Land Science

[redacted]

PHASE I & PHASE II
GEOTECHNICAL AND GEO-ENVIRONMENTAL REPORT

[redacted]

16TH NOVEMBER 2020

[redacted]

Site:	[redacted]
Title:	**PHASE I AND PHASE II GEOTECHNICAL AND GEO-ENVIRONMENTAL INVESTIGATION**
Project:	**CONSTRUCTION OF A REPLACEMENT DWELLING**
Client:	[redacted]
Architect:	[redacted]
Date:	**16TH NOVEMBER 2020**
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1 INTRODUCTION

1.1 General

Land Science was instructed to undertake a Phase I and Phase II Geotechnical and Geo-Environmental Report in relation to the proposed redevelopment at [redacted]. The location of the site is shown on Figure 1, which is centred at grid reference [redacted].

1.2 Client

The Client for this appointment was [redacted] This report may be used by this named client only and is subject to the confidentiality notice set out in section 3.1, and cannot be relied upon by any other party as set out in the report conditions.

1.3 The Site

The site comprised a broadly rectangular shaped parcel of land containing a two-storey residential dwelling to the centre, associated front garden and driveway, with a rear garden containing a swimming pool.

The layout of the existing site is indicated on Figure 2, and a walkover survey is presented in section 6.0. The area was approximately 0.16 hectares. It was understood that the Client was in ownership of the site, and that this investigation was not a pre-purchase appraisal.

1.4 Form of Development

The proposed development was understood to comprise the construction of a replacement two-storey residential dwelling following the demolition of the existing property.

The proposed development was covered under planning application number [redacted] Figure 3 illustrates the layout of the proposed redevelopment. The findings of this report may be not valid if the proposed development is altered.

1.5 Previous Investigations

Land Science was not aware of any previous desk studies or ground investigation(s) undertaken on this site.

The proposed scope of works was to comprise the following:

- A desk study;
- 4no. dynamic (windowless) sampler boreholes;
- 4no super heavy dynamic probes;
- A falling head soakage test; and
- In-Situ CBR determinations using a TRL DCP

The fieldwork was conducted on 26th October 2020, under the supervision of Land Science.

1.6 Geotechnical Objectives

A Ground Investigation Report was required in order to provide an interpretation of ground conditions with respect to proposed foundations, pavements, soakaways, concrete specification, and excavations.

1.7 Geo-Environmental Objectives

A phase I (desk study) and phase II (intrusive investigation) was required, to provide a generic quantitative risk assessment (GQRA) in respect of the proposed redevelopment, adjacent land uses, and the wider environment, in the context of the planning regime.

2 STANDARDS AND REFERENCES

2.1 Standards

Where practicable, the investigation was undertaken in accordance with the following primary standards and guidance:

- BS10175:2011+A1:2013, Investigation of Potentially Contaminated Sites.
- Model Procedures for the Management of Contaminated Land, DEFRA and Environment Agency, September 2004 ("CLR11").
- Guiding Principles for Land Contamination, Environment Agency, March 2010.
- National Planning Policy Framework, July 2018.
- Building Regulations Approved Document C: Site preparation and resistance to contaminants and moisture, HM Government, July 2013.
- NHBC Standards Chapter 4.1: Land Quality - Managing Ground Conditions, 2019.
- BS 5930:2015 Code of Practice for Site Investigations
- BS 1377:2018 Soils for Civil Engineering Purposes
- BS 8004:2015 Code of Practice for Foundations
- BS EN 1997-2:2007. Eurocode 7: Geotechnical Design – Part 2: Ground Investigation and testing.

Other technical sources have been cited in respect of specific aspects of the investigation, as referenced throughout the text.

2.2 References

A number of technical references have been referred to in the preparation of this document, including:

- Smith, I. (2014) Smith's Elements of Sil Mechanics. Chichester. Wiley Blackwell. 9th Edition.
- Highways England 2009. Interim Advice Note 73/06 revision 1: Design Guidance for Road Pavement foundations (draft HD25)
- BRE Design Guide 365. Soakaway design ("DG365")
- Radon: Guidance on protective measures for new buildings, BRE Report BR 211, 2015 2ND edition
- Revised EU Waste Framework Directive 2008 2008/98/EC [transposed into English law under The Waste (England and Wales) Regulations 2011]
- European Community (EC) Directive 1999/31/EC [transposed into English law under the Landfill (England and Wales) Regulations 2002]
- Defining Waste Recovery - Permanent Deposit of Waste on Land, EPR13 v1.0, EA 2010
- The definition of waste: Development Industry Code of Practice, v2, CL:AIRE 2011
- Guidance on the classification and assessment of waste Technical Guidance WM3 ("WM3") EA publication (1st edition 2015)

2.3 Notes

If a long delay exists between the investigation and commencement on site, it may be necessary to check whether any standards have changed in the intervening period.

3 REPORT CONDITIONS

3.1 Report Conditions

This report is issued subject to the conditions set out in section 3 and the terms and conditions of appointment agreed with the Client.

3.2 General

Interpretation of ground conditions inherently depends on the conditions revealed by a limited data set. Land Science takes all reasonable professional care in preparation of this report, using current standards and industry best practice. However, we accept no liability whatsoever expressed or implied in respect of:

- The scope, extent or design of an investigation.
- Any conditions not directly revealed by the investigation.
- Published standards or methodologies used or adopted in this report.
- The opinion of any other party including any regulator, authority or stakeholder.
- Any dispute, claim or consequential loss arising from this report.
- Any matter other than ground conditions.

Land Science does not accept any risk or any direct or consequential liability relating to ground conditions. The client should understand their risks and liabilities and seek further professional advice.

No aspect of this report constitutes a design. Where this information is used in design, the designer should verify that the information has been used appropriately.

3.3 Confidentiality

This report may only be relied upon by the Client and their design team, and should only be read and used in full. No responsibly will be accepted where this report is used, by any other party, who do so at their peril. The report may not be relied upon or transferred to any other parties without the express written agreement of Land Science.

3.4 Third Party Information

Third party information used in the production of this report has been relied upon as being accurate. Land Science cannot warrant or accept any liability for errors and/or omissions in third party information.

3.5 Regulators and Approvals

It is recommended that this report is submitted to any relevant authorities for their own assessments and to provide their approval or comments accordingly. This should be in good time before commencing on site in case additional work is to be carried out.

Standards, technical guidance and regulatory positions change over time and which may therefore affect the findings and recommendations made in this report. This should be verified by the client prior to any critical contractual points or commencing on site.

3.6 Variations with time

The report relates to conditions revealed at the time of the investigation and any monitoring visits. A number of parameters may vary over time or seasonally. Groundwater levels, ground gas compositions, or concentrations of contaminants are particularly variable in this respect. Further monitoring or verification should be considered as appropriate.

3.7 Other Matters

This report makes no representation on other matters such as ecology, agronomy, arboriculture, structural condition, building materials, boundaries and planning etc.

No aspect of this report should be taken as a guarantee whatsoever that a site is free of pollution, contamination or hazardous materials.

4 PHASE I DESK STUDY

4.1 General

A geotechnical and geo-environmental desk study was prepared, and included a review of:

- Maps and historical borehole records from the British Geological Survey
- Historical Ordnance Survey maps
- An environmental data report (Envirocheck reference [redacted])

Copies of relevant data are presented in Appendix A.

4.2 Geology

Based on mapping published online by the British Geological Survey (BGS), the geology of the site was anticipated to comprise the following succession:

Strata	Generic description
River Terrace Deposits	Sand and gravel, locally with lenses of silt, clay or peat.
White Chalk Subgroup	Chalk with flints. With discrete marl seams, nodular chalk, sponge-rich and flint seams throughout.

Beach and Tidal Flat Deposits were mapped adjacent to the south of the site.

4.3 Historical Boreholes

Records of old boreholes are held by the BGS. The following relevant borehole record was identified:

Location	BGS Reference	Drilled Length (m)	Borehole Name
[redacted]	[redacted]	15.00	[redacted]

This record has been summarised below:

Strata	Base Depth (m)	Summary Description
Hardstanding	0.10	Tarmac
Made Ground	0.50	Fill, brick rubble, resting on stoney brown clay
Brick Earth	2.00	CLAY, silty, slightly sandy, orange-brown and grey mottled with scattered small stones and chalk fragments.
	3.20	SAND, fine variably clayey, light orange-brown and grey with thin layers of very sandy clay, many small chalk fragments and scattered flints.
Coombe Deposit	7.20	CLAY, very sandy and silty, light orange-brown with frequent thin layers of variably clayey fine sand, occasional bands of silt, numerous chalk fragments and scattered flints
Upper Chalk	15.00	CHALK, clayey at the top, becoming variably clayey and rubbly and harder with depth. Contains occasional flints.

The Brick Earth and Coombe Deposit probably relate to the River Terrace Deposits used in the present day BGS mapping.

4.4 Background Geochemistry

The BGS publish a series of different estimated background levels of selected contaminants, which are useful for land quality assessments, to establish whether results may be attributed to pollution or soil parent material composition.

The BGS estimate the natural background concentrations of certain potentially harmful elements based on rural topsoil and stream sediment analysis. Data relevant to the site is summarised below:

Location	Arsenic	Cadmium	Chromium	Lead	Nickel
On site	<15mg/kg	<1.8mg/kg	60-90mg/kg	100-200mg/kg	15-30mg/kg

4.5 Geological Hazards

The BGS produce hazard assessment maps for a selection of common geotechnical datasets, and the classifications referring to the site (and immediate vicinity – if relevant) are summarised below:

Dataset	Location	Hazard
Shrinkability	On Site	Low
Running Sands		
Collapsible		
Landslide		Very low
Dissolution		
Compressible Ground		No hazard

4.6 Mining and Natural Cavities

A search of various databases for coal mining, mining, brine compensation, and natural cavities was carried-out, and the findings are summarised below:

Database	Results
CBSCB Compensation District	No features found
Coal Mining Affected Areas	
Non-Coal Mining Areas of Great Britain	
Mining Instability	
Man-Made Mining Cavities	
Natural Cavities	

4.7 Radon Potential

The requirement for Radon Protection Measures (RPM) has been assessed in accordance with BRE 211:2015. Public Health England and the BGS estimate the potential for radon and the requirement for Radon Protection Measures on site as follows:

Probability	Protection Measure
Not at risk - Less than 1% of homes are estimated by PHE to exceed the threshold for Radon gas in residential dwellings	No Radon Protection Measures (RPM) are required for new dwellings or extensions constructed at this location.

4.8 Hydrogeology

The BGS borehole records identified groundwater strikes at 3.20m and 5.00mbgl, the water levels rose to 3.10m and 4.00m respectively after 20 minutes.

4.9 Groundwater Flooding

The BGS have produced a series of hazard assessments for the potential of flooding from groundwater, and data relating to the site and a 50m radius is summarised below.

Location	Flooding type
On Site, 16m N, 19m S, & 45m E	Limited Potential for Groundwater Flooding to Occur

4.10 Aquifer Designations

The Environment Agency classifies geological units across England into different designations as Aquifers. The designations for strata beneath the site are given below, which corresponds to an overall designation as a Principal Aquifer.

Strata	Classification	Details
Groundwater Vulnerability	High	Areas able to easily transmit pollution to groundwater. They are characterised by high leaching soils and the absence of low permeability superficial deposits.
Superficial (River Terrace Deposits)	Secondary A	Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
Bedrock (White Chalk Subgroup)	Principal	Strata that have high inter-granular and/or fracture permeability, usually providing a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

4.11 Groundwater Abstractions

No groundwater abstractions were identified as part of the desk study within a radius of 1000m of the site.

4.12 Source Protection Zones

A groundwater Source Protection Zone (SPZ) is an area of protection placed around a well or borehole that supplies groundwater of potable quality. No SPZ's were identified on or within 250m of the site according to Environment Agency mapping.

4.13 Surface Water Features

The nearest surface water feature identified on Ordnance Survey mapping was located immediately to the south of the site, The English Channel.

4.14 River Quality

No river quality sampling points were noted within 50m.

4.15 Surface Water Abstractions

No surface water abstractions were identified as part of the desk study on site or in the vicinity of the site.

4.16 Surface Water Flooding

Land potentially susceptible to flooding from seas, rivers, reservoirs and surface water is identified by the Environment Agency. Current mapping indicated the following:

Source	Details
Rivers and Seas	Very low risk means that each year this area has a chance of flooding of less than 0.1%. Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding.
Surface water	
Reservoirs	The site does not lie within an area susceptible to reservoir flooding.

Whilst the site was not indicated to be susceptible to flooding, the site was located adjacent to the English Channel. It is recommended that further, more accurate details of potential flooding within the local area be obtained from the Environment Agency, in order to ascertain the level of any risk posed. It may become necessary to undertake a Flood Risk Assessment (FRA).

4.17 Licences Database Search

A search of various industrial land use databases was carried-out, and the findings relevant to the site are summarised below:

Database	Results
Prosecutions Relating to Authorised Processes	No features found
Integrated Pollution Controls	
Registered Radioactive Substances	
Contaminated Land Register Entries and Notices	
Enforcement and Prohibition Notices	
Integrated Pollution Prevention and Control	
Substantiated Pollution Incident Register	
LA Integrated Pollution Prevention & Control	
LA Pollution Prevention and Control Enforcements	
Prosecutions Relating to Controlled Waters	
Water Industry Act Referrals	
Hazardous Substances	

4.18 Contemporary Trade Directories

A search of contemporary trade directory databases was made, no data was identified on site or within 250m.

4.19 Points of Interest

A search of "points of interest" was made, and the following data relevant to this report was identified on site and in the vicinity.

Location	Name	Category:	Class Code:
202m SW	Outfall	Infrastructure and facilities	Waste storage, processing, and disposal

4.20 Fuel Station Entries

A search of "fuel station entries" was made; no data relevant to this report was identified on site and in the vicinity.

4.21 Underground Pipelines and Cables

A search of records of major underground pipelines and cable infrastructure (not to be confused with utilities) identified no features on site and in the vicinity.

4.22 Discharge Consents

No discharge consents were identified on site and in the vicinity.

4.23 Pollution Incidents

No pollution incidents were identified on site and in the vicinity

4.24 Waste Management Facilities

Searches of various databases of current and historical waste management facilities (including mapped areas of possible infilled land) are summarised on the following table:

Database	Results
Historical Landfill Sites	No features found
Licensed Waste Management Facilities	
Registered Landfill Sites	
BGS Recorded Landfill Sites	
Integrated Pollution Control Registered Waste Sites	
Local Authority Recorded Landfill Sites	
Registered Waste Transfer Sites	
Registered Waste Treatment or Disposal Sites	
Potentially Infilled Land	

No waste management facilities were identified on site and in the vicinity.

5 SITE HISTORY

5.1 Historical Maps

Historical maps dating between 1876 and 1994 were reviewed to identify the history of the site and local area. The outline of the site shown is geo-referenced to the current grid system; due to inaccuracies in mapping techniques the actual boundary on older maps may vary. Given the size of these files, smaller scale maps are not appended to the PDF version of this report but are available separately.

In summary, the site comprised open fields from the year 1876 to 1933. By 1933 a dwelling had been established on site, and by 1961 it appeared that the dwelling on site had been replaced by a larger dwelling that remains in the present day.

The local area also comprised open fields from 1876 to 1933, before progressively becoming developed with residential housing from the year 1933 to 1994, where most of the local area comprised residential dwellings, with recreational green spaces.

5.2 Aerial Photographs

Aerial photographs dating from 2015 and google earth imagery dating from 2001 to the present day were also reviewed. It was noted in 2001 that a built-in swimming pool was present to the rear of the site.

5.3 Planning Portal

No further planning applications, other than the current, we noted.

6 SITE WALKOVER

6.1 General

A site walkover was undertaken as part of the fieldwork on 26th November 2020. Photographs of the site are provided in Appendix B.

6.2 Site Layout

In summary, the site comprised a broadly rectangular shaped parcel of land with a two-storey dwelling located in the middle of the property with front and rear gardens.

The access to the site was possible through the north via [redacted] with a concrete driveway crossing the front garden to the current development. The front garden was mainly laid to lawn with hedges flanking the site boundaries and a small children's playground area located to the northeast corner of the site.

The rear garden entrance was located to the east of the current development through a wooden fence/gate to the east of the dwelling. The garden was also laid to lawn with a swimming pool towards the western boundary. The south boundary of the site was fenced off with wooden panels and gave direct access to the sea front.

6.3 Surrounding Area

The site was located in a predominantly residential area, and was primarily surrounded by further dwellings. The site fronted on to [redacted] to the north, with a sports club [redacted] beyond.

No potentially contaminative land uses were identified in the local vicinity.

6.4 Elevation and Topography

The topography of the local area was generally flat and level. The site was also generally flat and level and was located at an approximate elevation of 6.00mOD

6.5 Ground Conditions

No evidence of existing soil conditions was observed, such as open excavations or the like.

No immediate evidence of significant structural movement was observed, or was reported to Land Science. However, our inspection was cursory and a full survey was outside the scope of this report.

No known subsurface structures were identified.

6.6 Surface Water and Groundwater

Apart from the sea noted immediately to the south, no other surface natural water features were identified on site or in the immediate vicinity. No evidence of shallow groundwater, such as boggy waterlogged soils or water loving plants etc., were noted.

6.7 Trees and Vegetation

The site boundaries were noted to be populated with shrubs as fencing from the surrounding properties.

A detailed arboricultural survey was outside the scope of this report. A survey may be required for tree root protection purposes or for assessing the depth of foundations in the vicinity of trees.

There was no immediate evidence of invasive plant species, although this was not a full survey.

7 CONCEPTUAL SITE MODEL (CSM)

7.1 General

A preliminary geo-environmental Conceptual Site Model (CSM) was formulated for the site based on the desk study & site walkover, and in light of the proposed development. The model should be revised where the development proposals differ, any ground investigation data is available, or where unexpected conditions are encountered.

The model has been designed primarily in accordance with established procedures in BS5930, BS10175 and CLR11, and also draft ISO guidance. In accordance with best practice, the model has been used to identify possible contamination risks following a source-pathway-receptor ('SPR') approach.

7.2 Site Setting

Based on the anticipated ground conditions revealed in the desk study, the following generalised soil and groundwater model is anticipated:

Strata	Depths	Soil types	Groundwater
Made Ground	~1.00	Mixed composition with man-made fragments	Potentially perched
River Terrace Deposits	~5-6m	Sand, gravel and clay	Likely
White Chalk Subgroup	>20.00m	Chalk with flint	Likely at depth

7.3 Risk Assessment Framework

A qualitative estimate of the level of risk associated with the identified source-pathway-receptor linkages has been made. The estimate is based on the likely significance of an identified source and the sensitivity of the identified receptor, as follows:

		Secondary Source				
		Unlikely	**Very low**	**Low**	**Moderate**	**High**
Receptor	**Unlikely**	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
	Very Low	Unlikely	Unlikely	Very low	Low	Low to moderate
	Low	Unlikely	Very low	Low	Low to moderate	Moderate
	Moderate	Unlikely	Low	Low to moderate	Moderate	High
	High	Unlikely	Low	Moderate	High	Very High

The principle of primary and secondary sources has been adopted in accordance with draft ISO/CD 21365. Further information is given in the accompanying notes, and are summarised as follows:

- A **primary source** is for instance a leaking tank or drainage, industrial activity, buried fill materials, etc, identified as part of the desk study and site walkover.
- A **secondary source** is either soils, ground gases, volatile vapours and groundwater, in which any resulting contamination may occur.

For instance, a leaking tank may contaminate soils and generate vapours, or buried fill materials may represent a source of ground gases or groundwater pollution. It should be noted that sources may also be receptors; for instance, groundwater may both be a receptor (as in the background chemical quality of an aquifer or resource) and in turn become a source (contaminated waters impacting on buried concrete structures). Further guidance is given in the accompanying notes.

7.4 Primary Sources

Identified primary and secondary sources of possible contamination arising in soils identified as part of the desk study and site walkover on site are summarised on the following table.

Primary Source	Description
Made Ground	Made Ground may exist on site under buildings and hardstanding etc. The provenance of such materials is unknown and may be contaminated. Contaminants include a Wide range of possible metals, non-metals, organic contaminants, asbestos.

7.5 Secondary Sources

Based on the primary sources identified, the secondary sources (soils, volatile vapours, ground gases and groundwater) have been assessed as follows:

Secondary Source	Description	Rating
Soils	Made Ground may be present on site, the depth and composition of material is unknown.	Very low
Volatile vapours	No viable sources have been identified. The site is not located near to any petrol filling stations.	Unlikely
Ground gases	The site is not located near to any historical landfill sites. The site has undergone little or no development with Made Ground expected to be less than 1.00m deep, and therefore gas generation is unlikely.	Unlikely
Groundwater	No significant sources of groundwater pollution have been identified on site.	Unlikely

7.6 Potential Receptors

The following potential receptors associated with the site and the proposed development have been considered in this report:

Group	Receptors	Rating
Human Health	End Users - occupants of the proposed redevelopment. Proposed replacement two storey dwelling with private gardens.	High
	Adjacent Land Users - Sensitive land uses identified locally. Further residential land uses were identified to the west, north and east.	Moderate
Built Environment	Soft Landscaping - Proposed plans included soft landscaped garden areas.	Moderate
	Structural Concrete – New concrete foundations are anticipated to be cast. Concrete is susceptible to attack from Sulphate in soils and groundwater, which is exacerbated by low pH values.	Moderate
	Water Supply Pipework - water mains susceptible to chemical attack. Plastics laid in contact with ground contaminated by organic contaminants may degrade over time, which is especially an issue in respect of potable water supplies which are typically installed in plastic water mains and therefore risk becoming tainted.	Moderate
Controlled Waters	Groundwater - Water below ground in permeable strata. The site overlies strata classified a Principal Aquifer (White Chalk Subgroup) with a high vulnerability. No SPZ's or abstraction points were noted.	Moderate
	Surface Water- The sea was identified immediately to the south of the site.	Moderate

7.7 Receptors not considered

The following potential receptors were excluded from the assessment as they are covered by other legislative controls and are outside the remit of this report.

- Ecological receptors such as statutory protected species or wildlife areas. An assessment of such risks was outside the scope of this report.
- Site workers such as those involved in construction work or future maintenance. Any risks posed to site workers would be controlled through Health & Safety legislation, including the CDM and COSHH regulations etc.

The potential source-pathway-receptor linkages have been grouped by receptor and are discussed in the following sections:

7.8 End Users

The source-pathway-receptor linkages identified with respect to End Users are summarised below:

Source(s)	Pathway(s)	Risk rating
Soils	Dermal contact with soil and soil-borne dust	Low
Soils	Ingestion of soil and soil-borne dust	Low
Soils	Inhalation of soil-borne dust	Low
Soils	Consumption of homegrown produce	Low
Volatile vapours	Inhalation, ignition	Unlikely
Ground gases	Inhalation, ignition	Unlikely
Groundwater	Direct contact	Unlikely

7.9 Adjacent Land Users

Pathways for adjacent land users may be temporary (i.e. during development) or long term (on completion of the development). Off-site sources impacting on off-site receptors have not been considered.

The source-pathway-receptor linkages identified with respect to Adjacent Land Users are summarised below:

Source(s)	Pathway(s)	Risk rating
Soils	Inhalation of soil-borne dust	Very low
Volatile vapours	Inhalation, ignition	Unlikely
Ground gases	Inhalation, ignition	Unlikely
Groundwater	Direct contact	Unlikely

7.10 Soft Landscaping

The source-pathway-receptor linkages identified with respect to Soft Landscaping are summarised below:

Source(s)	Pathway(s)	Risk rating
Soils	Plant uptake, phytotoxic effects	Low
Volatile vapours	Root asphyxiation, ignition, phytotoxic effects	Unlikely
Ground gases	Root asphyxiation, ignition, phytotoxic effects	Unlikely
Groundwater	Plant uptake, phytotoxic effects	Unlikely

7.11 Structural Concrete

The source-pathway-receptor linkages identified with respect to Structural Concrete are summarised below:

Source(s)	Pathway(s)	Risk rating
Soils	Chemical attack	Low
Volatile vapours	Not applicable	Unlikely
Ground gases	Not applicable	Unlikely
Groundwater	Chemical attack	Unlikely

7.12 Potable Water Supplies

The source-pathway-receptor linkages identified with respect to Potable Water Supplies are summarised below:

Source(s)	Pathway(s)	Risk rating
Soils	Chemical attack	Low
Volatile vapours	Chemical attack	Unlikely
Ground gases	Not applicable	Unlikely
Groundwater	Chemical attack	Unlikely

7.13 Groundwater (receptor)

The source-pathway-receptor linkages identified with respect to Groundwater (as a receptor) are summarised below:

Source(s)	Pathway(s)	Risk rating
Soils	Leaching-out, migration through the water	Low to moderate

Source(s)	Pathway(s)	Risk rating
	table	
Volatile vapours	Not applicable	Unlikely
Ground gases	Not applicable	Unlikely
Groundwater	Not applicable	Unlikely

7.14 Surface water

The source-pathway-receptor linkages identified with respect to Surface Water (as a receptor) are summarised below:

Source(s)	Pathway(s)	Risk rating
Soils	Leaching-out, migration through the water table	Low
Volatile vapours	Not applicable	Unlikely
Ground gases	Not applicable	Unlikely
Groundwater	Lateral migration to identified surface water bodies	Unlikely

7.15 Other Factors

The following other areas of possible concern were identified, but were outside the geo-environmental risk assessment:

Asbestos	Asbestos may exist within buildings on site, including for instance in cement boarding. An appropriate survey should be undertaken to assess the presence of asbestos within the building fabric.

8 INTRUSIVE INVESTIGATION

A factual record of the conditions encountered during the physical investigation of the site is presented in the following sections.

8.1 Investigation Strategy

Based on the findings of the conceptual site model and the geotechnical objectives, the intrusive investigation was based on the following strategy:

Aspect	Position	Targets			Testing, installations etc
		Depth	Existing Location	Proposed Location	
Dynamic Sampler boreholes	DS01	3.00m	Front garden – NW corner	Possible soakaway	SHDP, DCP, FHST
	DS02	5.00m	Front garden – NE corner	Within the footings of the new proposed dwelling	SHDP, DCP
	DS03		Rear garden – SE corner	Within the garden of the proposed development, within proximity to the proposed development	SHDP
	DS04		Rear garden – south of dwelling		SHDP

An explanation of the excavation and testing types are given in the following sections.

DS01 reached the required depth of 3.00m in order to undertake a falling head soakage test. The remaining three positions were terminated prematurely on dense strata between 4.30m and 4.70mbgl.

8.2 Dynamic (Windowless) Sampling (DS)

Dynamic Sampling entails 1m long hollow tubes with liners driven into the ground and retracted in order to obtain samples. The process is repeated sequentially to the target depth, unless impenetrable strata or borehole instability prevent further progress. The liners are split, logged, tested, and subsampled. Sample compression can occur within the liners, and the sampler can sometimes become blocked. Sample recovery is typically class 2 as defined in Eurocode 7.

8.3 Super Heavy Dynamic Probing (SHDP)

Dynamic Probing involves hammering a cone point into the ground and recording the number of blows required for each increment of penetration. The mass and falling height of the hammer, the energy efficiency, the dimensions of the cone, the rod specifications and rod friction are important considerations. A range of configurations are prescribed in Eurocode 7 and EN ISO 22476-2; the type deployed was *DPSH-A*.

8.4 Dynamic Cone Penetrometer (DCP)

In-situ CBR determinations were undertaken using a TRL DCP. The test involves driving a 20mm diameter (60^0) cone attached to a penetration rod with an 8kg weight in a 'slide hammer' action and recording each blow's penetration. The weight is dropped from a height of 575mm.

8.5 Falling Head Soakage Test (SHDP)

A falling head soakage test involves filling a completed borehole with clean water and recording the drop in level over a period of time in order to obtain an infiltration rate.

9 GROUND CONDITIONS

9.1 General

The expected ground conditions were anticipated to comprise River Terrace Deposits over White Chalk Subgroup to depth; a thin capping of Made Ground was anticipated across the site. The investigation confirmed the anticipated ground conditions. A summary of the encountered conditions is presented below.

Base Depth (m)				Strata
DS01	DS02	DS03	DS04	
0.40	0.30	0.10	0.60	Made Ground
3.00+	4.30+	4.10	4.10	River Terrace Deposits
-	-	4.40+	4.70+	White Chalk Subgroup - Grade Dm

The identification of materials encountered as specific geological strata is tentative and should be used as a guide, and interpolation between or below investigation points should be treated with caution.

9.2 Made Ground

Made Ground was encountered to depths of between 0.10 and 0.60m.

Generally comprised a thin capping of dark brown slightly clayey, slightly gravelly sand, with abundant rootlets, with brick fragments at ground level to 0.10m, within all positions.

The Made Ground graded down into a light yellowish-brown slightly gravelly sand, of fine to medium, angular to subangular flints, and fine sand, with rare brick and concrete fragments with DS01 and DS02. Orangish-brown gravelly, sandy clay, with flints, fine sands, and occasional brick fragments was encountered within DS04 between 0.10 and 0.60m.

9.3 River Terrace Deposits

River Terrace Deposits were encountered to depths of between 3.00 and 4.30m, within all positions, and generally comprised mixed composition of sandy CLAY, and clayey SAND, with occasional fine to medium, subangular to subrounded flints, and rare chalk fragments within the lower clay stratum.

The sandy clays were encountered to depths of between 2.10m and 2.20mbgl within DS2 and DS4 respectively, with clayey SAND beneath to the base. No sands were encountered within DS1 to 3.00m, or DS3 to 4.10m.

9.4 White Chalk Subgroup

The White Chalk Subgroup was encountered in DS03 and DS04 and was proved to a maximum depth of 4.70mbgl where the boreholes refused. In accordance with CIRIA guide C574, the chalk comprised off-white low density structureless weak chalk with clay and sand pockets. These materials were classified as grade Dm.

9.5 Roots and Rootlets

Occasional rootlets were identified in DS03 (0.0 to 0.10m). No other roots or rootlets were identified throughout the remaining positions.

9.6 Field Evidence of Contamination

No evidence of possible soil contamination (such as staining, malodours, or brightly coloured soils) was identified in the field.

Made Ground was identified to depths to between 0.10 and 0.60m, and such materials may be imported from an unknown source or mixed with hazardous materials. All such materials should be treated as suspect unless proven otherwise. Preliminary testing has been carried out, as described in section 10.

9.7 Groundwater

Groundwater was struck during the excavation of DS02 at a depth of 3.10m. The level of water in a borehole can be affected by the drilling process and speed of infiltration; short-term rest levels should be used with caution.

Groundwater levels may vary seasonally and with variations in rainfall. Water may also become perched upon cohesive strata or around features such as foundations, and may also occur from leaking drains and water mains etc.

10 GEO-ENVIRONMENTAL TESTING

10.1 Geochemical Laboratory Analysis

Samples were selected for geochemical analysis, based on the following rationale:

- Made Ground was encountered, which may contain a wide range of contaminants. Selected samples were tested for a routine screening suite (LS1) and were screened for Asbestos. A sample of natural soil from the River Terrace Deposits was also tested for routine screening suite as a control sample.
- To provide information on waste disposal, one representative sample of Made Ground was tested for a Waste Acceptance Classification (WAC) test (LS2).

The scope and extent of testing was considered appropriate and in accordance with the Conceptual Site Model and preliminary risk assessment.

A summary of the testing scheduled is given below:

Sample	Strata	Suite		
		LS1	Asbestos	LS2
DS01-0.20m	Made Ground	✓	✓	-
DS02-0.20m		✓	✓	✓
DS03-0.40m	River Terrace Deposits	✓	-	-
DS04-0.30m	Made Ground	✓	✓	-

The relevant screening suites are defined below. Where duplicate analysis exists between suites, each test is performed only once:

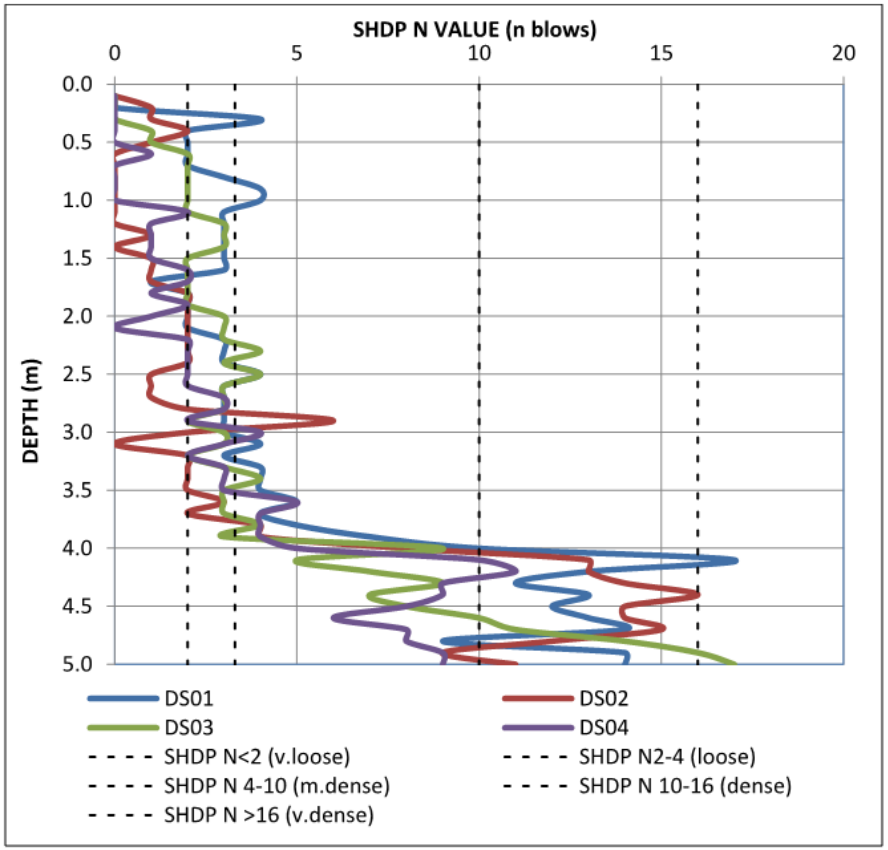
Suite	Definition
LS1	Screening suite: pH, fraction of organic carbon, Metals and Non Metals, water soluble Sulphate, Sulphide, total Cyanide, total Phenols, speciated PAH's.
Asbestos	Asbestos screen: Laboratory screening for fibres and Asbestos Containing Materials; identification where identified. Using polarising light and dispersion staining as described in HSG 248, HSE Contract Research Report No 83/1996and in Davies et al, 1996.
LS2	Waste Acceptance Criteria: Total Organic Carbon, Loss on Ignition, BTEX, speciated PCB's, Mineral Oil (EC10 – EC40), pH, Acid Neutralisation Capacity, speciated PAH's, 10:1 leachable Metals and Non Metals.

The results of geochemical analysis are discussed in section 14 to 18.

11 GEOTECHNICAL FIELD TESTING

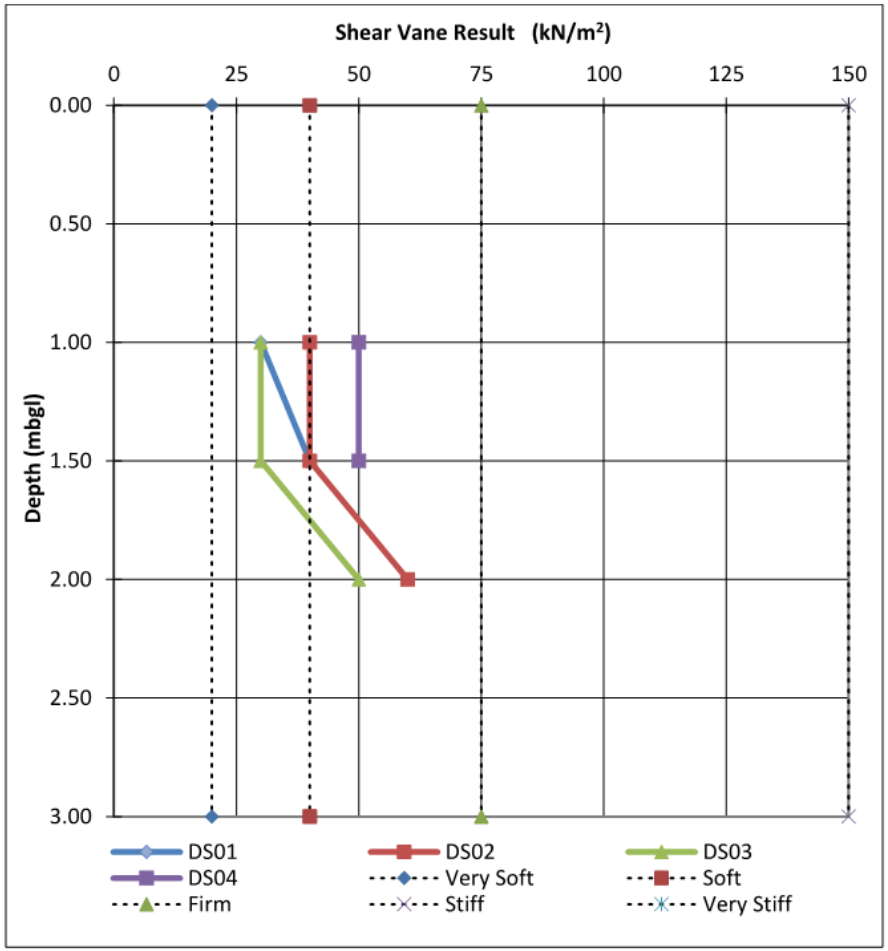
11.1 Dynamic probing (SHDP)

A super heavy dynamic probe (SHDP) was undertaken at to all positions. The test is used as a measure of the relative density of granular soils (as defined in BS5930:1999). The test provides limited data in cohesive soils but may be used to illustrate changes in consistency with depth. The test may be used in Chalk to assess the density grade. A typical range of results is summarised below.



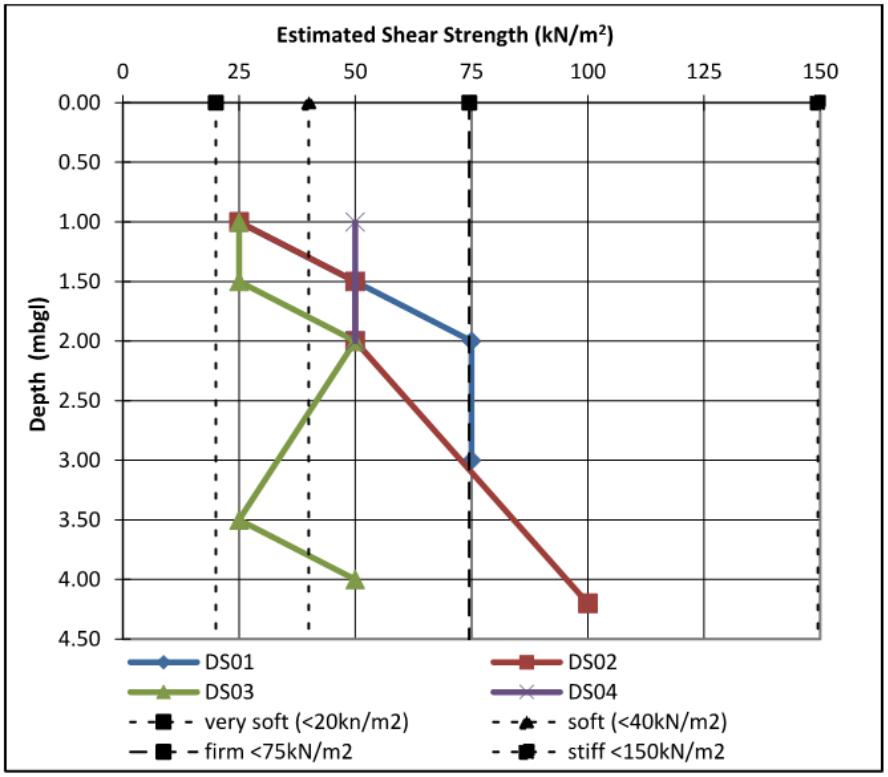
11.2 Shear Vanes

Laboratory shear vane tests were performed on samples of cohesive materials recovered within the boreholes. The test provides a direct estimate of undrained shear strength, and in turn may be used to give an indication of consistency as defined in BS5930. The results are summarised below. The maximum reading using this method is 120kN/m^2.



11.3 Penetrometers

Hand penetrometer tests were performed on samples of cohesive materials recovered within the boreholes. The test is used to approximate undrained shear strength and in turn has been used to give an indication of consistency as defined in BS5930. The results are summarised below. The maximum reading using this method is 4.5kg/cm^2 (225kN/m^2).



11.4 Soakage Testing

A falling head soakage test was undertaken in DS1. The water level fell 0.40m in 180mins, at a steady rate. The results gave preliminary infiltration rates in the order of 5.41x10^{-8}m/s.

12 GEOTECHNICAL LABORATORY TESTING

12.1 General

Samples of soil were sent for laboratory geotechnical testing; copies of the results are appended, and summaries are given in the following tables. The testing was undertaken in accordance with the relevant British Standards in BS1377 following documented quality procedures.

12.2 Particle Size Distribution

A single Particle Size Distribution test was performed on representative sample of more granular material from the River Terrace Deposits as summarised below.

Strata	% Clay/Silt	% Sand	% Gravel	% Cobbles
River Terrace Deposits	35.2	64.7	0.2	0.0

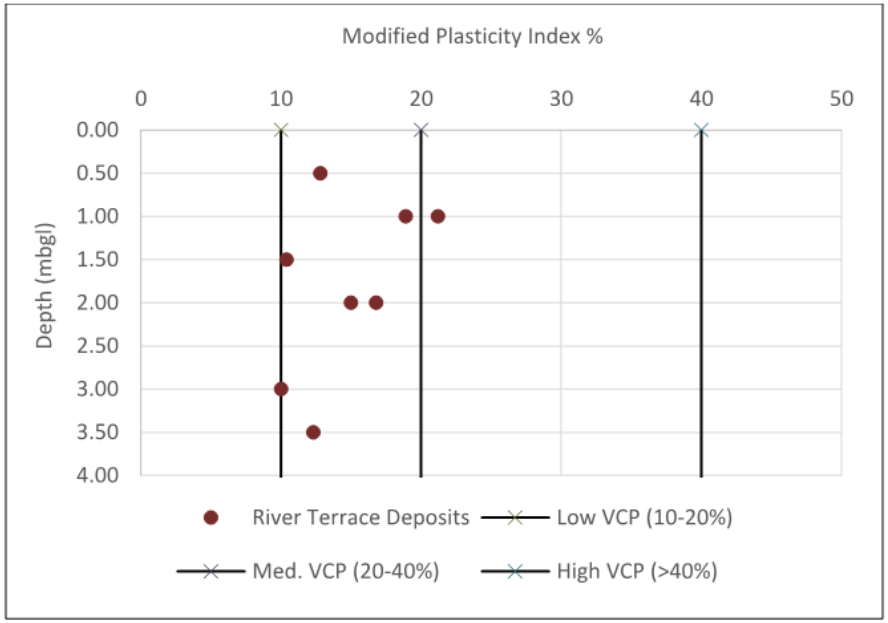
12.3 Plasticity Indexes (Atterberg Limits)

Atterberg Limit tests were undertaken on selected samples of cohesive soils, as summarised below.

Strata	No. of tests	Plasticity Index %		
		Minimum	Maximum	Average
River Terrace Deposits	8	10.9	22.1	15.5

A modified plasticity index (PI') was calculated following the NHBC methodology, to account for any non-shrinkable percentage not passing the 425µm sieve:

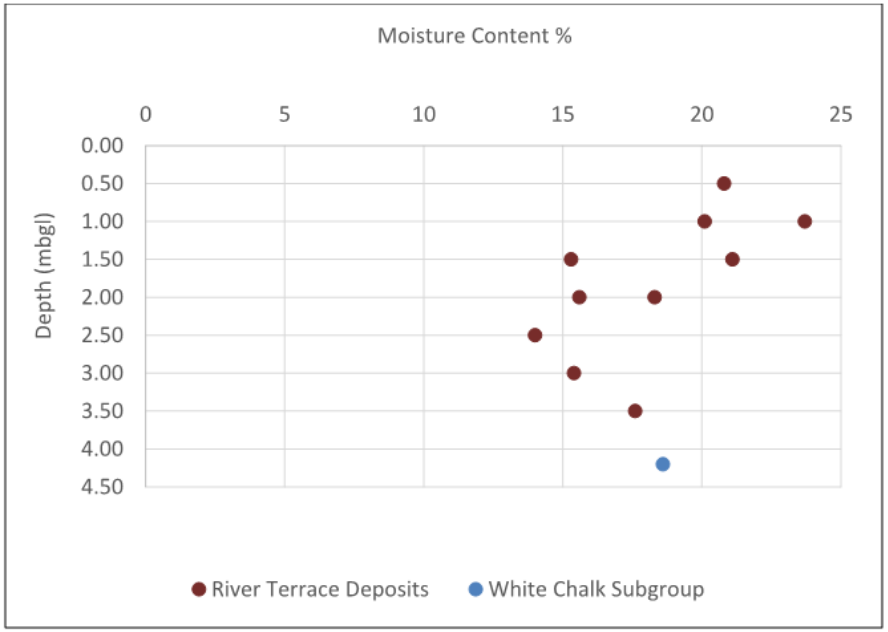
Strata	No. of tests	Modified Plasticity Index %		
		Minimum	Maximum	Average
River Terrace Deposits	8	10.0	21.2	14.7



12.4 Water Content

Water content determinations (formerly known as *moisture content*) were undertaken in combination with various classification tests, and the results are summarised below.

Strata	No. of tests	Moisture content %		
		Minimum	Maximum	Average
River Terrace Deposits	9	14.0	23.7	18.2
White Chalk Subgroup	1	18.6		



12.5 pH and Sulphate

Geochemical testing for water soluble Sulphate and pH were undertaken, and the results are summarised on the following table.

Strata	No. of tests	Water soluble Sulphate (SO_4 g/l)	pH (value)
River Terrace Deposits	4	0.0067 to 0.024	8.3 to 9.0

13 GEOTECHNICAL ASSESSMENT

The following recommendations have been made with respect to geotechnical design.

13.1 General Foundation Design

The proposed development was understood to comprise the construction of a replacement two-storey residential dwelling following the demolition of the existing property.

Shrinkable soils were identified, which may be susceptible to seasonal heave and shrinkage movements caused by changes in moisture content caused through the action of tree roots and rootlets.

Based on the ground and groundwater conditions encountered, it is considered that traditional strip foundations could be appropriate for the proposed development, albeit at a low bearing capacity due to variable ground conditions and soft clays within the River Terrace Deposits. The low bearing capacity could be mitigated by designing a raft.

Alternatively, consideration may be given to an alternative foundation solution, such as the use of piles. If such an option is chosen, a deeper hole circa 12-15m deep will need to be undertaken.

13.2 Volume Change Potential

Soil shrinkability has been assessed following the NHBC Standards Chapter 4.2 (January 2018 edition). It is recommended that the advice of this publication (or similar guidance) is taken when designing and constructing foundations in the zone of influence of trees and hedgerows that currently exist, are to be planted, or have recently been felled.

The average modified plasticity index result from the River Terrace Deposits was 14.7% with only one out of eight results exceeding 20%, as such the stratum is classified as susceptible to low volume change potential.

Strata	% passing 425µm sieve	Modified Plasticity Index	Shrinkability classification
River Terrace Deposits	-	10-20%	Low volume change potential

Specifications for heave precautions on low volume change susceptible soils are summarised below. In addition to the depths marked *, localised deepening of foundations will be required in the influence of trees; it will be necessary to evaluate tree species and height in relation to the proposed building footprints. If not already carried out, an arboricultural survey will be required.

Volume Change Potential		Low
Minimum depth for traditional foundations outside zone of influence of trees (m) *		0.75m
No tree planting zone required for minimum depth foundations above (m)		0.2 x mature tree height
Minimum depth for traditional foundations but allowing for restricted new planting (m) *		1.00m
Minimum void dimension	Against side of traditional foundations and ground beams etc.	0mm
	Beneath ground beam and suspended in-situ concrete ground floors etc.	50mm
	Beneath suspended precast concrete or timber floors etc.	200mm
Minimum allowance for potential ground movement for new drains		50mm

All foundations should extend below any major root zones or desiccated soil encountered, and trenches should be carefully inspected accordingly.

13.3 Traditional Shallow Foundations

The following recommendations are made where traditional foundations are to be used.

The primary design parameter for shallow foundations is maximum net allowable bearing pressure, which takes into account a tolerable degree of settlement, and is dependent not only on soil conditions but also the foundation dimensions, ground levels, sloping ground, and the symmetry of loading, amongst others.

All traditional shallow foundations should be taken through any Made Ground, soft or loose zones, disturbed soils, major root zones, or desiccated materials and taken wholly into or onto the firm clays of the River Terrace Deposits. The depth of foundations should be

limited to 1.50m in order to avoid foundations spanning between sandy clays and clayey sands.

Maximum net allowable bearing pressures have been calculated for a selection of example foundation dimensions as shown below. The calculations assume a level ground surface and broadly symmetrical loading. The values are rounded down in accordance with convention.

Depth (mbgl)	1.00m wide strip	Estimated Settlement
1.00	60kN/m²	21.9mm
1.50	70kN/m²	22.2mm

If a raft foundation option is to be used, the bearing pressures across the slab should be half that of strip footings. Where used in the design of a raft foundation, typical published values for the Modulus of Subgrade Reaction range be in the order of 8,200kN/m³ for the soft to firm clays.

In general terms, settlement will be broadly proportional to loading. Under no circumstances should a safe bearing pressure be exceeded (at which point there is a risk of shear failure).

Foundations should be subject to sensibly uniform loading, to minimise possible differential settlement.

Given the variability in engineering characteristics of the River Terrace Deposits at the anticipated formation level, it is recommended that all foundations are lightly reinforced to account for potential differential settlements.

The cohesive strata within the River Terrace Deposits will soften rapidly when exposed to free water. The final 50mm of any foundation trench should not be excavated until immediately before concreting, unless blinded or otherwise protected immediately after excavation.

13.4 Ground Floor Slabs

Given the presence of soils susceptible to volume change potential (i.e. shrinkable), it is recommended that all ground floor slabs should be fully suspended, with a suitable minimum void space.

Ground bearing floor slabs may be considered for other structures such as garages or outbuildings. The formation should be appropriately treated, and the design should allow potential future movements.

13.5 Excavations

The risks arising from excavation works should be properly assessed and appropriate safety precautions should be adopted. Reference may be made to various guidance including BS8000-1:1989, BS6031:2009 and CIRIA C97.

The likelihood of excavation instability through different strata has been assessed as summarised below. It should be noted that all open unsupported excavations have the potential to collapse.

Strata	Stability
Made Ground	Generally unstable. May be battered back to a safe angle. Deeper excavations may require trench support.
River Terrace Deposits (cohesive)	Generally stable in the short to medium term.

Excavations which are to remain open for prolonged periods will require trench support.

Water seepages may be encountered at shallow depth, particularly during wetter climatic conditions, and therefore some localised dewatering and trench support may be required.

It is considered that normal-rated plant and machinery will be sufficient for undertaking excavations. Breakers will be required for removing any former foundations, retaining walls etc. Care should be taken so as not to undermine existing structures, services, or adjacent property.

Adjacent excavations should generally be tackled in order of depth with the deepest first. Vehicles and spoil heaps etc. should not surcharge excavations, and edge protection and fencing should be used as appropriate. Frozen materials should generally not be used as backfill.

13.6 Pavements

The design of pavements will depend on the performance requirements and specification, as well as the ground conditions and finished levels etc. The suitability of shallow soils encountered as a formation level for pavements is summarised as follows:

Strata	Depth range	Suitability
Made Ground	0.10m to 0.60m	Only suitable for pavements with low performance requirements. A CBR value for these materials will not reflect the possible settlements that may occur. The materials will be frost susceptible so a minimum pavement thickness of up to 450mm will be required, and the formation will need to be adequately proof-rolled and treated.
River Terrace Deposits (cohesive)	>1.00m	These materials are generally a suitable formation level. Based on the Atterberg Limit test results in conjunction with the field observations, the formation will be frost susceptible. A minimum pavement thickness of up to 450mm should therefore be considered

The results of the in-situ CBR tests generally ranged between 3.6% and 4.3% on the Made Ground and between 7.4% and 20% on the River Terrace Deposits.

With reference to Transport Road Research Laboratory Report LR1132 "The Structural Design of Bituminous Roads", a CBR index of 6% is considered appropriate for cohesive River Terrace Deposits, assuming average construction conditions and a deep groundwater table.

CBR design values can be derived from a combination of in-situ and laboratory testing, as summarised below:

Strata	In-situ tests	Published values	Design CBR Value	Frost susceptible?
Made Ground	3.6% to 4.3%	N/A	4%	Yes
River Terrace Deposits	7.4% to 20%	6%	7%	No

The formation level should be carefully inspected, and any soft or loose zones should be removed and replaced with engineering fill, well-compacted in layers to a suitable specification. Consideration might be given to installing geotextiles. Cohesive formations will degrade rapidly if exposed to standing water for even short periods. All engineering fill should be granular and non-frost susceptible (i.e. <10% fine material passing 425µm sieve).

13.7 Building Materials

Based on BS8500-1:2015+A1:2016, the results of the Sulphate and pH analyses fell into Class DS-1 and an ACEC class AC-1 is deemed appropriate. The advice of this publication should be taken for the design and specification of all sub surface concrete.

13.8 Surface Water Drainage

A preliminary falling head soakage test was undertaken within the River Terrace Deposits at DS1. The results gave preliminary infiltration rates in the order of 5.41×10^{-8}m/s.

Given the low permeability of shallow soils, the use of soakaways will be marginal at this site. Consideration might be given other means of disposal such as discharge to surface water sewer.

14 HUMAN HEALTH SCREENING

14.1 Screening Values

Several different partly overlapping schemes are currently in use in the UK, based on the Environment Agency's CLEA Model but with differing toxicological parameters. For the purpose of this report these schemes have and have been applied in the following hierarchy:

- Suitable For Use levels (S4UL) recently published by LQM in association with the CIEH.
- Category 4 Screening Levels (C4SL) recently published by the DEFRA and CL:AIRE.

The soil chemical analysis results have been compared against respective screening values for residential with plant uptake land uses.

Whilst other standards exist, such as the LQM Generic Assessment Criterion and the Environment Agency's Soil Guideline Values, these are considered to have been superseded by the above publications.

For contaminants where the respective screening value is dependent on Soil Organic Matter (SOM), the corresponding value for 1.00% was used (the arithmetic mean SOM value for the soil was 0.93%).

Where no standard exists, the contaminant is either not considered a priority in terms of human health (at least in the scenario being considered), or no screening value has been published.

14.2 Screening results

In accordance with CL:AIRE *Guidance on Comparing Soil Contamination Data with a Critical Concentration*, the use of statistical tools was not considered appropriate in this instance. The results of the chemical analysis have therefore been compared directly against the respective standards.

None of the results exceeded the screening criteria.

14.3 Other Determinants

No elevated PAH's or heavy metals were noted above their generic assessment criteria. In addition, no TPH's or PCB's were noted.

14.4 Asbestos

A total of three samples of Made Ground were screened for the presence of Asbestos; no such traces were found.

15 BUILT ENVIRONMENT SCREENING

15.1 Soft Landscaping

A number of documents include guidance on screening levels of phytotoxic contaminants within soils, including:

- BS3882:2015 "Specification for topsoil and requirements for use" (although stipulated as not to be used in contaminated land risk assessment).
- ICRCL in publication 70/90 1990 'Notes on the Restoration and Aftercare of Metalliferous Mining Sites for Pasture and Grazing' (although indirectly withdrawn) (where marked *).

The results of the chemical analysis for determinands known to pose a potential phytotoxic risk to plant growth are summarised on the following table, together with the respective adopted screening values for plant growth. The results of the chemical analysis were evaluated singularly without the use of statistical tools.

Determinand	Phytotoxicity Value (mg/kg)			Results in excess of screening value
	pH <6.0	pH 6.0-7.0	pH >7.0	
Zinc	<200	<200	<300	None
Copper	<100	<135	<200	
Nickel	<60	<75	<110	
Cadmium *	50			
Arsenic *	1,000			

15.2 Structural Concrete

Recommendations with respect to Sulphate and buried concrete are made in section 13.7. It is noted that no onerous precautions in this respect are warranted.

15.3 Potable Water Supplies

The risk of chemical attack on water supply pipework has been assessed following the general Principals set out in the joint Water UK/HBF *Contaminated Land Assessment Guidance* dated January 2014. A summary of the main chemical criteria is reproduced below.

Test group (in mg/kg)	Polyethylene (PE)	Polyvinyl Chloride (PVC)	Metal or Aluminium Barrier
VOC's	0.5	0.125	Pass
VOC's + BTEX & MTBE	0.1	0.03	Pass
SVOC's (excl. PAH's etc.)	2.0	1.4	Pass
SVOC's + Phenols	2.0	0.4	Pass
SVOC's + Cresols & Chlorinated Phenols	2.0	0.04	Pass
Mineral oil EC11-20	10	Pass	Pass
Mineral oil EC21-40	500	Pass	Pass

16 CONTROLLED WATERS SCREENING

16.1 General

For a preliminary tier 1 risk assessment, the relevant analytical results have been compared directly against the standard set out in the water framework directive for surface waters, and the current UK potable water supply regulations.

16.2 Soil leachate screening

In comparison to the adopted surface water (coastal) standards, the following determinands exceeded the respective thresholds:

Determinand	WFD	Units	DS2 0.20m
Copper	0.0007	mg/l	0.013
Lead	0.001	mg/l	0.0022

In comparison to the adopted drinking water standards, none were found to exceed the respective standards.

17 CONTAMINATION RISK ASSESSMENT

17.1 End Users

The results of the chemical analysis did not indicate any elevated levels of contaminants within the Made Ground or natural soils. In addition, no asbestos was identified within three samples.

No remediation or further site investigation is considered necessary in this respect.

17.2 Adjacent Land Users

Surrounding land uses were identified to comprise residential land use, analogous with the proposed development on site. With reference to section 17.1, no significant risk was posed to human health from soil contamination. It is therefore concluded that the soils on this site pose no significant risk to surrounding land uses and no specific measures are required except for good site management.

17.3 Soft Landscaping

In addition, no evidence of potentially phytotoxic effects to existing soft landscaping was noted during the site walkover survey inspection.

Based on the above assessment in conjunction with field evidence from the site walkover survey, it is concluded that no risk was likely to be posed in this respect.

17.4 Concrete specification

Recommendations with respect to Sulphate and buried concrete are made in section 13.7. It is noted that no onerous precautions in this respect are warranted.

17.5 Potable Water Supplies

The concentrations of each determinand were below the respective threshold standards, and therefore any type of potable water supply pipework appears to be appropriate. It is recommended that the local water utility company is consulted to confirm this assessment. Ethers, nitrobenzene, ketones, aldehydes and amines were not suspected. Redox potential and Conductivity should be checked where metal pipework is to be installed. Aluminium barrier pipework is acceptable under all conditions. No pipework should be laid where there is evidence of free product.

17.6 Controlled Waters

Although the soil leachate test marginally exceeded the standards set for surface water (coastal), the WAC analysis met the requirements for Inert waste with no significant risk detected.

It was therefore concluded that groundwater chemical quality beneath the site had not been impacted by the site. Therefore, no remedial measures were considered necessary in this respect.

17.7 Conclusions

On the basis that no soils or groundwater contamination risks were identified, it was concluded that no remediation was necessary.

18 PRELIMINARY WASTE ASSESSMENT

18.1 General

Waste may be defined as any substance or object in Annex 1 of the Waste Framework Directive which the holder discards, intends to discard, or is required to discard. Subject to certain provisions, soils may either be handled as either:

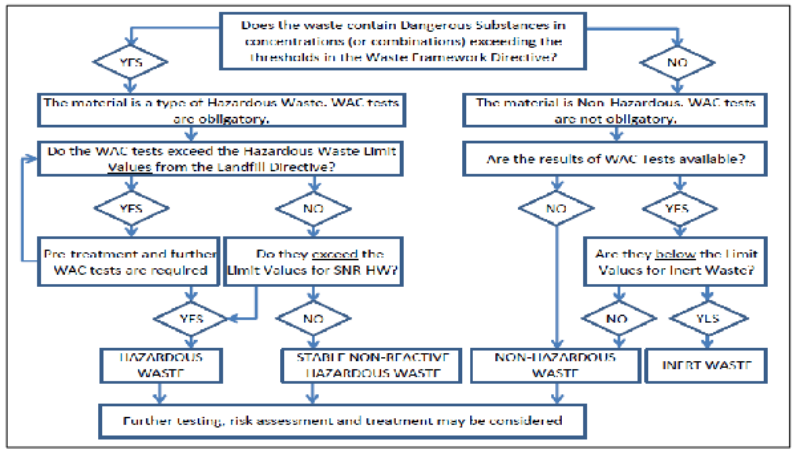
- Non-Waste, and re-used (on or off-site), or
- Waste, and disposed of (to a waste management facility).

Given the confines of the site, it was anticipated that all materials would be disposed of from site as waste.

The waste producer has a legal duty of care to ensure that waste materials are handled properly and sent to the appropriate licenced facility. Further inspection, testing, segregation etc will be required on site, and the advice of a suitably qualified consultant sought wherever necessary. Substantial tax penalties and fines are being levied by the regulators. The advice contained in this section is preliminary only.

18.2 Waste Disposal

Where materials are not re-used they must be handled as Waste, and must be sent to a licenced waste management facility. The classification of waste is prescribed under the Waste Framework Directive and the Landfill Directive, as summarised below. Different waste management facilities may also have specific acceptance criteria, and their advice should be sought.



The results of the soil analysis have been classified as follows:

Soil	Hazardous		Non Hazardous		Details
	Hazardous	Stable Non-Reactive	Non-Hazardous	Inert	
Made Ground DS2 0.20m				✓	The soil analysis was not identified as hazardous and the WAC test met the requirements for Inert.
Made Ground DS1 0.20m DS4 0.30m			✓	(✓)	Classified as Non-Hazardous. No WAC test undertaken. Likely to be inert given the WAC test on DS2 0.20m.
River Terrace Deposits DS3 0.30m					

With reference to the current List of Wastes (formerly European Waste Catalogue), waste soils and stone derived from construction and demolition sites may be disposed of under either of the following codes as appropriate:

Waste	Code	Description
Hazardous	17 05 03*	soil and stones containing dangerous substances
Non-Hazardous	17 05 04	soil and stones other than those mentioned in 17 05 03

(Note, the asterix is a Mirror Entry, as defined in the List of Wastes, conferring the relationship with the non-hazardous code 17-05-04).

19 SUMMARY AND CONCLUSIONS

This summary is a brief precis of the main findings and conclusions of the investigation. For detailed information, the reader is referred to the main report.

19.1 General

The intrusive investigation included 4no dynamic sampler boreholes, 4no super heavy dynamic probes, a falling head soakage test and in-situ CBR determinations. The site comprised a broadly rectangular shaped parcel of land containing residential dwelling to the centre and associated front driveway and rear garden.

19.2 Soils Encountered

A summary of the encountered conditions is presented below.

Strata	Depth	Summary
Made Ground	0.10m to 0.60m	Clayey gravelly sand with brick fragments with gravelly sand containing brick and concrete fragments beneath.
River Terrace Deposits	4.10m to 4.30m	sandy CLAY, and clayey SAND, with occasional fine to medium, subangular to subrounded flints, and rare chalk fragments within the lower clay stratum. No sands were encountered withinDS1 to 3.00m, or DS3 to 4.10mbgl
White Chalk Subgroup	4.70m+	Off -white low density structureless weak chalk with clay and sand pockets.

19.3 Groundwater

Groundwater was noted within DS2 only standing at a depth of 3.10mbgl. No other groundwater strikes were noted.

19.4 Foundations

Traditional foundations could be adopted, however bearing pressures are low on account of soft clays and variable ground conditions. Alternatively, a raft or piled foundation design could be considered. The River Terrace Deposits should be treated as being low volume change potential. All foundations should be lightly reinforced.

19.5 Excavations

The cohesive River Terrace Deposits are generally stable in the short to medium term, with the Made Ground considered as unstable.

19.6 Pavements

CBR value of 6% recommended for the River Terrace Deposits, which is classified as being frost susceptible non frost susceptible.

19.7 Building Materials

DS-1 and AC-1 in accordance with BS8500. Water supply pipe work will not require protection from aggressive soil contaminants.

19.8 Soakaways

Given the low infiltration rate, it is concluded that soakaways will perform unsatisfactorily.

19.9 Radon Protection

No issues with respect to Radon gas have been identified.

19.10 Soil Contamination

No issues with soil contamination have been identified.

19.11 Waste Disposal

The chemical results confirmed that the Made ground should be handled as Inert Waste for disposal purposes. It is likely that natural soils could also be handled as Inert Waste.

19.12 Further Action

If a pile design is required, a deeper borehole will need to be carried out. No other immediate requirements for further ground investigation have been identified. This report should be submitted to relevant planning and building control in good time for approval.

GLOSSARY OF TERMS

ACM	Asbestos Containing Material
BGS	British Geological Survey
BRE	Building Research Establishment
BS	British Standard
CBR	California Bearing Ratio
CDM	Construction Design and Management regulations
CIRIA	Construction Industry Research and Information Association
CL:AIRE	Contaminated Land: Applications in Real Environments
CLEA	Contaminated Land Exposure Assessment model
CoC	Chemical of Concern
CSM	Conceptual Site Model
EA	Environment Agency
EQS	Environmental Quality Standards
FOC	Fraction of Organic Carbon
GAC	Generic Assessment Criterion
mbgl	Meters Below Ground Level
NHBC	National House Building Council
mod	Metres above Ordnance Datum
PAH's	Polycyclic Aromatic Hydrocarbons
PCoC	Potential Contaminant of Concern
PBET	Physiological Based Extraction Testing
PHE	Public Health England
PID	Photo-Ionisation Detector
PQRA	Preliminary Quantitative Risk Assessment
PSD	Particle Size Distribution Test
RMS	Remediation Method Statement
SGV	Soil Guideline Value
SOM	Soil Organic Matter
SPZ	Source Protection Zone
SPT	Standard Penetration Test
SSSI	Sites of Special Scientific Interest
ST-WEL	Short Term Workplace Exposure Limit
SVOC's	Semi-Volatile Organic Compounds
TPH	Total Petroleum Hydrocarbons
TRRL	Transport Road Research Laboratory
TWA-WEL	Time Weighted Average Workplace Exposure Limit
UK HBF	United Kingdom House Building Federation
VOC's	Volatile Organic Compounds
WAC	Waste Acceptance Criteria

ACCOMPANYING NOTES – SOIL CONTAMINATION

LS1 routine screening suite

The LS1 suite is based broadly upon determinands listed within the former ICRCL guidance note 59/83 2nd edition 1987, CLR publication CLR8, and Environment Agency R&D66 publication. Stone and moisture content, fraction of organic carbon ('foc'), and pH value, are also undertaken. Total Sulphate is not a priority in terms of human health, so water soluble Sulphate is analysed instead to assess the risks to buried concrete.

Site Workers

Site managers are responsible for the safety of persons in their employ under a variety of instruments including the CDM regulations and Health & Safety at Work Act. In terms of working on contaminated sites, guidance can be sought from the CIRIA publication entitled "A Guide for Safe Working on Contaminated Sites". Any work in confined spaces confined spaces should only be carried out following appropriate risk assessment. Detailed risk assessment for workers is outside the scope of this report.

Discovery Strategy

Unexpected soil conditions may be encountered during the process of site demolition and construction. Examples may include oily pockets within the soil, pockets of cement boarding or fibrous materials within the soil, black ashy materials, soils exhibiting strong odours, brightly coloured materials, and former structures or brickwork.

Should previously undiscovered contamination be encountered during construction by the ground worker's, this should be reported to the Geo-Environmental Consultant immediately in order that any necessary inspection may be made. All site workers should be made aware of their responsibility to observe, report, and act on any potentially suspicious or contaminated materials they may encounter.

General

Contamination may be identified as the occurrence of a substance in or on the ground which has a potential to cause significant harm (humans, ecological systems, or property) or pollution of a controlled water.

Sources – Pathways – Receptors

Primary Source – the point at which contamination starts to occur e.g. a leaking tank

Secondary source – the media affected by contamination, including soil, groundwater and ground gases, as summarised below

Receptor – Persons, living organisms, ecological systems, controlled water, atmosphere, structures and property, and utilities.

Secondary source	Summary
Soil	Contaminants bound into or entrained with the soil matrix, for instance ashes, clinkers, bituminous materials, asbestos containing materials, etc. Also, soils may become contaminated by other activities, such as leaking chemical storage, drainage and the like, becoming bound into the soil mineralogy or organic matter. Soils may also generate soil-borne dusts and volatile organic compounds may generate organic vapours.
Volatile vapours	Many organic compounds are either volatile or semi volatile (at different temperatures and pressures) which mean they will volatilise and generate vapours. In an enclosed system, the ratio of vapours to other compartments will come into equilibrium, but in open systems the process may continue until the source has been depleted.
Ground gases	Organic matter, including wastes, hydrocarbons and other compounds, will decay through microbial action. This will primarily release Carbon Dioxide but may also release Methane under anaerobic conditions. This may be an issue in natural soils (e.g. alluvium and dock silt) in man-made soils (e.g. landfill sites and filled ground) and other environments (e.g. mine workings).
Groundwater	Contaminants may dissolve into pore water which in turn can percolate downwards into the groundwater table. Rapid discharge of fluids may also enter groundwater directly. Organic compounds may form separate light or dense non-aqueous phase liquids upon or at the base of the water column. Organic contaminants may generate organic vapours.