



Portsmouth City Council

Bunting Gardens, Waterloooville

Phase 2 Geo-environmental Factual and Interpretive Report

305258-R01 (01)

RSK GENERAL NOTES

Project No.: 305258 R01

Title: Phase 2 Geo-environmental Factual and Interpretive Report: Bunting Gardens, Waterlooville, PO8 9UW

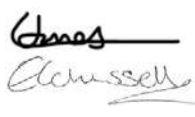
Client: Portsmouth City Council

Date: August 2022

Office: RSK Environment Limited, Chancery House, Premier Way, Abbey Park Industrial Estate, Romsey, SO51 9DQ

Status: Rev 01

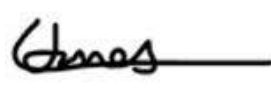
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Revision control sheet				
Revision ref.	Date	Reason for revision	Amended by:	Approved by:
Rev 01	Aug 22	Additional water-soluble sulphate test results included	CA	Georgina Donbroski 
Rev 00	Aug 22	First issue	n/a	see above

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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.

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EXECUTIVE SUMMARY

Commissioning and purpose of assessment	RSK Environment Limited (RSK) was commissioned by Portsmouth City Council to carry out a Phase 2 ground investigation of the land at Bunting Gardens, Waterlooville, PO8 9UW, grid reference 468608, 111717. The overall aim of the project was to assess land contamination sources and geotechnical constraints to the proposed development.
DESK-BASED ASSESSMENT	
Site description and proposed development	The site is currently occupied by grass covered communal landscaping between Bunting Gardens and Dove Close, with a footpath running through the centre from northeast to southeast. It occupies an area of 0.13 hectares and is being considered for development for residential use.
History of site and surrounding area	The site itself has remained largely undeveloped since the first available maps dated 1868. Evidence of the current footpath running from northeast to southeast through the centre of the site appeared in 1976 and has remained until the present day along with grassed landscaping. No potentially contaminative current activities have been identified in the surrounding area. Although, made ground may be present due to the multiple phases of surrounding residential development as well as infilled chalk and gravel pits within close proximity.
Geology and environmental setting	The site is underlain by head deposits overlying the Lambeth Group. Potential environmental receptors identified comprise: • Secondary (undifferentiated) aquifer relating to the superficial geology with the Head Deposits, • Secondary A Aquifer relating to the bedrock Lambeth Group; • Groundwater is estimated to between 19m to 30m bgl based off BGS hydrogeological mapping records.
Initial conceptual site model (CSM) and preliminary risk assessment (PRA)	Potentially complete contaminant linkages identified with a moderate / low or higher risk estimate include: • Future site users – residential users [oral, dermal and inhalation exposure with impacted soil, soil vapour and dust/fibres, ingestion of home-grown produce, inhalation of vapours from groundwater and/or NAPL if present] • Future site users – Public Open Space (POS) users [oral, dermal and inhalation exposure with impacted soil, soil vapour and dust, inhalation of vapours from groundwater and/or NAPL if present] Although the following linkages were considered to be low, it may be prudent to also investigate the following potential complete linkages to confirm their absence: • Potential risk to future vegetation from made ground on-site via root uptake leading to phytotoxicity • Potential risk to future buildings and services from made ground on-site via direct contact/chemical attack pathways. • Potential risk to future residents and future buildings from made ground on-site via migrations and ingress of ground gases into proposed buildings, build-up in confined spaces and explosion/asphyxiation.

INTRUSIVE INVESTIGATION & ASSESSMENT	
SI scope	The specific objectives of the investigation were as follows: • to establish the ground conditions underlying the site including the extent and thickness of any made ground; • to investigate specific potential sources of contamination identified in initial CSM; • to determine groundwater depth and flow direction, if possible; • to assess geotechnical properties of soils, including drainage and desiccation; and • to address data gaps identified in the initial CSM. 5no. window sample boreholes were drilled to a maximum depth of 5.00m bgl and five locations were installed with a combined gas and groundwater monitoring wells. 3no. trial pits were excavated to a maximum depth of 3.00m bgl with soil infiltration testing being undertaken in accordance with BRE365.
SI factual findings	The ground investigation confirmed the strata sequence onsite to be made ground and superficial Head Deposits of variable thickness over the Lambeth Group Formation. Groundwater was not encountered during the ground investigation or during a subsequent monitoring round.
Refined conceptual site model and geo-environmental assessment	Total organic concentrations (TOC) of the made ground were found to be <5% and as such the contaminant linkage for future site users / adjacent site users / buildings from gas migration and accumulation was eliminated with no further assessment required. Asbestos (ACM) was identified a fragment of ACM within 1No. made ground sample at exploratory location TP2. A quantification test of asbestos content within the fragment was carried out following the positive identification of amosite and chrysotile fibres. The quantification for bulk fibres was 18.249% w/w which is above the acceptable limit for human health of <0.001 % w/w.
Geotechnical assessment	The key findings of the initial geotechnical assessment are as follows: • Foundations should bear within the Head Deposits or cohesive Lambeth Group and be taken to a minimum depth of 1.00 m below the final or existing ground level, or at least 0.2m into the founding stratum below any overlying made ground, whichever is lower. • Owing to the variability of the founding strata, consideration should be given to incorporating appropriate reinforcement into the strip foundations to minimise the risk of future differential foundation movements. • A presumed bearing capacity of 100 kN/m² can be achieved at a founding depth of at least of 1.00 mbgl. Given the presence of desiccated soils, foundations may need to be locally deepened. It is recommended that foundation excavations are inspected by a geotechnical engineer to confirm suitable bearing soils at formation levels; • An ACEC Classification of AC-1 with a Design Sulphate Class of DS-1 can be utilised for foundations bearing within the head deposits only. If foundations are to extend into the underlying Lambeth Group, this classification should be increased to AC-3 with a Design Sulphate Class of DS-3; and, • The infiltration testing indicates that the ground conditions are not suitable for soakaways.

**Recommendations
including issues for
further assessment**

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

- It is recommended that extra trial pitting / SI work is carried out prior to development to confirm or rule out the presence of more asbestos. Alternatively, a watching brief could be put in place during the development phase to monitor the possible asbestos contamination.

The information given in this summary is necessarily incomplete and is provided for initial briefing purposes only. The summary must not be used as a substitute for the full text of the report.

1 INTRODUCTION

1.1 Commissioning

RSK Environment Limited (RSK) was commissioned by Portsmouth City Council to carry out a ground investigation at the land off Bunting Gardens, Waterloooville, PO8 9UW. The project was carried out to an agreed brief as set out in RSK's proposal (Ref. 305258 T01 (01) dated 31st May 2022).

This report revision includes additional sulphate attack laboratory test results and a summary of the results is presented in Section 7.6.

RSK's service constraints are shown in **Appendix A**.

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

1.2 Objectives

The objective of the work is:

- to identify any land contamination and/or geotechnical constraints to the proposed development and to support discharge of relevant planning conditions and relevant building control requirements; and,
- to identify the need for any additional investigation or remediation works to demonstrate that the site is suitable for its proposed use.

1.3 Scope of works

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

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

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

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

- design and implementation of an intrusive investigation, in situ testing, soil sampling, laboratory geo-environmental and geotechnical testing, groundwater monitoring of installed boreholes;
- interpretation of data to develop a refined conceptual site model (CSM);

- generic quantitative risk assessment (GQRA) of relevant contaminant linkages;
- interpretation of ground conditions and geotechnical data to provide preliminary recommendations with respect to foundations and infrastructure design;
- preliminary assessment of the potential waste classification; and,
- preparation of this factual and interpretative report.

1.4 Existing reports

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

- RSK, Phase 1 Desk Study, Ref. 305258 R01, dated May 2022

Pertinent information from these reports has been summarised in Section 2.5.

1.5 Limitations

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

Preliminary geotechnical recommendations are presented, and these should be verified in a Geotechnical Design Report once proposed construction and structural design proposals are confirmed.

2 SITE DETAILS

2.1 Site location

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

Table 1 Site location details

Site name	Bunting Gardens, Waterlooville
Full site address and PO8 9UW	Bunting Gardens, Wecock, Cowplain, Havant, Hampshire PO8 9UW
National Grid reference (centre of site)	468613, 111715

2.2 Site description

The Site boundary and current site layout are shown on **Figure 2**. The Site covers an area of c. 0.13 hectares. It is currently occupied by grass covered communal landscaping between Bunting Gardens and Dove Close with a footpath running through the centre from northeast to southeast.

2.3 Surrounding land uses

The site is located in Wecock, Cowplain, Havant, Hampshire, within a predominantly residential setting. Immediate surrounding land uses are described in **Table 2**.

Table 2 Surrounding land uses

North	Residential properties including apartments and double-storey houses.
East	
South	
West	

2.4 Development plans

The proposed layout of the site, at the time of preparing this report, is shown in **Figure 2**.

The site is to be developed with three double-storey properties with associated private gardens and parking.

2.5 Summary of previous reports

2.5.1 Desk-based assessment

The desktop study was undertaken by RSK (May 2022) and designed generally to meet the objectives of a preliminary (phase 1) investigation. A summary of the pertinent information from desk study is included below in Table 3.

Table 3 Summary of previous investigation reports

Report Details	Phase I Desk Study, RSK, May 2022
Site coverage	Whole site
Summary scope of works	A desk-based assessment comprising of a review of anticipated geology and hydrogeology, historic mapping and land uses, and potential pollution indicators. The review further detailed an environmental database, a data collection summary and a preliminary conceptual site model and risk assessment methodology.
Does the client have reliance upon the report?	Yes
Historic Development	The site itself has remained largely undeveloped since the first available maps dated 1868. Evidence of the current footpath running from northeast to southeast through the centre of the site appeared in 1976 and has remained until the present day along with grassed landscaping. No potentially contaminative current activities have been identified in the surrounding area. Although, made ground may be present due to the multiple phases of surrounding residential development as well as infilled chalk and gravel pits within close proximity.
Geology and hydrogeology	The site is underlain by Head Deposits overlying the Lambeth Group. Potential environmental receptors identified comprise: • Secondary (undifferentiated) aquifer relating to the superficial geology with the Head Deposits, • Secondary A Aquifer relating to the bedrock Lambeth Group; Groundwater is estimated to between 19m to 30m bgl based off BGS hydrogeological mapping records.
UXO	Medium UXO risk

Initial conceptual site model (CSM) and preliminary risk assessment (PRA)	Potentially complete contaminant linkages identified with a moderate / low or higher risk estimate include: • Future site users – residential users [oral, dermal and inhalation exposure with impacted soil, soil vapour and dust/fibres, ingestion of home-grown produce, inhalation of vapours from groundwater and/or NAPL if present] • Future site users – Public Open Space (POS) users [oral, dermal and inhalation exposure with impacted soil, soil vapour and dust, inhalation of vapours from groundwater and/or NAPL if present] Although the following linkages were considered to be low, it may be prudent to also investigate the following potential complete linkages to confirm their absence: • Potential risk to future vegetation from made ground on-site via root uptake leading to phytotoxicity • Potential risk to future buildings and services from made ground on-site via direct contact/chemical attack pathways. • Potential risk to future residents and future buildings from made ground on-site via migrations and ingress of ground gases into proposed buildings, build-up in confined spaces and explosion/asphyxiation.
Recommendation	The desk-study and preliminary conceptual site model indicated the development site to be a low/moderate risk of contamination and recommended an intrusive investigation be undertaken to quantify the risk.

3 SITE INVESTIGATION STRATEGY & METHODOLOGY

3.1 Introduction

RSK carried out intrusive investigation works on the 23rd and 24th June 2022 and the subsequent monitoring rounds were completed between 6th and 20th July 2022.

3.2 Objectives

The specific objectives of the investigation were as follows:

- to establish the ground conditions underlying the site including the extent and thickness of any made ground;
- to investigate potential sources of contamination identified in initial CSM;
- to determine groundwater depth and flow direction, if possible;
- to assess geotechnical properties of soils, including drainage; and,
- to address data gaps identified in the RSK Phase 1 report.

3.3 Selection of investigation methods

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

Window sample drilling was chosen based on the requirement for manoeuvrability around site, proposed drill depth of 4.00m - 5.00m bgl, requirement for in-situ geotechnical data, and installation of monitoring wells.

One day with a JCB and water tanker to excavate 2 trial pits for the purpose of infiltration testing generally in accordance with BRE 365.

Prior to conducting intrusive works, utility service plans were provided by the client. A service clearance was also scheduled to mark out any unmapped services and clear the proposed exploratory locations.

As the site was found to have medium risk for UXOs, UXO supervision was provided for both days of intrusive works. Additionally, a detailed UXO investigation report was issued to Portsmouth City Council under a separate cover.

3.4 Investigation strategy

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

The investigation strategy involved targeted boreholes and trial pits with locations selected by the client.

The constraints to the investigation were as follows:

- Due to large amounts of services located within and adjacent to the public footpath, no exploratory hole locations were able to take place within the proposed footprint of Plot C; and,
- Extremely compacted made ground material was encountered within the first 0.50m bgl from ground level during the hand pitting beneath the proposed garden of Plot B. It was decided to terminate WS3 and WS5 within the first metre in order to focus on the other proposed borehole locations to gain information on the deeper geology.

Exploratory hole locations were proposed to avoid known service locations and buried service clearance was undertaken in line with RSK's health and safety procedures. The locations were positioned within the proposed development, to obtain the most relevant data.

Details of the investigation locations, installations and rationale are presented in Table . 3No. machine excavated pits were dug to a maximum depth of 2.60m bgl to facilitate infiltration testing and 5No. window sample boreholes were drilled to a maximum depth of 4.00m – 5.00m bgl with 3no. boreholes installed with a combined gas and groundwater monitoring well complete with a flush cover. An exploratory hole location plan is shown on **Figure 3**.

Table 4 Exploratory hole and monitoring well location rationale

Investigation type	Number	Designation	Monitoring well installation	Rationale examples below
Boreholes by window sampling methods	5	WS1 to WS5	Gas/ groundwater	To determine the contamination and geotechnical status of the ground beneath the site and to install additional dual-purpose groundwater and gas monitoring wells.
Trial Pits excavated by JCB	3	TP1, TP2, and TP2a	n/a	To provide information on soil infiltration of the geology beneath the site.

3.4.1 Implementation of investigation works

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

The monitoring well construction and associated response zones are detailed on the exploratory hole records in **Appendix E**.

The soil sampling and analysis strategy was designed to characterise each encountered soil strata, to permit an assessment of the potential contaminant linkages identified and

investigate the geotechnical characteristics. In addition, samples were taken to allow for geo-environmental and geotechnical testing to be undertaken.

Soils collected for laboratory analysis were placed in a variety of containers appropriate to the anticipated testing suite required. They were dispatched to the laboratory in cool boxes under chain of custody documentation. Samples were stored in accordance with the RSK quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination.

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

3.4.2 Infiltration testing

Infiltration tests were carried out at 2No. locations in machine excavated pits to establish the infiltration rate of the ground encountered at c. 3.00m bgl as requested by the client. The tests were carried out in general accordance with the method described in BRE Digest 365 (BRE, 2016). This involved filling the pits with water from a bowser and recording the drop in water level with time as the water soaked into the ground.

Copies of the testing records are included in **Appendix F**.

3.5 Monitoring programme

A groundwater monitoring programme was completed for geotechnical analysis as well as to identify any contaminant linkages. Two rounds of groundwater level monitoring were completed following the completion of the intrusive ground investigation.

3.6 Laboratory testing

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

3.6.1 Chemical analysis of soil samples

The soil sampling strategy was designed to characterise made ground and/or natural strata typically within the upper 1.0 m of the ground profile whilst also characterising deeper strata and the potential for contaminant migration from relevant sources identified within the preliminary CSM.

The programme of chemical tests undertaken on soil samples obtained from the intrusive investigation is presented in

Table with the laboratory testing results contained in **Appendix G**.

Table 5 Summary of chemical testing of soil samples

Stratum	Tests undertaken	No. of tests
Made ground	Asbestos screening and ID	3

	Speciated PAH-16MS, TPHCWG (spec.TPH), pH, As, Cd, Cr, hexavalent Cr, Cu, Hg, Pb, Ni, Se, Zn, Total Sulphate, ws Sulphate	4
	TOC	2
	Chromium VI	4
	Bulk Asbestos ID	1
Head deposits	Speciated PAH-16MS, TPHCWG (spec.TPH), pH, As, Cd, Cr, hexavalent Cr, Cu, Hg, Pb, Ni, Se, Zn, Total Sulphate, ws Sulphate	2
	Chromium VI	2

3.6.2 Geotechnical analysis of soils

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

Where appropriate, testing was undertaken in accordance with BS 1377:1990 Method of Tests for Soils for Civil Engineering Purposes or, where superseded, by the relevant part of BS EN ISO 17892:2014 Geotechnical investigation and testing - Laboratory Testing of Soil.

Tests carried out in order to classify the concrete class required on-site have been undertaken following the procedures within BRE SD1:2005.

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

Table 6 Summary of geotechnical testing undertaken

Strata	Tests undertaken	No. of tests
Head deposits	Atterberg Limits	9
	PSD	3
	Moisture Content	19
	BRE Suite D	5
Lambeth group	Atterberg Limits	3
	Moisture Content	17

4 SITE INVESTIGATION FACTUAL FINDINGS

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

4.1 Ground conditions encountered

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

Photographs of the ground encountered within the exploratory hole locations are presented on the photo-plates presented in **Appendix C**.

The exploratory holes revealed that the site is underlain by a variable thickness of made ground over superficial head deposits with the Lambeth Group Formation encountered at depth. This generally confirms the stratigraphical succession described within the preliminary CSM. For the purpose of discussion, the ground conditions encountered during the fieldworks are summarised in Table with the strata discussed in subsequent subsections.

Table 7 General succession of strata encountered

Stratum	Exploratory holes encountered	Minimum depth to top of stratum (m bgl)	Proven thickness (m)
Topsoil	All	GL	0.10 – 0.20
Made ground (including reworked natural)	All	0.10	0.30 - 0.90
Head deposits	WS1, WS2, WS4, TP1 and TP2a	0.40	1.45 - 2.40
Lambeth Group	WS1, WS2, WS4 and TP2a	1.95	0.65 - 2.00*
Note: * Depth to base of stratum / total thickness not proven			

4.1.1 Topsoil

Topsoil was encountered across all locations and comprised a dark brown slightly clayey fine to coarse sand with rare subangular to subrounded flint fine gravels and frequent rootlets.

No in-situ and physical geotechnical laboratory testing was undertaken on this stratum.

4.1.2 Made ground

Made ground was encountered beneath the topsoil across all exploratory locations. The composition of the made ground varied at each of the locations but generally consisted of a brown slightly clayey gravelly fine to coarse sand with moderate high cobble content. The gravel is angular to subrounded fine to coarse flint. Cobbles are subangular to subrounded flint.

The anthropogenic materials recorded comprised plastics, brick fragments and chalk fragments. At location TP2, a potential fragment of asbestos tile board was identified at 0.30m bgl. Made ground comprised a reworked natural/fill material stratum, possibly associated with historic landfill and construction debris.

No in-situ and physical geotechnical laboratory testing was undertaken on this stratum.

4.1.3 Head deposits

This stratum was encountered beneath the made ground within all the exploratory locations and predominantly comprised a cohesive clay stratum ranging between 1.45m and 2.40m in thickness where encountered.

The cohesive head deposits were generally encountered as a dark orangish brown slightly sandy gravelly clay with moderate cobble content, with gravel and sand proportions locally varying at depth. Sand is generally fine to medium but shows variation across the site. Gravel is subangular to subrounded fine to coarse flint. Cobbles are subangular to subrounded flint.

A summary of the in-situ and laboratory test results recorded in the stratum is presented in Table below.

Table 8 Summary of in-situ and laboratory test results for head deposits

Soil parameters		Min. Value	Max. Value	Reference
Grading (%)	Gravel	1.8	46	Appendix H
	Sand	17.5	21.6	
	Silt	27.1	39.7	
	Clay	9.4	37.7	
Moisture content (%)		13.1	24.6	
Modified moisture content (%)		16.5	28	
Liquid limit (%)		33	52	
Plasticity term		Low	High	
Plasticity limit (%)		13	22	-
Plasticity index (%)		19	44	
Modified plasticity index (%)		8.33	44	-
Volume change potential		Low	High	-
SPT 'N' values		8	21	Appendix E

Soil parameters	Min. Value	Max. Value	Reference
Undrained shear strength inferred from SPT 'N' values (kN/m ²)*	36	94.5	-
* derived using a Stroud Factor of 4.5			

4.1.4 Lambeth Group Formation (bedrock)

This stratum was encountered at a depth of between 1.95m and 3.00m bgl and the proven thickness varies between 0.65m and 2.00m (the total depth of this stratum was not proven). It was predominantly recorded as a soft orangish brown mottled grey or red sandy clay with rare subangular to subrounded fine flint gravel. Sand is generally fine.

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

Based on the site descriptions, laboratory, and in-situ tests carried out this layer can be described as a stiff to very stiff cohesive soil, with in-situ SPT testing resulting in SPT refusal at 4.60m bgl at WS2.

Table 9 Summary of in-situ and laboratory test results for the Lambeth Group deposits

Soil parameters	Min. Value	Max. Value	Reference
Moisture content (%)	10.7	16.6	Appendix H
Modified moisture content (%)	16	22.5	
Liquid limit (%)	35	39	
Plasticity term	Intermediate		
Plasticity limit (%)	16	18	
Plasticity index (%)	19	27	
Modified plasticity index (%)	9.45	17.48	-
Volume change potential	Low		-
SPT 'N' values	11	54	Appendix E
Undrained shear strength inferred from SPT 'N' values (kN/m²)*	49.5	243	-
Undrained shear strength measured by shear vane testing (kN/m²)	45	76	Appendix E
Undrained strength classification based on shear vane testing	Low	Medium	-
* derived using a Stroud Factor of 4.5			

4.1.5 Visual/olfactory evidence of soil contamination

Potential asbestos tiles were identified within TP2 at a depth of 0.30m bgl. A sample was subsequently collected and tested for asbestos ID.

Soil PID testing recorded levels of between 0 – 0.1 ppm.

No other visual or olfactory evidence of contamination was encountered.

4.2 Groundwater

4.2.1 Groundwater encountered during intrusive works

Groundwater was not encountered during the intrusive investigation works.

4.2.2 Groundwater encountered during monitoring

2No. rounds of groundwater monitoring were completed on the 6th and 20th July 2022. At both visits all monitoring wells were noted to be dry.

4.3 Chemical laboratory results

The soil testing results are presented in **Appendix G**.

Asbestos in the form of amosite and chrysotile board and cement were identified in TP2 within the made ground encountered from 0.30m bgl. Subsequent quantification was completed, with an asbestos quantification of 18.249 % w/w.

4.4 Geotechnical laboratory results

The results of the geotechnical testing are discussed in Section 7 and presented in **Appendix H**.

5 GEO-ENVIRONMENTAL ASSESSMENT

5.1 Refinement of initial CSM

The ground investigation confirmed the localised presence of shallow made ground soil in all exploratory hole locations across the site. This made ground was between 0.25m – 0.90m in thickness and was consistent in composition across each location. The laboratory testing confirmed the made ground to be of low organic content (maximum 0.77% TOC). It contained a range of anthropogenic material comprising brick, concrete and plastics. Pollutant linkages associated with water supply pipes and future users/adjacent site users through oral, dermal and inhalation exposure with impacted soil, soil vapour and dust/fibres require further assessment.

With limited made ground soil and low organic content (<5%), the risk to future site users / adjacent site users / and buildings from migration and accumulation from gases associated from the made ground is considered unlikely.

In addition to the recorded made ground over the head deposits, a localised pocket of asbestos containing material (ACM) was identified in exploratory location TP2. One fragment was collected for laboratory analysis. The lab results have confirmed that the suspected material is asbestos board and cement, containing amosite and chrysotile. A quantification was additionally requested following the positive identification of ACM. Therefore, this linkage cannot be discounted at this stage and has been further assessed in Section 5.2.

5.1.1 Linkages eliminated after refinement of the initial CSM

Based on the discussion above, the following potential contaminant linkages have been eliminated after refinement of the initial CSM (CSM):

- future users (residents) / adjacent site users / buildings - migration and accumulation of gases from potential made ground on site.

5.2 Linkages for assessment

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

Following the refinement of the CSM, the potentially complete contaminant linkages that require further assessment and the methodology of assessment are presented in Table 11.

Table 11 Linkages for GQRA

Potentially relevant contaminant linkage	Assessment method
Human health and phytotoxic-related linkages	
H1. Oral, dermal and inhalation exposure with impacted soil, soil vapour and dust by future residents	Human health GAC in Appendix I for a proposed residential end use without home-grown produce since the proposed end use includes only residential / public use small gardens.
H2. Inhalation exposure of future residents / ground workers to asbestos fibres	Qualitative assessment based on the asbestos minerals present, their form, concentration, location and the nature of the proposed development.
H3. Uptake of contaminants by vegetation potentially impacting plant growth (phytotoxicity)	Comparison of soil data to GAC in Appendix J for phytotoxicity.
H4. Organic contaminants permeating potable water supply pipes	Comparison of soil data to GAC in Appendix K for plastic water supply pipes using UKWIR (2010) guidance.

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

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

A soil organic matter (SOM) of 1% has been selected since laboratory results within the soils range from 0.59 % and 1.33%. The soil screening output spreadsheet is presented as **Appendix L**.

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

The soil analytical screening of samples collected by RSK indicates that no samples exceeded their respective GAC.

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

There was visible confirmation of ACM at exploratory location TP2 within the made ground, in the form of a single fragment of tile. The sample taken of this material at 0.30m – 0.40m bgl identified amosite and chrysotile bulk asbestos fibres. Subsequent quantification testing was completed, with an asbestos quantification of 18.249 % w/w within the fragment of tile, which is above the acceptable limit for human health of <0.001

% w/w. As asbestos was identified, qualitative assessment based on the asbestos minerals present, their form, concentration, location and the nature of the proposed development is required.

There may be potential for asbestos to be found elsewhere within the made ground, thus asbestos contamination across the entirety of the site cannot be ruled out. It is recommended that further SI work is carried out targeting asbestos contamination within the made ground. Alternatively, a watching brief could be utilised across the duration of the proposed works.

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

The results have been compared with the GAC presented in **Appendix J** for this linkage. The results indicate that a relevant contaminant linkage is unlikely to exist associated with phytotoxic effects. The soil screening output spreadsheet for this linkage is presented in **Appendix L**.

5.3.4 H4. Organic contaminants permeating potable water supply pipes

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

The results indicate that a relevant linkage is unlikely to exist associated with organic contaminants and pollutants for polyvinyl chloride (PVC) water supply pipes and as such are expected to be suitable for use on the development.

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

5.4 Uncertainties and implications in refined CSM and GQRA

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

Table 12 Data gaps and uncertainties

Data gap/ uncertainty	Details	Implications
Asbestos in the made ground.	ACM was identified within the made ground in TP2. Several tiles found displayed visual evidence of asbestos fibres within the material. Laboratory testing confirmed that it was amosite and chrysotile board and cement with an asbestos quantification of 18.249 % w/w.	Despite the asbestos in made ground only being visually identified within ACM at exploratory location TP2, vigilance should be maintained for any potential additional ACM, fibrous material or loose fibres during ground works.

6 PRELIMINARY WASTE ASSESSMENT

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

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

Please note that this preliminary waste assessment relates to made ground only.

6.1 Hazardous waste assessment

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

6.1.1 Chemical contaminants

EnviroLab, an RSK company, has developed a waste soils characterisation assessment tool (HASWASTE), which follows Technical Guidance WM3. The analytical results have been assessed using this tool for potential off-site disposal of materials in the future. The results are presented in **Appendix M**.

6.1.2 Asbestos within waste soils

Technical Guidance WM3 requires that within a mixed waste, the separately identifiable wastes be assessed separately.

For instance, where waste soil contains identifiable pieces of asbestos (visible to the naked eye) the asbestos should, where feasible, be separated from the soil and classified separately. This should be disposed of within a hazardous, stable non-reactive hazardous waste landfill or a special cell in a non-hazardous waste landfill.

Samples of potential asbestos-containing material were collected from site and analysed for the presence of asbestos, the results of which are presented in Appendix G. Analysis confirmed that asbestos is present within sample TP2 at 0.30m bgl comprising of amosite and chrysotile board and cement. Analysis confirmed that the percentage of asbestos fibres is 18.249 % w/w and therefore the waste should be disposed of within a hazardous waste landfill.

It should be noted that irrespective of the classification of the waste, landfill site-specific conditions could further restrict the types of wastes that sites can accept.

7 GEOTECHNICAL ASSESSMENT

7.1 Proposed development

The site's proposed development includes three, two-storey terrace houses, all of which include a rear garden.

At this stage no specific information relating to building loads has been provided and therefore a wall loading of 100 kN/m has been considered. It has been assumed the ground-bearing floor slabs will not be required, and that beam and block flooring will be utilised.

7.2 Key geotechnical hazards / development constraints

The key risks identified from the available ground investigation data are discussed below:

- ***Shrinkable clay soils.***

The investigation encountered cohesive Head deposits, with low to high volume change potential and cohesive Lambeth Group with low volume change potential.

- ***Silt-rich soils susceptible to rapid loss of strength in wet conditions.***

The cohesive portion of the Head Deposits and the Lambeth Group with silt content generally variable.

7.3 Foundations

7.3.1 Foundation options

Beneath the thickness of topsoil / made ground the ground conditions beneath the site comprise initially soft, becoming firm and stiff with depth, locally slightly gravelly sandy clay (Head Deposits) with the Lambeth Group at depths from below 2.00m bgl.

The tentative Driscoll desiccation criteria indicates slight desiccation of the clays at 1.0m and 1.4m depth in TP2a. A comparison of moisture content with depth across the site indicates the potential presence of desiccation at 1.80 m bgl in TP2a, 2.50 m bgl in WS1 and 1.60 m bgl in WS2. No indication of desiccation or the onset of desiccation was indicated at TP1 or WS4. No visual evidence of desiccation was observed during the fieldwork at these locations and the indication of desiccation at the above locations may be attributable to the presence of sandy horizons in the Head Deposits, however TP2a and WS1 are located in the vicinity of existing trees and a precautionary approach is recommended. This assessment is limited to the number of samples in the dataset.

NHBC guidance should be followed for the design of new foundations near trees.

Based on the above, traditional spread foundations are considered suitable for the proposed development. However, these foundations need to be taken fully within the firm clays and below any desiccated soils, which may require locally deeper foundations, below 2.50m bgl.

7.3.2 Spread foundations

The recommendations for the design and construction of spread foundations in relation to the ground conditions are set out in Table 13

Table 13 Design and construction of spread foundations

Design/construction considerations	Design/construction recommendations
Founding stratum	Head deposits/Lambeth Group
Depth	Foundations should be taken to a minimum depth of 1.00m below the final or existing ground level, or at least 0.2m into the founding stratum below any overlying made ground, whichever is lower, to any greater depth required in respect of the special design considerations given below.
Special design considerations	
Variable founding soils	Owing to the variability of the founding strata, consideration should be given to incorporating appropriate reinforcement into the strip foundations to minimise the risk of future differential foundation movements.
Shrinkable soils	Owing to the presence of shrinkable clay soils, foundations should be designed taking into account all the normal precautions, including minimum founding depths, to minimise the risk of future foundation movements in accordance with NHBC standards or similar. The findings of the ground investigation indicate that foundations should be designed for shrinkable soils of high-volume change potential.
Presumed bearing capacity	Strip foundations with a width of up to 1.0m, extending through granular soils and constructed on the cohesive Head Deposits or Lambeth Group Formation at a minimum depth of 1.0 m may be designed using a presumed bearing capacity of 100 kN/m ² . The presumed bearing capacity includes a partial factor on bearing resistance of 3 (cohesive soils) against bearing capacity failure. Total settlements associated with the presumed bearing pressure are anticipated to be less than 25 mm.
Construction considerations	All foundation excavations should be inspected, and any made ground and soft, organic or otherwise unsuitable materials removed and replaced with mass concrete. The proposed founding stratum is a clay-rich soil with dissolution potential hence susceptible to rapid softening once exposed. Hence all foundation excavations should immediately be blinded with concrete, or the full foundation constructed.

7.3.3 Piled foundations

Piled foundations are not considered to be required as part of the proposed development. Should changes be made to the proposed development, the foundation options should be reviewed to ensure the most suitable foundation options is adopted.

7.3.4 Foundation works risk assessment

It is anticipated that a foundation works risk assessment report will not be required for the development because:

- the type of foundation proposed does not have the potential to create preferential pathways for migration of ground gas to surface or groundwater to depth
- there are no identified ground gas sources present at depth that could be affected by the type of foundation proposed.

7.3.5 Floor slabs

The soils encountered during the investigation showed signs of being desiccated. Therefore, it is recommended that ground floor slabs should be suspended. Alternatively, an appropriate depth of the desiccated material could be removed from site and replaced with well – compacted, suitable granular fill.

7.4 Roads and hardstanding

In the 1 m to 1.5 m below the proposed finished ground level, the exploratory holes have revealed a soil profile generally comprising made ground overlying cohesive head deposits overlying the Lambeth Group.

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

The estimated minimum, equilibrium soil-suction, California bearing ratio (CBR) value for the soils and groundwater conditions described above under a completed pavement where granular soils are encountered is 2 - 4%, based upon Table C1 in TRRL (1984) Report LR1132.

7.5 Excavations for foundations and services

The trial pits remained stable during excavation which indicates that foundation excavations should also remain stable in the short term. In the event that excavations are to remain open for longer periods, consideration should be given to the use of trench support systems.

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

7.6 Chemical attack on buried concrete

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

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

Based on geotechnical laboratory results, Table 14 gives the characteristic pH, water-soluble and total sulphate content values for soils from each of the geological units encountered on-site.

Table 14 Characteristic pH, water soluble sulphate and total sulphate values

Stratum	pH	Water Soluble Sulphate (g/l)	Total Acid Soluble Sulphate (%)	Total Potential Sulphate (%)
Head Deposits	8.3 - 8.6	<0.010	<0.010 – 0.018	0.03 – 0.039
Lambeth Group	8.4 - 8.6	<0.010	<0.010 – 0.051	0.099 – 1.11

Based on the results above and following the steps outlined in the BRE guidance, the Design Sulphate Classes and Aggressive Chemical Environment for Concrete classifications are summarised in Table 15, on the basis of pH with water-soluble sulphate and total potential sulphate, respectively and assumes mobile groundwater conditions and using Table C2 of the BRE (2005) guidance.

Table 15 Concrete design class

Stratum	Groundwater	Water Soluble Sulphate		Total Potential Sulphate	
		DS Class	AC Class	DS Class	AC Class
Head Deposits	Mobile	DS-1	AC-1	DS-1	AC-1
Lambeth Group	Mobile	DS-1	AC-1	DS-3	AC-3

The recommended ACEC Classification for foundations extending into the Head Deposits only is therefore AC-1 with a Design Sulphate Class of DS-1. If foundations are to extend into the underlying Lambeth Group, this classification should be increased to AC-3 with a Design Sulphate Class of DS-3.

7.7 Infiltration drainage

The results of soakaway testing are summarised in Table 16.

Copies of the testing records are included in **Appendix F**.

Table 16 Infiltration test results

Trial pit	Geological unit	Test result (m/s)
TP1	Head Deposit	3.65×10^{-6}
TP2A	Lambeth Group	5.15×10^{-7}
Notes: ¹ Both tests did not drain 75-25%, extrapolated results reported should be used with caution.		

Based upon the results of the infiltration tests presented above, the ground conditions do not appear suitable from a geotechnical viewpoint for the use of pit soakaways to discharge surface run-off water into the underlying Lambeth Group.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Geo-environmental assessment

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

- Inhalation exposure of future residents / ground workers to asbestos fibres

[asbestos identified in made ground at TP2, and quantified to be 18.249 % w/w]

The confirmation of asbestos in TP2 should be treated with concern. Laboratory results have confirmed the presence of chrysotile/amosite fibres (ACM). Although asbestos (ACM) was only observed in TP2, additional asbestos contamination cannot be ruled out across the remainder of the made ground on-site. It is recommended that extra trial pitting / SI work is carried out prior to development to confirm or rule out the presence of more asbestos. Alternatively, a watching brief could be put in place during the development phase to monitor the possible asbestos contamination.

All other relevant contaminant linkages are absent based on the data available.

8.2 Geotechnical assessment

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

- Foundations should bear within the Head Deposits or Lambeth Group and be taken to a minimum depth of 1.00 m below the final or existing ground level, or at least 0.2m into the founding stratum below any overlying made ground, whichever is lower.
- Owing to the variability of the founding strata, consideration should be given to incorporating appropriate reinforcement into the strip foundations to minimise the risk of future differential foundation movements.
- A presumed bearing capacity of 100 kN/m² can be achieved at a founding depth of at least 1.00 m bgl. Given the potential presence of desiccated soils, foundations may need to be locally deepened. It is recommended that foundation excavations are inspected by a geotechnical engineer to confirm suitable bearing soils at formation levels;
- An ACEC Classification of AC-1 with a Design Sulphate Class of DS-1 can be utilised for foundations bearing within the Head Deposits only. If foundations are to extend into the underlying Lambeth Group, this classification should be increased to AC-3 with a Design Sulphate Class of DS-3.
- The infiltration testing indicates that the ground conditions are not suitable for soakaways.

8.3 Recommendations

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

- It is recommended that extra trial pitting / SI work is carried out prior to development to confirm or rule out the presence of more asbestos. Alternatively, a watching brief could be put in place during the development phase to monitor the possible asbestos contamination.

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July 2022

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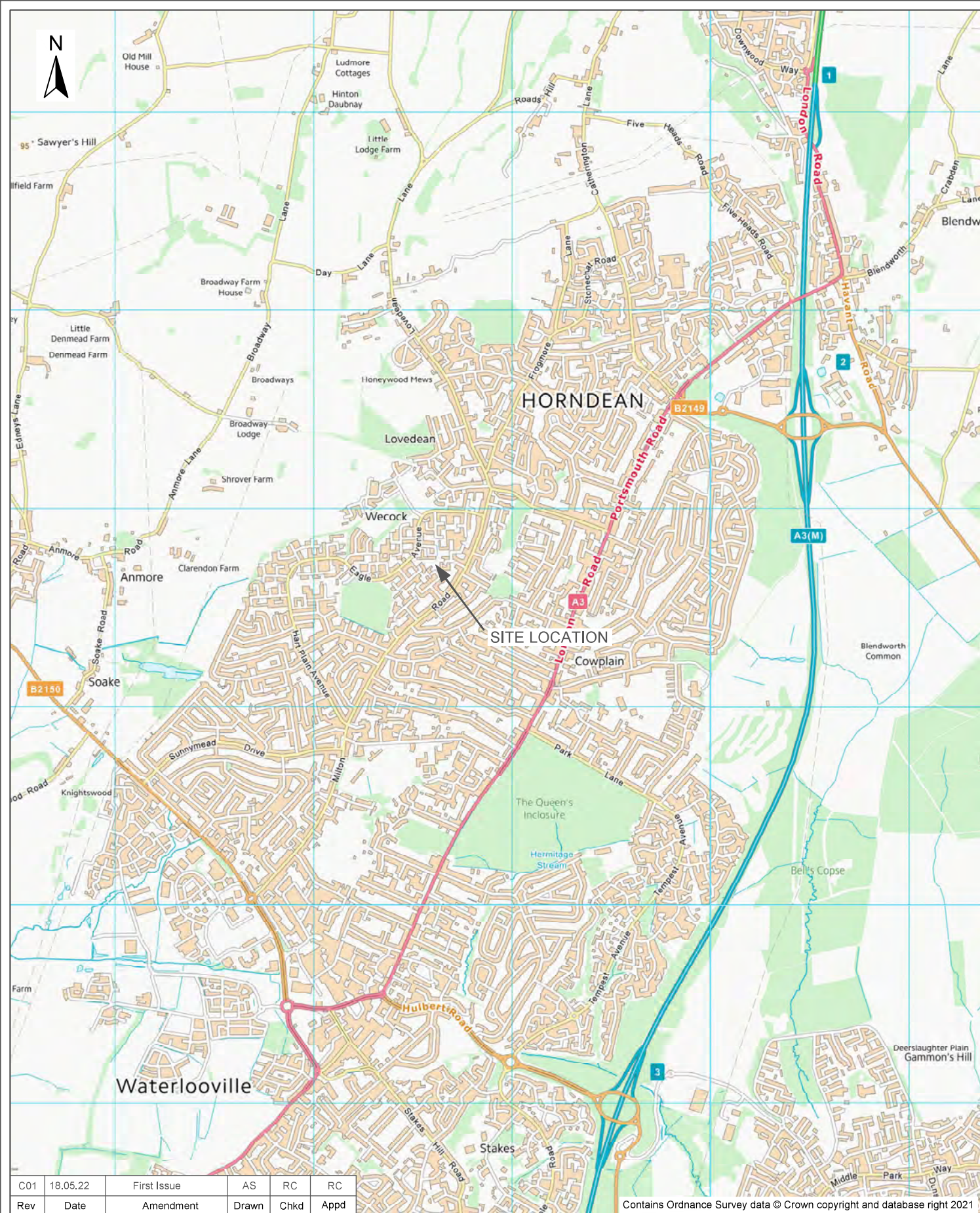
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FIGURES

FIGURE 1 SITE LOCATION PLAN



C01	18.05.22	First Issue	AS	RC	RC
Rev	Date	Amendment	Drawn	Chkd	Appd

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Client
Portsmouth County Council

Project Name
Bunting Gardens, Waterloooville

Description
Site Location Plan

Dimension m	Size A4	Scale 1:25,000	Geolocation 468613, 111717	Project ID 305258	Drawing no. 11101	Rev C01	File name 305258-ST-111-SS-D-C-11101-C01
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FIGURE 2 SITE DEVELOPMENT PLAN



LEGEND

— Site boundary

Notes:

Base plan provided by the client No.Ref: 2637-1200-P2 .

C01	01.08.22	First Issue	AS	JL	JL
Rev	Date	Amendment	Drawn	Chkd	Appd



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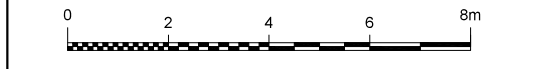
Client Portsmouth City Council		
Project Name Bunting Gardens, Waterlooille		
Description Site Development Plan		
Project ID 305258	Drawing no. 34201	Revision C01
File name 305258-ST-324-SS-D-C-32401-C01		
Dimensions m	Scale 1:150	Size A3
		

FIGURE 3 EXPLORATORY HOLE LOCATION PLAN



LEGEND

- Site boundary
- Trial Pit Location
- Window Sample Location

Notes:

Base plan provided by the client No.Ref: 2637-1200-P2 .

C01	01.08.22	First Issue	AS	JL	JL
Rev	Date	Amendment	Drawn	Chkd	Appd



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Client		
Portsmouth City Council		
Project Name		
Bunting Gardens, Waterloooville		
Description		
Exploratory Hole Location Plan		
Project ID	Drawing no.	Revision
305258	22201	C01
File name		
305258-ST-222-SS-D-C-22201-C01		
Dimensions	Scale	Size
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