



EARTH ENVIRONMENTAL
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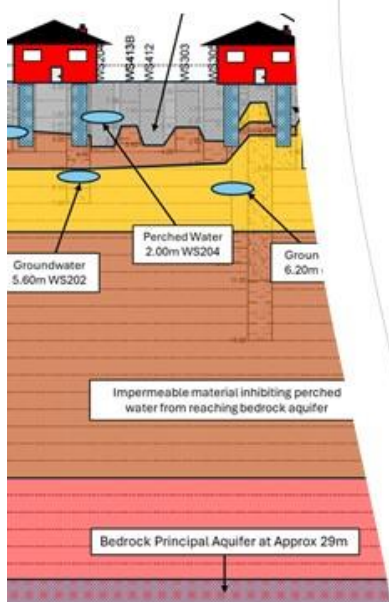
Ground Improvement Risk Assessment

Louisa Street

Openshaw

October 2024

for



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**GROUND IMPROVEMENT RISK
ASSESSMENT**

LOUISA STREET

OPENSHAW

Report Ref: A4755/22/GRA/V2

OCTOBER 2024

Prepared on Behalf of:

Westchurch Homes

By:

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Definition of Version Code:

- D. Applied during initial drafting of the report before it has been reviewed.
- C. Applied after the report has been reviewed but before it has been approved by the Project Manager.
- B. Applied after the Project Manager has approved the report ready for issue to the client.
- A. Applied to reports after external/internal review.

The version number starts at "0" and is raised by "1" at each re-type.

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TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	BACKGROUND	1
1.2	RELEVANT GUIDANCE.....	1
1.3	PREVIOUS INVESTIGATIONS.....	1
1.4	TERMS OF REFERENCE.....	9
1.5	REPORT SCOPE	9
2.0	PROPOSED DEVELOPMENT	10
3.0	SITE HISTORY	11
4.0	GROUND CONDITIONS ENCOUNTERED	12
4.1	SOIL PROFILE ENCOUNTERED.....	12
4.2	OBSERVABLE INDICATIONS OF CONTAMINATION.....	15
4.3	WATER	15
5.0	FOUNDATION DESIGN RISK ASSESSMENT	16
5.1	PROPOSED FOUNDATIONS	16
5.2	GROUNDWATER REGIME	16
5.3	TIER 2 CONTROLLED WATER RISK ASSESSMENT	17
5.4	CONTAMINATION	17
5.5	RISK ASSESSMENT	17
5.6	FUTURE CONTROL / MITIGATION MEASURES.....	20
6.0	CONCLUSIONS.....	21

LIST OF FIGURES

Figure 1	Chemical Exceedance Location Plan
Figure 2	Location of 2002 Hotspots
Figure 3	Additional Sampling September 2023
Figure 4	Location of Boreholes WS302 to WS305
Figure 5	Conceptual Site Model
Figure 6	Extent of Shallow Clay Horizon
Figure 7	Extent of Deep Clay Horizon
Figure 8	Excavated Tank
Figure 9	Proposed Development Plan Showing Historical Features & SI Points
Figure 10	Land Use in 1905
Figure 11	Land Use in 1948

TABLES

Table 1	Summary of Ground Conditions Encountered
Table 2	Summary of Hotspots from 2002 Site Investigation
Table 3	Controlled Water Risk Assessment
Table 4	Summary of Environmental Risks

1.0 INTRODUCTION

1.1 Background

The development of a Ground Improvement Risk Assessment has been commissioned by Westchurch Homes (the Client), to support the use of vibro-stone columns as a ground improvement technique to accommodate a shallow reinforced strip foundation solution for a new residential development of 71 affordable new homes at Louisa Street, Openshaw, Manchester.

Planning Condition 12 of consent ref: 134775/FO/2022 states *“Piling or any other foundation designs using penetrative methods shall not be permitted other than with the express written consent of the local planning authority, which may be given for those parts of the site where it has been demonstrated that there is no resultant unacceptable risk to groundwater. The development shall be carried out in accordance with the approved details.”*

Given that the vibro-compaction, (which is not a foundation but is a ground improvement technique) uses a “penetrative” stone injection methodology, this report has been prepared to demonstrate that compliance with the condition can be achieved.

1.2 Relevant Guidance

This report has been written in line with the current guidance

-  Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination Guidance of Pollution Prevention (National Groundwater & Contaminated Land centre 2001 (now withdrawn)).
-  Piling in layered ground risk to groundwater and archeology, Environment Agency Science Report SC020074/SR, October 2006.
-  BR470 (2004) Working platforms for tracked plant, good practice guide to the design, installation, maintenance and repair of ground-supported working platforms.
-  The Environment Agency's approach to groundwater protection' and pursuant to policies EN17 and EN 18 of Manchester Core Strategy (2012).
-  Land contamination risk management framework (LCRM).
-  National Quality Mark Scheme for Land Contamination Management.

1.3 Previous Investigations

1.3.1 Earth Environmental & Geotechnical Ltd, Phase I GeoEnvironmental Desk Study (A4755/22/FDS), dated June 2022.

Historically the site was vacant land until it was occupied by an Iron Foundry from the early 1900's.

The area was dominated by heavy industry including, iron and steel works, mills, steam hammer works, electric motor works and railway sheds and sidings.

The majority of the buildings on site were demolished in 2017/2018.

1.3.2 Earth Environmental & Geotechnical Ltd, Geo Environmental Site Investigation Report (A4755/22/SI), dated June 2022.

The fieldwork was carried out by EEG on the 25th April 2022 and comprised:

Five window sample boreholes (designated WS1 – WS5 inclusive) were each sunk to a maximum depth of 5.00m below existing ground level.

Groundwater observations were noted where possible.

50mm diameter standpipes were installed in all the window sample boreholes to a maximum depth of 5.00m below ground level.

One 150mm diameter borehole (designated CP1) was sunk to a depth of between 15.00m below existing ground level, using a cable percussion boring rig.

Six trial pits (designated TP1 to TP6 inclusive) were excavated by use of a JCB 3CX to a maximum depth of 3.50m bgl. Trial pits were backfilled immediately on completion of sampling and testing.

Eleven contaminant concentrations were found in exceedance of the screening criteria relevant to a Residential End Use.

The samples with identified contaminant exceedances include WS1 at 0.30m, WS5 at 0.65m, and TP1 at 0.40m.

The contaminants found in exceedance of the screening criteria relevant to a Residential End Use with Plant Uptake include Petroleum Hydrocarbon Aromatic EC >16-21 and several Polycyclic Aromatic Hydrocarbons: Benzo(a)anthracene, Chrysene, Benzo(a)pyrene, Benzo(b)fluoranthene and Dibenzo (a, h) anthracene.

Elevated Naphthalene, which is volatile, was identified at WS1 (0.30m).

Asbestos was identified in two of the samples tested.

Figure 1 Chemical Exceedance Location Plan



Follow up testing on the 8th September 2023 found these hotspots to be free of the previously identified contamination due to removal of the material during the archaeological excavations.

Groundwater samples could only be recovered within WS1 and WS4, all other wells were dry

Measured contaminants of concern were assessed by comparison with Drinking Water Standards.

There were no contaminant exceedances in the groundwater samples taken on the 16th May 2022 and therefore the risk to controlled waters was considered to be very low.

1.3.3 Earth Environmental & Geotechnical Ltd, Site Investigation, dated September 23

Five boreholes (WS201 to WS205) were drilled on the 14th September 2023 in order to provide supplementary information to assist with the design of a ground improvement scheme.

Water strikes were noted in WS202 (5.6m in sand), WS203 (3.1m in clay), WS204 (2m in made ground) and WS205 (2m in clay).

Chemical testing was not conducted on soil or groundwater samples.

1.3.4 Earth Environmental & Geotechnical Ltd, Site Investigation, dated October 2023

EEG were requested to further delineate hotspots of shallow contamination identified within the June 2022 site investigation. An archaeological dig had been undertaken which extended across hotspot areas and therefore many of the hotspot areas had already been excavated and removed.

Table 1 below details the hotspots which are all shallow and in Made Ground.

Table 1 Summary of Hot Spots from 2022 Site Investigation

Location	Land Use	Depth (m)	Soil Description	Contaminant
WS1	House Plot	0.3	Made Ground	Chrysotile asbestos fibres <0.001% Naphthalene Benzo(b) fluoranthene Dibenzo (a, h) anthracene
WS2	House Plot	0.50	Made Ground	Chrysotile asbestos fibres 0.001%
WS5	House Plot	0.65	Made Ground	Benzo(b) fluoranthene Dibenzo (a, h) anthracene
TP1	Landscaped Area	0.40	Made Ground	TPH Aromatic 16-21 Benzo(a)anthracene Chrysene Benzo(a)pyrene Benzo (b) fluoranthene Dibenzo (a, h) anthracene

Figure 2 shows the location of the hotspots.

Samples ranged in depth from 0.4m to 1.45m and all in an made ground.

All concentrations were proved to be below residential end use (with plant uptake) criteria.

1.3.5 Earth Environmental & Geotechnical Ltd, Soil & Groundwater Assessment, dated April 2024

The letter report consisted of a summary of ground conditions, additional drilling, leachate chemical testing and further assessment to controlled waters.

Figure 4 Location of Boreholes WS302 to WS305



No significant contamination was encountered and the risk to controlled waters was considered to be low.

1.3.5 Earth Environmental & Geotechnical Ltd, Additional Site Investigation Letter Report, dated October 2024

The letter report consisted of a summary of ground conditions, additional drilling, soil and groundwater chemical testing, refined conceptual site model and further assessment to controlled waters. The location of the boreholes can be found in Figure 9.

The salient points were;

- (i) Sandstone rockhead greater than 15m beneath the site and locally at 23.6m;
- (ii) Superficial deposits consist of Boulder Clay with a sequence of sand and clay;
- (iii) Groundwater table within superficial sand horizon with shallowest encounter at 5.60m;
- (iv) No groundwater abstraction points within 2km of the site;
- (v) Site is not located within a drinking water safeguarding zone;
- (vi) Landfill site adjacent to western site boundary;
- (vii) No significant contamination identified in soil or groundwater samples in material remaining on site.

A conceptual side model was developed which is presented in Figure 5.

Figure 5 Conceptual Site Model

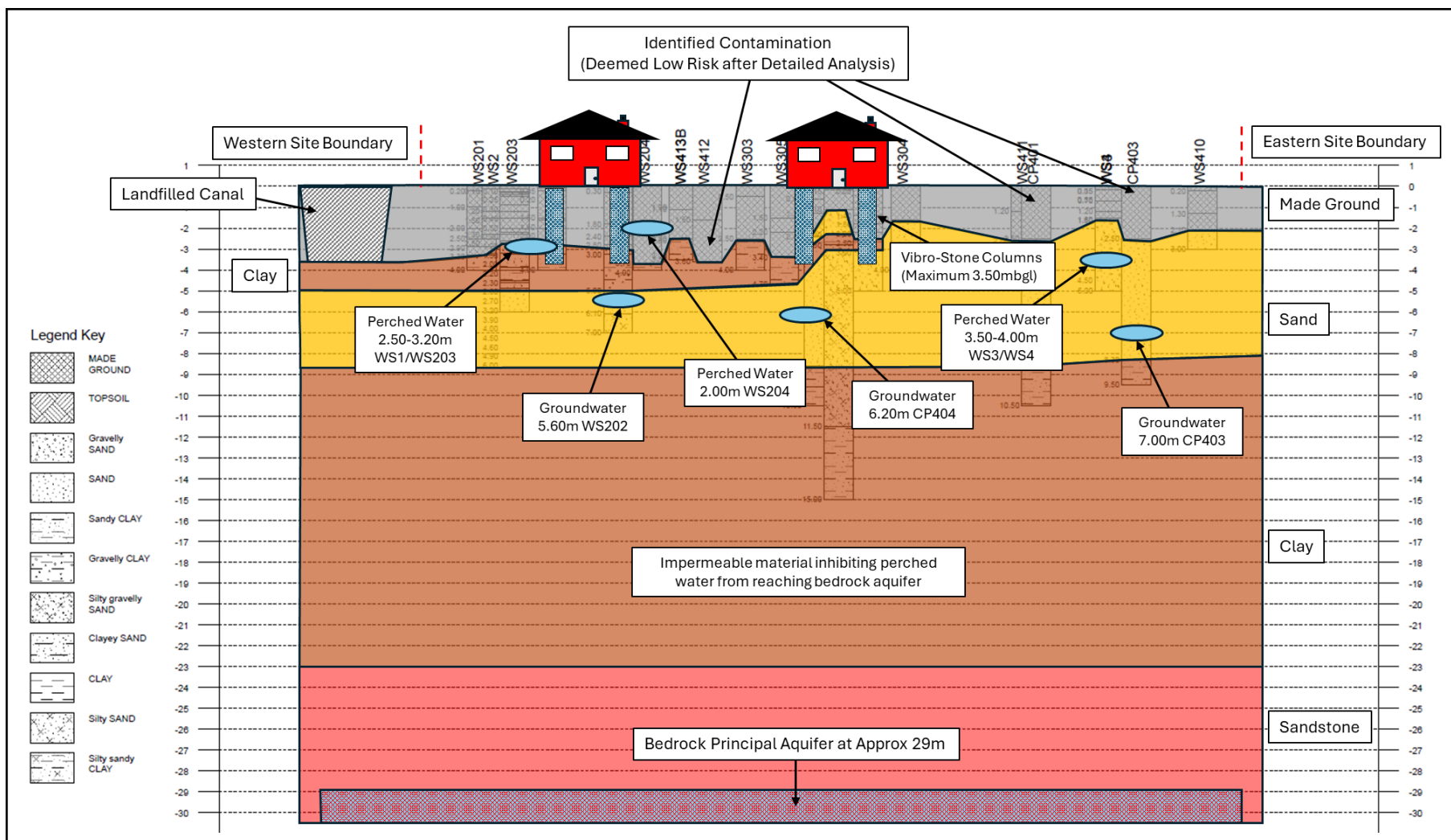


Figure 6 below shows the extent of a clay horizon beneath the made ground.

Figure 6 Extent of Shallow Clay Horizon



It should be noted that a deeper thick clay horizon was encountered below the entire site that forms an impermeable barrier to the underlying principal bedrock aquifer, the presence of which was definitively established in the September 2024 investigation. A plan of the deeper clay horizon is shown as Figure 7.

Figure 7 Extent of Deep Clay Horizon



Figure 8 shows the location of an underground tank that was encountered during site works. This tank was removed offsite with the sidewalls and base sampled and chemical testing.

Figure 8 Excavated Tank



1.4 Terms of Reference

Earth Environmental and Geotechnical Ltd (EEG) have been commissioned by the Client to develop a Ground Improvement Risk Assessment.

1.5 Report Scope

This report presents full factual records of the site work carried out, the ground conditions encountered in the exploratory holes, the in situ and laboratory test results. All information collected has been used to provide an interpretation of the ground conditions, with recommendations on geotechnical design and potential ground contamination risks for the proposed development.

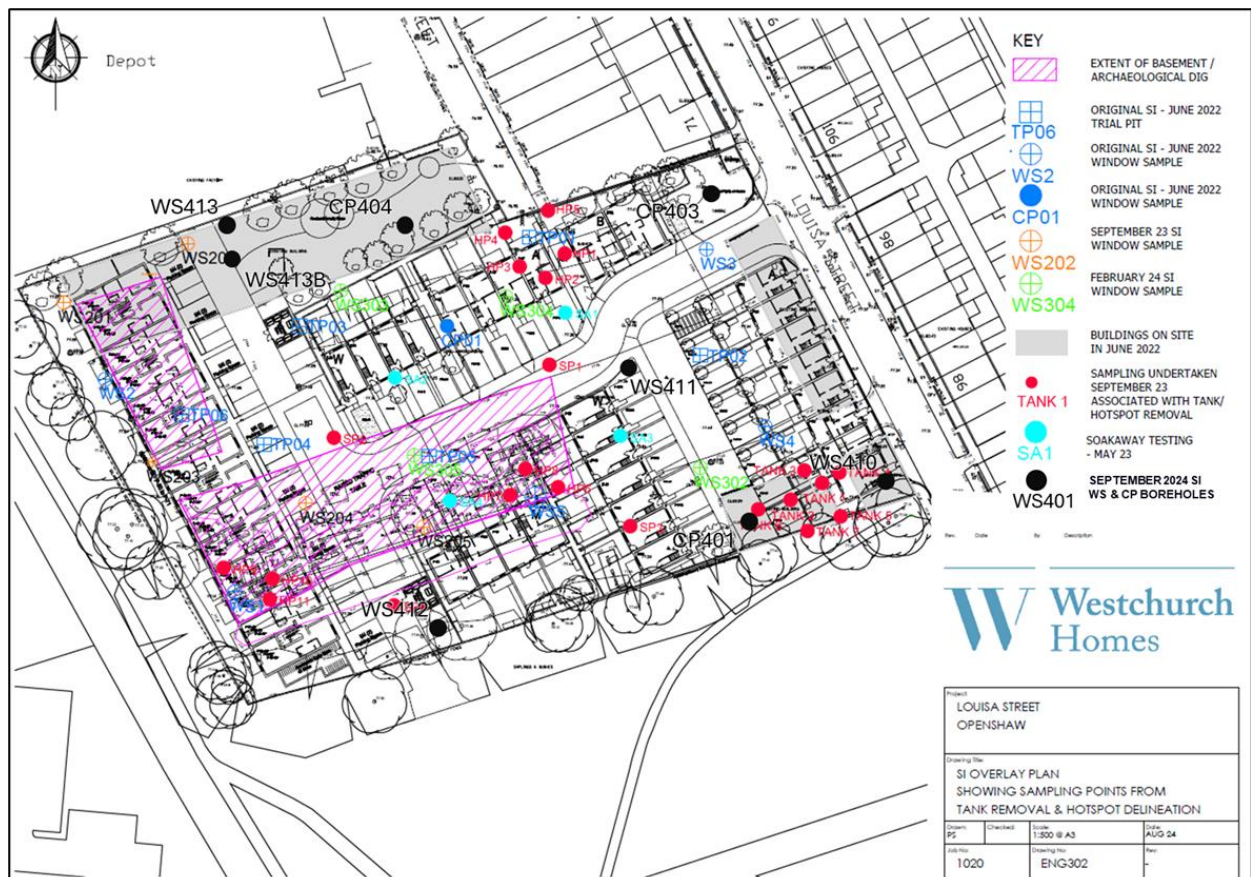
2.0 PROPOSED DEVELOPMENT

The existing buildings on site are to be demolished and 71 new low rise (max 3 storey) affordable homes will be constructed on behalf of a Registered Provider (RP).

Site access will be retained via Louisa Street to the east of the site, via a new access road.

The proposed development layout details are shown in Figure 9 below.

Figure 9: Proposed Development Plan Showing Historical Features & SI Points



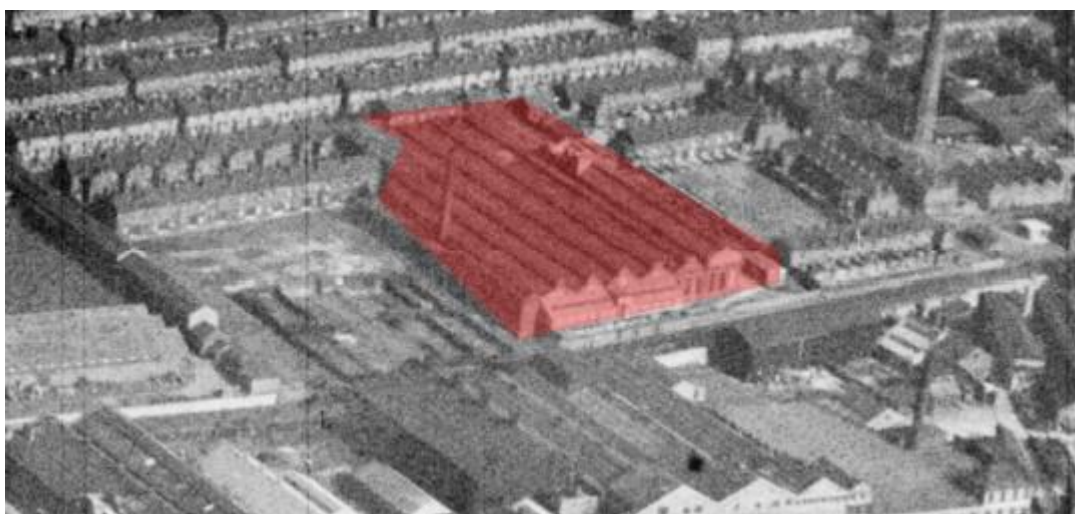
3.0 SITE HISTORY

Historically, the site was an Iron Foundry, developed for Joseph Stubbs Ltd to the design of Joseph Nodal. The Desktop Study produced in June 2022 (Report Ref: A4755/22/FDS), provides a detailed assessment of the industrial site history.

Figure 10 Land Use in 1905



Figure 11 Land Use in 1948



4.0 GROUND CONDITIONS ENCOUNTERED

4.1 Soil Profile Encountered

BGS digital mapping shows the site is underlain by superficial deposits of Devensian Till, comprising Diamicton.

The solid geology beneath the site is recorded as the Chester Pebble Beds Formation, comprising sandstone (Early Triassic Age). The eastern part of the site is also recorded to be underlain by artificial deposits of infilled ground.

The sequence of strata encountered beneath the site was as follows:

- **Made Ground** – Variable Made Ground was encountered in all of the exploratory holes to a maximum depth of 2.90m bgl, comprising:
 - Asphalt Hardstanding
 - Concrete (with rebar in TP6 only)
 - Sandy GRAVEL containing gravel of sandstone, ash, clinker, slag, metal and redbrick with cobbles of red brick, metal, and timber (CP1 and WS1)
 - Gravelly SAND containing gravel of sandstone, plastic, concrete, and red brick with cobbles of redbrick
 - Gravelly CLAY containing gravel of ash and clinker
 - Sandy gravelly CLAY containing gravel of red brick and sandstone
 - SAND
 - Clayey sandy GRAVEL containing gravel of sandstone and red brick with cobbles of red brick and timber
 - Sandy CLAY
 - Sandy gravelly COBBLES containing gravel of red brick and yellow brick with cobbles of red brick and yellow brick

- **Superficial Deposits** –

Sand was encountered in exploratory holes CP1, WS3, WS4, WS5, TP1 and TP2 to a maximum depth of 11.50m bgl, comprising:

- Gravelly SAND containing gravel of sandstone
- Silty gravelly SAND containing gravel of sandstone and carbonaceous fragments
- Clayey gravelly SAND containing gravel of sandstone with cobbles of sandstone

Clay was encountered in exploratory holes CP1, WS1, WS5, TP3, TP4 and TP5 to a maximum depth of 15.00m bgl, comprising:

- Sandy CLAY
- CLAY

The depths of the various materials encountered in the exploratory holes are summarised in Table 2, overleaf.

Table 2: Summary of Ground Conditions Encountered

Location	Made Ground Thickness (m)	BASE SAND (m bgl)	BASE CLAY (m bgl)	Installation Response Zone	Water Strike	Water Depth 30/5/22	Water Depth 23/1/24	Water Depth 1/2/24	Water Depth 20/9/24	Water Depth 30/9/24
WS1 (April 2022)	2.9	-	4.0+	1.0-4.0	2.5	2.68 (MG)	-	-	-	-
WS2 (April 2022)	2.5+	-	-	0.5-2.5		DRY	-	-	-	-
WS3 (April 2022)	1.5	5.0+	-	1.0-5.0	4.0	3.57 (SAND)	-	-	-	-
WS4 (April 2022)	1.6	4.5+	-	1.0-4.0	3.5	3.02 (SAND)	-	-	-	-
WS5 (April 2022)	2.5	5.0+	3.0	1.0-5.0	DRY	DRY	-	-	-	-
CP1 (April 2022)	1.1	11.5	15.0+	No Well	DRY	-	-	-	-	-
TP1 (April 2022)	0.6	2.6+	-	-	DRY	-	-	-	-	-
TP2 (April 2022)	1.2	2.8+	-	-	DRY	-	-	-	-	-
TP3 (April 2022)	2.5	-	3.2+	-	DRY	-	-	-	-	-
TP4 (April 2022)	2.7	-	3.5+	-	DRY	-	-	-	-	-
TP5 (April 2022)	2.9	-	3.3+	-	DRY	-	-	-	-	-
TP6 (April 2022)	0.4+ (Basement)	-	-	-	DRY	-	-	-	-	-
WS201 (Sept 2023)	3.3	-	4.0+	-	-	-	-	-	-	-
WS202 (Sept 2023)	3.0	7.0+	5.0	-	5.6	-	-	-	-	-
WS203 (Sept 2023)	2.7	6.0+	3.2, 3.9-4.6	-	3.2	-	-	-	-	-
WS204 (Sept 2023)	3.7	-	4.0+	-	2.0	-	-	-	-	-
WS205 (Sept 2023)	1.0	7.0+	4.3	-	2.0	-	-	-	-	-

Location	Made Ground Thickness (m)	BASE SAND (m bgl)	BASE CLAY (m bgl)	Installation Response Zone	Water Strike	Water Depth 30/5/22	Water Depth 23/1/24	Water Depth 1/2/24	Water Depth 20/9/24	Water Depth 30/9/24
WS302 (Jan 2024)	1.5	4.0+	-	1.0-4.0	DRY	-	DRY	DRY	-	-
WS303 (Jan 2024)	2.5	-	4.0+	1.0-4.0	DRY	-	DRY	DRY	-	-
WS304 (Jan 2024)	1.6	4.0+	-	1.0-4.0	DRY	-	DRY	DRY	-	-
WS305 (Jan 2024)	3.4	-	4.7+	1.0-4.7	DRY	-	DRY	DRY	-	-
CP401 (Sep 2024)	2.5	8.5	10.5+	5.0-8.5	DRY	-	-	-	3.42	3.20
CP403 (Sep 2024)	2.5	8.3	9.5+	5.0-8.5	7.0	-	-	-	4.65	4.37
CP404 (Sep 2024)	2.4	8.6	10.5+	5.0-8.5	6.2	-	-	-	4.72	4.75
WS410 (Sep 2024)	2.1	3.0+	-	1.0-3.0	-	-	-	-	-	-
WS411 (Sep 2024)	2.6	4.4+	-	2.6-4.4	-	-	-	-	-	-
WS412 (Sep 2024)	3.6	-	-	1.0-3.5	-	-	-	-	-	-
WS413 (Sep 2024)	2.5	-	3.5	1.0-3.5	-	-	-	-	-	-
Minimum	0.60	-	-	-	2.50	2.69	-	-	3.42	3.20
Average	2.22	-	-	-	3.33	3.10	-	-	4.26	4.11
Maximum	3.70	-	-	-	4.00	3.58	-	-	4.72	4.75

4.2 Observable Indications of Contamination

Gravel/cobbles of red brick, concrete, plastic, and yellow brick were observed in the Made Ground encountered on site, but these materials are generally considered inert.

However, gravel of clinker, ash, slag, metal, and timber were also encountered in the Made Ground.

A strong hydrocarbon odour was observed in TP1.

No other visual or olfactory indications of contamination were observed.

4.3 Water

Groundwater strikes were encountered in WS202 (5.60m), CP403 (7.00m) and CP404 (6.20m) within a sand horizon below a sequence of clay 3m to 5m.

WS3 and WS4 encountered water at a depth of 3.00m and 3.57m within the sand horizon which are considered to be perched and not representative of a local water table.

Chemical testing of water samples in WS1 (perched water), WS4 (perched water), CP401 (groundwater), CP403 (groundwater) and CP404 (groundwater) has revealed an absence of any contaminants of concern.

Water wells were installed in WS302-WS305 to a depth of 4.7m. Subsequent monitoring on the 23rd January 2024 and 1st February 2024, revealed that all boreholes were dry, despite the presence of sand in WS302 and WS304.

These wells further reinforce that the water in WS3 and WS4 are perched and not representative of a local groundwater table

5.0 FOUNDATION DESIGN RISK ASSESSMENT

5.1 Proposed Foundations

Due to the presence of weak made ground and underlying superficial deposits a programme of ground improvement (vibro-stone columns) is being considered by the client.

The stone columns are planned to extend to a maximum depth of 3.5m below existing ground level. As shown in Figure 6, roughly 85% of the site is underlain by shallow impermeable clay. The vibro-stone columns in this area are proposed to not penetrate through this clay layer. In the remaining 15% of the site, the stone columns will be within already mostly granular made ground.

Building Foundations will comprise of traditional, nominally reinforced concrete strips onto which the houses will be constructed.

5.2 Groundwater Regime

The Conceptual Site Model (Figure 5) indicates that the site is underlain by a variable thickness of made ground underlain by clay and sand.

Perched groundwater has been found, supported by impermeable clay at WS1, WS203, WS203 and WS204.

Groundwater strikes were encountered in WS202 (5.60m), CP403 (7.00m) and CP404 (6.20m) within a sand horizon below a sequence of clay 3m to 5m.

WS3 and WS4 encountered water at a depth of 3.00m and 3.57m within the sand horizon which are considered to be perched and not representative of a local water table.

Chemical testing of water samples in WS1 (perched water), WS4 (perched water), CP401 (groundwater), CP403 (groundwater) and CP404 (groundwater) has revealed an absence of any contaminants of concern.

Water wells were installed in WS302-WS305 to a depth of 4.7m. Subsequent monitoring on the 23rd January 2024 and 1st February 2024, revealed that all boreholes were dry, despite the presence of sand in WS302 and WS304.

These wells further reinforce that the water in WS3 and WS4 are perched and not representative of a local groundwater table.

The overall groundwater regime is therefore complex and variable below the site. However, the groundwater table was encountered above the superficial clay deposits at depth between 5.60m to 7.00m below ground level.

5.3 Tier 2 Controlled Water Risk Assessment

Table 3: Controlled Water Risk Assessment

RISK PROFILE	DISCUSSION	SENSITIVITY RATING
Groundwater Source Protection Zone or Drinking Water Safeguard Zone	Non	Low
Distance to the Closest Groundwater Abstraction Point	758m (not active) No potable abstraction points within 2km	Low
Aquifer Classification in Superficial Drift Deposits	Superficial Undifferentiated (not Secondary A or Secondary B)	Medium
Aquifer Classification in Bedrock	Principal	Low
Water Framework Directive Groundwater Classification	Poor (2019)	Low
Groundwater Vulnerability		Low
Is the Site Located Within 50m of a Surface Watercourse?	Non within 250m	Low

The CSM developed within the context of the site setting has identified the following viable pollutant pathways:

- Vertical migration to the Primary / Secondary Aquifer

5.4 Contamination

Within the preliminary site investigation water samples could only be recovered in WS1 and WS4.

All of the testing proved an absence of contaminants (metals, speciated PAH's, speciated hydrocarbons, BTEX) of concern when compared to UK Drinking Water Standards and Environmental Quality Standards.

Due to an absence of groundwater within wells in WS302 to WS305, leachate chemical testing was conducted on samples of made ground.

All of the leachate testing proved an absence of contaminants (metals, speciated PAH's, speciated hydrocarbons, BTEX) of concern when compared to UK Drinking Water Standards and Environmental Quality Standards.

The groundwater sampling carried out in the September 2024 investigation also reported an absence of significantly elevated contamination.

5.5 Risk Assessment

The Conceptual Site Model (Figure 5) indicates that the ground improvement at the site would not have an adverse impact on the future residents, construction workers, a Principal Aquifer, and the built environment (above and below ground).

The overall risk to controlled waters is perceived to be low.

The risks posed via the hazards identified are considered in the following sections and summarised in the subsequent Table 3 for the identified viable foundation option.

Pollution Scenario 1 - Creation of preferential pathways through an aquitard to allow potential contamination of an aquifer

There are no natural clay-rich strata present at the site which could be considered to act as an aquitard and hence, there is no natural aquitard present between the made ground and underlying Secondary Undifferentiated Aquifer.

This feature, therefore, cannot be breached by vibro-stone columns.

Rainwater infiltration and vertical migration will therefore have been occurring in all areas of the site not covered by hardstanding for an extended period of time.

There is no risk of the creation of a preferential pathway through the clay between the superficial and principal bedrock aquifer as the clay extends beyond 15m bgl and the maximum dept of the vibro-stone columns will be 3.50m bgl.

Pollution Scenario 2 – Creation of preferential pathways through a low permeability surface layer allowing migration of landfill gas, soil gas or contaminant vapours to surface

Any gases will have therefore been venting readily to surface except for in areas where hardstanding has been historically present (prior to its recent removal when the historical office building was demolished).

No offsite sources of land gases have been identified and the made ground at the site has been concluded to be insufficiently thick to present a meaningful potential source.

Pollution Scenario 3 – Direct contact of site workers and others with contaminated soil arisings that have been brought to the surface

Adopting risk assessment and industry best practice procedures will minimise any risk to construction workers.

Pollution Scenario 4 – Direct contact of the vibro-stone columns with contaminated soil or leachate causing degradation of materials

The likelihood of encountering any significant contamination within the soils or groundwater is considered to be extremely low.

Pollution Scenario 5 – The pushing of solid contaminants down into an aquifer during vibro-stone column operations

The proposed methodology minimises the potential for contaminated material to be migrated to depth during the process. There is minimal potential for vertical contaminant migration especially given that all work will be undertaken above the water table and no significant soil contamination is anticipated at any depth.

Pollution Scenario 6 – Contamination of groundwater and, subsequently, surface waters by wet concrete, cement paste or grout

Not applicable.

Pollution Scenario 7 – Off-site human health impacts

There is the potential (albeit it a low risk given the proposed timing of the works in the wetter months of the year) that dust could be generated through the ground improvement works, posing a risk to both on and off-site receptors. There is no evidence of asbestos being present in the soils at the site. The contractor will be required to ensure that dust in is minimised, and waste is handled in accordance with the Duty of Care thusly significantly reducing the risk of dust nuisance.

Table 4: Summary of Environmental Risks

HAZARD	LIKELIHOOD	CONSEQUENCE	RISK	COMMENT
Preferential pathway – increased risk to underlying aquifer	Very Low	Moderate	Low	The vibro-stone columns will extend to 3.5m and will be above the regional water table in underlying sands. Principal Aquifer at a depth of >23m.
Vertical migration of hydrocarbon vapour and ground gas	Very Low	High	Low	No offsite sources of land gas have been identified and the made ground thickness at the site has been deemed insufficient to present a potential source. No elevated volatile hydrocarbon fractions have been measured in soil or groundwater.
Contaminated arisings	Very Low	Moderate	Low	No arisings.
Degradation of stone column fabric	Very Low	Moderate	Low	No soil contamination anticipated based on laboratory test results. Natural soils not overly aggressive to concrete.
Contamination of deeper aquifer	Very Low	Moderate	Low	Vibro stone columns only extending to 3.5m.
Contamination of aquifer by vibro-stone column material	Very Low	Low	Low	No groundwater present at vibro-stone column depths.
Off-site human health impact	Very Low	High	Low	Generation of dust unlikely given the time of year during which the works will be undertaken, and asbestos detected in soil <0.001% concentration.

5.6 Future Control / Mitigation Measures

Required mitigation measures will comprise:

- Ensuring that the vibro-stone column mat is installed to sufficient thickness in accordance with the contractor's specification for H&S purposes.
- Good construction site management to minimise the risk of any fuel spills which could present an environmental risk and dust suppression measures on standby in the unlikely event that they be required.

6.0 CONCLUSIONS

Significant contamination has not been identified in samples of shallow perched water or groundwater, and a significant pollutant linkage to the deeper groundwater is not considered to be present.

The perched water is not a true water body and therefore not likely to be continuous shallow groundwater that may be disturbed by the proposed vibro stone column installation and therefore there will be limited (if any) interaction with groundwater.

Furthermore, there is a history of heavy industry in the area thus reducing the sensitivity of the aquifer.

Vibro-stone columns will be terminated within the near-surface deposits, and as such, will have no penetrative influence on the deeper bedrock aquifer that is protected by a thick layer of impermeable clay. This clay horizon is well below the depth even the deepest vibro-stone column.

The stone columns are planned to extend to a maximum depth of 3.5m below existing ground level. Roughly 85% of the site is underlain by shallow impermeable clay. The vibro-stone columns in this area are proposed to not penetrate through this clay layer. In the remaining 15% of the site, the stone columns will be within already granular made ground and will therefore not increase the risk of contaminant migration.

The sensitivity of the bedrock aquifer is further reduced, given there are no groundwater abstractions within influencing distance.

EEG therefore consider that the underlying Secondary Undifferentiated and Principal Aquifers will not be detrimentally impacted by the use of vibro stone column at the site, and the proposals present a very low risk.

All theoretical residual risks can be controlled to ensure that no pollution risk is generated from penetrative foundation works. The proposed method offers a high degree of risk management and control to ensure there is no risk to a sensitive receptor.

APPENDIX 1

REPORT LIMITATIONS

REPORT LIMITATIONS

This contract was completed by Earth Environmental & Geotechnical Ltd on the basis of a defined programme and scope of works and terms and conditions agreed with the client. This report was compiled with all reasonable skill, and care, bearing in mind the project objectives, the agreed scope of works, the prevailing site conditions, the budget, and staff resources allocated to the project.

Other than that, expressly contained in the above paragraph, Earth Environmental & Geotechnical Ltd provides no other representation or warranty whether express or implied, is made in relation to the services. Unless otherwise agreed this report has been prepared exclusively for the use and reliance of the client in accordance with generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon, or transferred to, by any other party without the written agreement of a Director of Earth Environmental & Geotechnical Ltd.

If a third party relies on this report, it does so wholly at its own and sole risk and Earth Environmental & Geotechnical Ltd disclaims any liability to such parties.

It is Earth Environmental & Geotechnical Ltd understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was an important 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 will no longer be valid and any further use of, or reliance upon the report in those circumstances by the client without Earth Environmental & Geotechnical Ltd review and advice shall be at the client's sole and own risk.

The report was written in 2024 and should be read in light of any subsequent changes in legislation, statutory requirements, and industry best practices. Ground conditions can also change over time and further investigations, or assessment should be made if there is any significant delay in acting on the findings of this report. 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 Earth Environmental & Geotechnical Ltd. In the absence of such written advice of Earth Environmental & Geotechnical Ltd, reliance on the report in the future shall be at the client's own and sole risk. Should Earth Environmental & Geotechnical Ltd be requested to review the report in the future, Earth Environmental & Geotechnical Ltd shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between Earth Environmental & Geotechnical Ltd and the client.

The observations and conclusions described in this report are based solely upon the services that were provided pursuant to the agreement between the client and Earth Environmental & Geotechnical Ltd. Earth Environmental & Geotechnical Ltd has not performed any observations, investigations, studies or testing not specifically set out or mentioned within this report.

Earth Environmental & Geotechnical Ltd 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, Earth Environmental & Geotechnical Ltd did not seek to evaluate the presence on or off the site of electromagnetic fields, lead paint, radon gas or other radioactive materials.

The services are based upon Earth Environmental & Geotechnical Ltd observations of existing physical conditions at the site gained from a walkover survey of the site together with Earth Environmental & Geotechnical Ltd interpretation of information including documentation, obtained from third parties and from the client on the history and usage of the site. The findings and recommendations contained in this report are based in part upon information provided by third parties, and whilst Earth Environmental & Geotechnical Ltd have no reason to doubt the accuracy and that it has been provided in full from those it was requested from, the items relied on have not been verified.

No responsibility can be accepted for errors within third party items presented in this report. Further Earth Environmental & Geotechnical Ltd was not authorised and 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. Earth Environmental & Geotechnical Ltd is not liable for any inaccurate information, misrepresentation of data 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 Earth Environmental & Geotechnical Ltd and including the doing of any independent investigation of the information provided to Earth Environmental & Geotechnical Ltd save as otherwise provided in the terms of the contract between the client and Earth Environmental & Geotechnical Ltd.

Where field investigations have been carried out these have been restricted to a level of detail required to achieve the stated objectives of the work. Ground conditions can also be variable and as investigation excavations only allow examination of the ground at discrete locations. The potential exists for ground conditions to be encountered which are different to those considered in this report. The extent of the limited area depends on the soil and groundwater conditions, together with the position of any current structures and underground 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 contract between the client and Earth Environmental & Geotechnical Ltd] based on an understanding of the available operational and historical information, and it should not be inferred that other chemical species are not present.

The groundwater conditions entered on the exploratory hole records are those observed at the time of investigation. The normal speed of investigation usually does not permit the recording of an equilibrium water level for any one water strike. Moreover, groundwater levels are subject to seasonal variation or changes in local drainage conditions and higher groundwater levels may occur at other times of the year than were recorded during this investigation.

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.

