaminated by surface spillages and also will potentially be in contact with future residents.