Preliminary Ground Investigation Report

Land South of the M4, University of Reading

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Preliminary Ground Investigation Report
V0
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Quality Management

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Contents

1 INTRODUCTION 1
1.1 Background 1
1.2 Objectives 2
1.3 Report Structure 2

2 OVERVIEW OF CONTAMINATED LAND POLICY AND GUIDANCE 3
2.1 Legislation 3
2.2 National Planning Policy Framework 3
2.3 National Guidance 4

3 SITE AND ENVIRONMENTAL SETTING AND PRELIMINARY RISK ASSESSMENT 5
3.2 Site Location & Description 5
3.3 History 5
3.4 Geology 5
3.5 Hydrogeology and Hydrology 6
3.6 Coal Mining and Mineral Extraction 7
3.7 Ground Stability 7
3.8 Radon 8
3.9 Landfills and Waste Sites 8
3.10 Environmental Permits 8
3.11 COMAH/NIHHS Sites 8
3.12 Pollution Incidents 8
3.13 Unexploded Ordnance 8
3.14 Revised Conceptual Site Model 8

4 GROUND INVESTIGATION METHODOLOGY 3
4.1 Outline Scope of Works 3
4.2 Exploratory Hole Location Rationale 3
4.3 Constraints 4
4.4 Contamination Sampling Plan 4
4.5 Investigation Methodology 4
Windowless Sampling Boreholes 4
Trial Pits 4
Hand Pits 4
4.6 Volatile Organic Hydrocarbon (VOCs) Screening 5
4.7 Laboratory Chemical Analysis 5
Soil Chemical Analysis 5
Water Chemical Analysis 5
4.8 Groundwater and Ground Gas Monitoring 6

5 GROUND CONDITIONS 7
5.1 Introduction 7
5.2 Artificial Ground 7
Northwestern Investigation Area 7
Southwester Investigation Area 7
5.3 Topsoil and Made Ground Topsoil 8
Northeastern Investigation Area 8
Southwestern Investigation Area 8
5.4 Made Ground 8
Northeastern Investigation Area 8
Southwestern Investigation Area 8
5.5 Superficial - Alluvial Deposits 9
Northeastern Investigation Area 9

Southwestern Investigation Area 9
5.6 Superficial - River Terrace Deposits 9
Northeastern Investigation Area 9
Southwestern Investigation Area 9
5.7 Bedrock – London Clay Formation 10
Northeastern Investigation Area 10
Southwestern Investigation Area 10
5.8 Groundwater 10
Northeastern Investigation Area 10
Southwestern Investigation Area 10
5.9 Ground Gas Monitoring 11

6 RESULTS OF LABORATORY RESULTS 12
6.1 Introduction 12
6.2 Soil Chemical Analysis Results 12
Chemical Analysis 12
6.3 Asbestos Results 14
6.4 Groundwater Chemical Analysis Results 14
River Terrace Deposits 15
Alluvial Deposits 15

7 HUMAN HEALTH RISK ASSESSMENT 17
7.1 Introduction 17
7.2 Risk Assessment Methodology 17
Tier 1 – Qualitative Risk Assessment 17
Tier 2 – Generic Quantitative Risk Assessment (GQRA) 17
Tier 3 – Detailed Quantitative Risk Assessment (DQRA) 18
7.3 Tier 2 – Generic Quantitative Risk Assessment 18
Introduction 18
7.4 Asbestos Analysis 20
7.5 Summary of Risks to Human Health 20
Chemical Contamination 20

8 CONTROLLED WATERS RISK ASSESSMENT 21
8.1 Introduction 21
Overview 21
8.2 Generic Quantitative Risk Assessment 21
Introduction 21
Groundwater Sampling Summary 21
8.3 Summary of Risks to Controlled Waters 23

9 GROUND GAS RISK ASSESSMENT 24
9.1 Introduction 24
9.2 Risk Assessment 24
9.3 Gas Regime 24
Flow Rate 25
Potential Gas Sources and Migration Pathways 25
9.4 Defensibility of Gas Data 26
9.5 Gas Risk Assessment 27
9.6 Summary of Ground Gas Risks 29

10 CONCLUSION AND RECOMMENDATIONS 30

Tables

Table 3-1 – Descriptions of Geological Strata 6
Table 3-2 – Licensed Groundwater Abstractions 6
Table 3-3 – Licensed Surface Water Abstractions 7
Table 3-4 – BGS Ground Stability Hazard Ratings 7
Table 3-5 – Revised Conceptual Site Model 1
Table 4-1: Targeting of Boreholes 3
Table 4-2 – Windowless Sample Borehole Installation Details 4
Table 6-1 - Chemical Soil Results Summary for Made Ground 12
Table 6-2 - Chemical Soil Results Summary for River Terrace Deposits 13
Table 6-3 - Chemical Soil Results Summary for London Clay Formation 14
Table 6-5 - Chemical Groundwater Results Summary for River Terrace Deposits Above LLOD 15
Table 6-6 - Chemical Groundwater Results Summary for Alluvial Deposits Above LLOD 15
Table 7-1 - Summary of Chemical Soil Data Analysis for Made Ground 19
Table 8-1 - Summary of Chemical Groundwater Data Analysis Above LOD – River Terrace Deposits 22
Table 8-2 - Summary of Chemical Groundwater Data Analysis Data Above LOD – Alluvial Deposits 22
Table 9-1 - Modified Wilson and Card Classification 27
Table 9-2: Ground Gas Monitoring Results 28
Table 9-3 Modified Gas Monitoring Results Summary 29

Drawings & Figures

Figure 1: Investigation Areas
Drawing 1 794-ENV-GDE-21850, DWG-002: Exploratory Hole Location Plan

Appendices

Appendix A Exploratory Hole Logs
Appendix B Monitoring Results
Appendix C Soil Chemical Results
Appendix D Groundwater Chemical Results

1 INTRODUCTION

1.1 Background

1.1.1 RPS Consulting Services Ltd (RPS) were commissioned by the University of Reading (the Client) to undertake a preliminary phase of targeted intrusive ground investigation works on land belonging to the University of Reading (UoR), south of the M4 motorway in support of a planning application for a mixed use development. The red line boundary for the site and proposed development is presented upon drawing ??????, which also outline the proposed development. The area covered by the red line boundary in this plan is herein referred to as the '*Assessment Site'*.

1.1.2 The proposed development comprises 2,930 dwellings, employment space, two primary schools, a secondary school, a district centre, local centre, a country park, SANG and green infrastructure and associated strategic infrastructure including drainage and engineering works. The development covers an area of 413 hectares.

1.1.3 The intrusive ground investigation works are required to provide an initial assessment of a small number of areas within the Assessment Site boundary, where previous uses indicate the potential for localised areas of contamination.

1.1.4 RPS has previously undertaken a Desk Top Study (DTS) and Preliminary Risk Assessment (PRA) covering the Assessment Site and surrounding area. The findings this DTS and PRA are detailed in the following report, which should be read in conjunction with this report and is referenced as:

- 'Ground Conditions Desk Top Study and Preliminary Risk Assessment, University of Reading', RPS JER9482 V0 R1, dated June 2022.

1.1.5 The RPS DTS and PRA identified the following potentially contaminative features within or adjacent to the Assessment Site, which were considered to require characterisation and assessment, as detailed upon Drawing JER21850Z. These are:

1. Local Authority Priority inspection sites comprising:
    a. Former Arborfield Paper Mill.
    b. Backfilled gravel pits, as follows
        i. Gravel Pit 1 in the north west of the Assessment Site.
        ii. Gravel Pits 3Ai, 3Aii, 3Bi and 3Bii (4 number) in the south west of the Assessment Site.
    c. A former tank in the south west of the Assessment Site.
    d. One historical landfill (at the location of the below Gas Consultation Zone).
2. One Gas Consultation Zone partially within the Assessment Site near Carters Hill Farm in the south east of the Assessment Site.
3. One Gas Consultation Zone partially within the north east of the Assessment Site.

1.1.6 Two of the above features have been excluded from requiring characterisation for the reasons set out below:

- Gravel Pit 1: This gravel pit falls within the extents of existing planning permission (Application Reference 211841: Science Park Creative Hub at the Thames Valley Science Park including erection of film stages, workshops and office space) and will be assessed and remediated as necessary as part the consented development.
- Northeastern Gas consultation Zone: The development does not include structures in this area that could be impacted by ground gas. See drawing ???? for development details.

1.1.7 The remaining features have been subject to intrusive investigation and assessment as set out in the remainder of this document.

1.1.8 Pertinent information from the DTS and PRA report is included in this report, which aims to summarise recent targeted intrusive investigation works and provide an evaluation of potential contamination risks to human health and controlled waters in relation to the proposed development.

1.2 Objectives

1.2.1 The targeted ground investigation was undertaken to achieve the following objectives in relation to assessing the potential contamination risks posed to human health and controlled water receptors. The main objectives of this report are:

- To review the environmental and assess the potential risks posed to human health and controlled waters and to revise the Preliminary Conceptual Site Model (CSM), within the DTS and PRA, specifically in relation to these areas;
- To provide an assessment of the risks posed by soil and groundwater contamination including chemical contaminants, asbestos and hazardous ground gases using current UK good practice and guidance; and
- To provide recommendations for further investigation or remediation of any contamination identified, if deemed necessary.

1.3 Report Structure

1.3.1 The remainder of the report structure is as follows:

Section 2: Overview of Contaminated Land Policy and Guidance;

Section 3: Site and Environmental Setting and Preliminary Risk Assessment;

Section 4: Ground Investigation Methodology;

Section 5: Ground Conditions;

Section 6: Results of Laboratory Analysis;

Section 7: Human Health Risk Assessment;

Section 8: Controlled Waters Risk Assessment;

Section 9: Ground Gas Risk Assessment;

Section 10: Conclusions and Recommendations.

2 OVERVIEW OF CONTAMINATED LAND POLICY AND GUIDANCE

2.1 Legislation

2.1.1 The main legislative drivers for managing risks to human health and the environment from historical land contamination from current site user and any future development are:

- Part IIA of the Environmental Protection Act (EPA) 1990 (as amended), i.e. the 'contaminated land' regime;
- Contaminated Land Regulations 2006 / 2012;
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017
- The Water Resources Act 1991;
- The Water Act 2003; and
- The Town and Country Planning Act 1990 (as amended).

2.1.2 Under Part IIA of the EPA, sites are identified as 'contaminated land' if they are causing, or if there is significant possibility of causing significant harm to human health or significant pollution of controlled waters is being caused. Controlled waters are defined as including both surface waters and groundwater in an aquifer (Water Act 2003). Once a site is determined to be 'contaminated land' the enforcing authority must consider how it should be remediated and where appropriate, issue a remediation notice to require such remediation. Where a company volunteers to remediate a site, the local authority should support this and publish a remediation statement.

2.2 National Planning Policy Framework

2.2.1 The National Planning Policy Framework (NPPF) (The Ministry for Housing, Communities and Local Government (MHCLG), (2025) sets out how the planning system should contribute to and enhance the natural environment and local environment in a number of ways during proposed redevelopment, including:

- Preventing new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability; and,
- Remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.

2.2.2 The NPPF requires that planning authorities ensure that new development is appropriate for its location taking account of the effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the sensitivity of the area or proposed development to adverse effects from pollution.

2.2.3 NPPF paragraph 196 also requires planning decisions to ensure that:

"A site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation). After remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990".

2.3 National Guidance

2.3.1 In the UK there is a wealth of relevant guidance that is used in the assessment of land contamination. The following is a list of key relevant guidance that although not statutory, is widely accepted as industry good practice:

- Land Contamination: Risk Management (LCRM, 2023);
- Protect groundwater and prevent groundwater pollution (Environment Agency (EA), 2017);
- Construction Industry Research and Information Association (CIRIA) 132: A guide for safe working on contaminated sites (CIRIA, 1996);
- CIRIA C665: Assessing risks posed by hazardous ground gases to buildings (CIRIA, 2007);
- BS8485: Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings (BSI, 2019);
- CIRIA 73: Role and Responsibility in Site Investigation (CIRIA, 1991);
- BS5930:2015+A1:2020: Code of Practice for Site Investigations (BSI, 2020);
- BS10175:2011+A2:2017: Investigation of Potentially Contaminated Sites: Code of Practice (BSI, 2017);
- A pragmatic approach to Ground Gas Risk Assessment. RB17. (CL:AIRE, 2012); and
- CIRIA C659: Assessing Risks posed by hazardous ground gases to buildings (CIRIA, 2006).

2.3.2 This list is not exhaustive and there are a number of other guidance documents published by the likes of BSI, CIRIA, BRE and DEFRA that can be used in the assessment of land contamination. This report draws upon the guidance listed above and other relevant guidance documents, as and where appropriate.

3 SITE AND ENVIRONMENTAL SETTING AND PRELIMINARY RISK ASSESSMENT

3.1.1 Information contained within the following sections has been obtained from the previous RPS Phase 1 DTS and PRA and from searching online resources.

3.2 Site Location & Description

3.2.1 The Assessment Site is situated roughly 1.2 km south of the southern outskirts of Reading and the M4 motorway and north of the Village of Arborfield. The nearest post code for the Assessment Site, at Hall Farm (formerly known as Arborfield Hall Farm), is RG2 9HX. The approximate Ordnance Survey (OS) National Grid Coordinates for Arborfield Hall Farm are E: 475110, N: 168180.

3.2.2 Irregular in plan, the Assessment Site is relatively flat and covers roughly 413 hectares of agricultural fields and woodland pockets. Buildings belonging to Hall Farm are situated towards the southern end of the Assessment Site along with the ruins of Arborfield Old Church, sporadic houses, including Arborfield Mill House, land belonging to Arborfield Angling Club and the UoR International Cocoa Quarantine Centre. Situated centrally on the Assessment Site are various buildings belonging to the UoR Centre for Dairy Research. The fields covering the Assessment Site are used for grazing, growing crops and voluntary set-aside purposes. Access is off Arborfield Road (A327), situated along the southern site boundary.

3.3 History

3.3.1 From the earliest historical OS maps, dated 1872, the Assessment Site and immediate surrounding area has remained as relatively undeveloped agricultural land with the buildings associated with Arborfield Hall Farm and Carlton Hill Farm, formerly identified as Newland Farm, in their existing locations.

3.3.2 Maps dated 1910 to 1938 show two gravel pits, identified as ‘Gravel Pit’, to the north east of the Arborfield Hall Farm buildings, and ‘Old Gravel Pit’, to the east. These features are not shown on later maps and appear to have either been infilled or built over with later farm buildings. Arborfield Mill, identified on later maps as the existing Arborfield Mill House, was shown on historical OS maps to the immediate west of Arborfield Hall Farm.

3.3.3 The existing UoR Dairy Research Centre buildings were shown on historical OS maps dated from 1987 onwards. ‘Arborfield Hall Farm’ had been renamed as ‘Hall Farm’ on maps dated from 1988 onwards.

3.3.4 Google Earth imagery dated December 2003 to 2005 show a bunded pond feature, on the northern corner of the Hall Farm buildings, close to where the ‘Gravel Pit’ was shown on historical OS maps. This feature is no longer shown on images dated after 2005. Recent inspections have confirmed that this area is heavily vegetated to the extent that inspection to confirm the current topography was not possible. The existing International Cocoa Quarantine Centre structure, to the west of Hall Farm, is shown on images dated from December 2005 onwards.

3.4 Geology

3.4.1 The published British Geological Survey (BGS) map for the area, Sheet 268, ‘Reading’, Series 1:50,000, Solid and Drift, dated 2000, shows the Assessment Site to be underlain with patchy superficial Alluvial and River Terrace Deposits. The underlying bedrock is shown as clay rich strata belonging to the London Clay Formation.

3.4.2 Whether Made Ground is present beneath the Assessment Site is not shown on the BGS maps. However, given the presence of Hall Farm and the Research Centre, a potential localised Made Ground presence is anticipated.

3.4.3 The anticipated geological sequence underlying the Assessment Site is given in Table 3-1, below:

Table 3-1 – Descriptions of Geological Strata

Strata	Description (Source: BGS GeoIndex and Historical BGS Logs)	Approximate Thickness (m)*
Superficial Deposits		
Alluvium	Unconsolidated detrital material deposited by a river, stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope. Associated with the River Loddon and tributaries.	Unknown
River Terrace Deposits 3, 4	Sand and gravel with subsidiary clay and silt. Borehole descriptions: fine to coarse angular to subrounded gravel and fine to coarse sand; clayey pebbly sand.	2.4 – 3.9
Bedrock		
London Clay Formation	Bioturbated or poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay. Borehole descriptions: Loamy sandy clay/blue clay; Firm silty clay becoming stiff bluish grey clay; Grey and brown silty clay; mottled brown and grey becoming stiff bluish grey silty clay.	>9.14

*BGS borehole log references: SU76NE1, SU76NE16 and SU76NE27.

3.4.4 Three BGS boreholes are present within the Assessment Site. Within one of the BGS borehole records a groundwater (possibly perched) strike is identified at 2.00 m bgl associated with the River Terrace Deposits. No groundwater strikes were recorded for the other two borehole records.

3.4.5 No faults or other major geological structures are shown either on-site or within 250 m of the Assessment Site.

3.5 Hydrogeology and Hydrology

3.5.1 The Assessment Site is situated on relatively low-lying and flat ground, at around 40 meters Above Ordnance Datum (m AOD) to 50 m AOD. Published topographic and geological information indicates that perched groundwater is likely to be present within the superficial River Terrace Deposits in hydraulic continuity with the River Loddon. However, groundwater is anticipated to be present at depth within fractured bedrock and/or granular strata.

3.5.2 According to the Environment Agency, the superficial Alluvium and River Terrace Deposits have been classed as Secondary A Aquifers and the London Clay Formation as Unproductive Strata.

3.5.3 Arborfield Hall Farm is situated with a groundwater Source Protection Zone (SPZ) 1 (Inner Catchment) and SPZ 2 (Outer Catchment). The remainder of the Assessment Site is not located within an SPZ.

3.5.4 A single active licensed groundwater abstraction is identified for the Assessment Site and is associated with Hall Farm. The license details are presented in Table 3-2, below:

Table 3-2 – Licensed Groundwater Abstractions

Licence Holder	Approx. Distance and Direction from Site	Source	Use
University of Reading (Licence no. 28/39/24/0255/R01)	On site (SE Area)	Thames groundwater. Hall Farm, Arborfield, Reading – Borehole.	General Farming & Domestic Non-Evaporative Cooling

3.5.5 The Assessment Site is predominantly covered with agricultural fields with localised areas of buildings and hardstanding associated with Hall Farm and the Dairy Research Centre. Surface water is predominantly expected to drain directly into the ground and percolate downwards, through granular soils, before intercepting less permeable strata and occurring as throughflow down topographic gradient, towards the north west. In areas with buildings and hardstanding, surface water is expected to drain into localised drainage networks.

3.5.6 There are four watercourses on the Site that are designated as 'Main Rivers' by the Environment Agency (EA); River Loddon, Barkham Brook and two unnamed watercourses.

3.5.7 The River Loddon dissects the Assessment Site centrally trending north east to south west, whilst Barkham Brook trends north to south in the east of the Site. The unnamed watercourse to the north of the River Loddon trends north east to south west in the north of the Assessment Site and is referred to as the 'Long Ten Watercourse'. The unnamed watercourse in the south / south-west of the Site trends from east to west before flowing in a southerly direction off-site. This watercourse is herein referred to as the 'The Dell Watercourse'.

3.5.8 The Quality Classification given for the River Loddon is Overall – Moderate (2019), Chemical -Fail (2019) and Ecological – Moderate (2019).

3.5.9 A single active licensed surface water abstraction is identified for the Assessment Site and is associated with Hall Farm. The license details are presented in Table 3-3, below

Table 3-3 – Licensed Surface Water Abstractions

Licence Holder	Approx. Distance and Direction from Site	Source	Use
The Environment Agency (Licence no. TH/039/0024/008)	On site (Hall Farm)	Thames Surface Water. Arborfield Off-Take Structure.	Transfer between sources

3.6 Coal Mining and Mineral Extraction

3.6.1 The Assessment Site is not located within an area at risk from past or future coal mining.

3.6.2 A single entry for a Brit Pit is shown on-site, immediately north east of Hall Farm, and identified as Arborfield Hall Gravel Pit where Sand & Gravel was extracted. The status is given as ceased.

3.7 Ground Stability

3.7.1 BGS Ground Stability Hazard ratings for the Application Site are shown in Table 3-4, below:

Table 3-4 – BGS Ground Stability Hazard Ratings

Ground Stability Hazard	BGS Risk rating (highest pertaining to site)
Collapsible ground	No Hazard to Very Low
Compressible ground	No Hazard, for most of the Assessment Site to Moderate (associated with Alluvium along the River Loddon)
Ground dissolution	No Hazard
Landslide	Very Low
Running sand	Very Low
Shrinking or swelling clay	Low to Very Low

3.8 Radon

3.8.1 The Application Site is not located within a radon affected area and basic radon protective measures are not considered necessary in the construction of new dwellings or extensions based on the available information.

3.9 Landfills and Waste Sites

3.9.1 There in one recorded landfill on Assessment Site. This is recorded as follows:

- Located to the north, beyond the M4. The address is given as Lower Earley Way, Reading, Berkshire. The site is referenced as WOK66. No further details are provided.

3.9.2 There is one recorded landfill adjacent to the Assessment Site. This is recorded as follows:

- Located to the north east, adjacent to Carter's Hill Farm. The address is given as Park Farm, Carter's Hill, the Licence Holder as D Harding and the licence details as Reference: WOK14. 54/12/4/251, 30/04/1990 to 31/12/1993. The site was authorised to take inert and industrial waste. The licence was surrendered on 31/12/1993. This landfill is associated with the Gas Consultation Zone which extends into the east of the Assessment Site.

3.10 Environmental Permits

3.10.1 EA and Local Authority data indicates that there are no processes regulated by an Environmental Permit (under the Environmental Permitting Regulations 2016) within 500 m of the Assessment Site.

3.11 COMAH/NIHHS Sites

3.11.1 There are no records of any operations under the Control of Major Accident Hazards (COMAH) Regulations, 1999 or the Notifications of Installations Handling Hazardous Substances, 1982 (amended 2002) (NIHHS), located within 250 m of the Assessment Site.

3.12 Pollution Incidents

3.12.1 There are no recorded pollution incidents within the Assessment Site Boundary.

3.13 Unexploded Ordnance

3.13.1 The Application Site is indicated to be within an area of low potential risk from Unexploded Ordnance.

3.14 Revised Conceptual Site Model

3.14.1 An outline Conceptual Site Model (CSM) was developed as part of the Phase 1 DTS and PRA to cover the Assessment Site and wider area. The CSM identifies potential sources, pathways and receptors (i.e. potential pollutant linkages) on-site post development.

3.14.2 Table 3-5, below, provides a revised CSM in relation to the potential contamination sources, pathways and receptors specific to the current Assessment Site.

3.14.3 Potential contaminative sources include:

- Contaminated Made Ground and on-site soils; and
- Hydrocarbon vapours in soils and ground gas associated with Made Ground and the landfill.

3.14.4 Potential pathways include:

- Direct contact, ingestion and inhalation of contaminated soils / dust;
- Vertical contaminant migration from soil leaching;
- Horizontal migration in groundwater through permeable soils and overground flow; and
- Horizontal migration, ingress and accumulation of hydrocarbon vapours and ground gas.

3.14.5 Potential receptors include:

- Future site users and off-site users;
- Perched groundwater in the superficial River Terrace Deposits Secondary A Aquifer;
- The River Loddon; and
- Buildings and services.

Table 3-5 – Revised Conceptual Site Model

Potential Source	Contaminants of Concern	Via	Potential Pathways	Linkage Potentially Active?	Receptors	Qualitative Risk Rating	Notes
On site – current: Made Ground / farmland and existing farm buildings / structures associated with Hall Farm.	Metals, Hydrocarbons, Non-metallic compounds, Herbicides/ Pesticides and Asbestos.	Soil	Direct contact, ingestion or inhalation of soil and dust.	✓	Future site users / Off-site users	Moderate	Masterplan includes residential garden plots and large areas of open space.
			Vertical leaching of mobile contaminants.	✓	Perched groundwater in Alluvial and River Terrace Deposits (Secondary A Aquifer)	Low to Moderate	Proposed end use includes soft cover which will permit high infiltration and subsequent leaching of potential contaminants.
On site – historical: Former Arborfield Mill, infilled gravel pits and on-site tanks associated with Hall Farm.	Metals, Hydrocarbons, Non-metallic compounds, Herbicides/ Pesticides and Asbestos.		Horizontal migration as overground flow and through permeable deposits.	✓	Surface waters (River Loddon and its tributaries)	Low to Moderate	Infiltration and mobilisation of potential contaminants through underlying permeable superficial deposits.
			Direct contact	✓	Buildings and water supply pipes.	Low to Moderate	Potentially deleterious Made Ground from past activities may pose a risk to buried structures / services.
On and off-site – Made Ground, infilled gravel pits / landfills / Alluvium containing peat and other organic material at Hall Farm and within the Gas Consultation Zone.	Ground Gas (carbon dioxide and methane) and volatile hydrocarbon vapours.	Ground Gas / Vapours	Inhalation of ground gas / vapours in enclosed and unventilated spaces	✓	Future site users Off-site users	Moderate health risk in enclosed and unventilated spaces. Low – outdoor exposure.	Published geological information does not indicate a Made Ground presence, however, given the Assessment Site historical use, Made Ground is anticipated. Infilled gravel pits, Alluvial Deposits and a landfill have been identified associated with the Assessment Site.
			Migration, ingress and accumulation into enclosed and unventilated spaces.	✓	Future site users Off-site users	Moderate explosive risk in buildings. Low outdoor risk.	
				✓	Off-site buildings.		

Note The Qualitative Risk Rating does not consider the potential for the pathway to be active. In the event that a Moderate or High Qualitative Risk Rating is identified further assessment is recommended.

3.14.6 Based on the identified potential sources and the site setting, there is not considered to be a significant risk posed to ecological receptors, crops / vegetation or archaeological receptors.

4 GROUND INVESTIGATION METHODOLOGY

4.1 Outline Scope of Works

4.1.1 The scope of intrusive ground investigation works comprised:

- Preparing necessary RAMS and agreeing proposed locations and access with landowners and all other interested parties;
- Scanning each exploratory hole location with Cable Avoidance Tool (CAT) scanning equipment;
- Advancement of 7 No. shallow boreholes using dynamic windowless sampling techniques;
- Excavating 5 No. No using a backhoe excavator;
- Advancement of 2 No. hand pits;
- Installation of groundwater and ground gas monitoring wells at selected windowless sample borehole locations;
- Collecting soil samples for logging purposes and laboratory chemical analysis.
- Groundwater sampling and ground gas monitoring over a 3 week period on a weekly basis;
- Full time supervision and logging of ground conditions and collecting samples in general accordance with BS5930:2015 and BS10175:2011;
- Field screening for Volatile Organic Hydrocarbons (VOCs) using Photoionization detector (PID) at all locations;
- Laboratory chemical analysis of soil and groundwater samples for the following:

4.2 Exploratory Hole Location Rationale

4.2.1 As previously set out in *Section 1* the intrusive investigation works have been progressed to target specific features. The specific features targeted by each investigation location are set out in Table 4-1.

Table 4-1: Targeting of Boreholes

Feature	Location
Former Arborofield Paper Mill	WS04, WS05, WS08, HP01 and HP02.
Gravel Pit 3Ai	TP02
Gravel Pit 3Aii	None: see below
Gravel Pit 3Bi	TP03 and TP04
Gravel Pit 3Bii	TP06 and TP07
Former tank	WS03
Gas Consultation Zone partially within the Assessment Site near Carters Hill Farm	WS01, WS02 and WS09

4.2.2 As previously set out in *Section 1* Gravel Pit 1 and the Gas Consultation zone in the north east of the assessment site are not considered to require investigation.

4.2.3 The ground investigation layout is presented on the Exploratory Hole Location Plan (794-ENV-GDE-21850, DWG-002, presented towards the rear of this report.

4.3 Constraints

4.3.1 Investigation works could not be undertaken at the location of Gravel Pit 3Aii (proposed trial pit TP05) due to the presence of thick vegetation. Inspection of the area could not clearly identify if the topography within the area. Based on the limited observations that were able to be made the area appeared to be bunded with a potential depression in the centre, indicating that the void associated with the former gravel pit may remain.

4.4 Contamination Sampling Plan

4.4.1 Based on the proposed end use, the sampling and analysis plan is more positively biased towards near surface samples, i.e. within the upper 0.75 m, as these represent the soils most likely to be available to future site users. Additionally, where present, Made Ground horizons and visual and / or olfactory evidence of contamination are targeted.

4.4.2 Given the Assessment Site's history, chemical analysis was scheduled, on soil and groundwater samples, for a general suite of typically occurring contaminants associated with potentially contaminated sites.

4.5 Investigation Methodology

Windowless Sampling Boreholes

4.5.1 In total 7 No. shallow boreholes (WS01 to WS05, WS08 and WS09) were sunk using windowless sampling techniques. Boreholes were advanced to a maximum 4.00m depth.

4.5.2 Prior to sinking each borehole, a hand dug service inspection pit was undertaken at each location to 1.20 m depth.

4.5.3 Upon completion, the boreholes installed with 50 mm groundwater and ground gas monitoring standpipes, the details of which are presented in Table 4-2, below:

Table 4-2 – Windowless Sample Borehole Installation Details

Borehole	Screened Strata	Depth Range of Screen (m BGL)
WS01	London Clay Formation	0.50 – 4.00
WS02	River Terrace Deposits and London Clay Formation	0.50 – 1.50
WS03	River Terrace Deposits	0.50 – 2.00
WS04	River Terrace Deposits	0.50 – 1.00
WS05	River Terrace Deposits	0.50 – 2.00
WS08	Made Ground and Alluvial Deposits	0.50 – 2.00
WS09	London Clay Formation	0.50 – 4.00

Trial Pits

4.5.4 In total 5 No. trial pits (TP02 to TP04, TP06 and TP07), were excavated using a mechanical excavator, to between 1.50m and 2.30m depth.

4.5.5 Upon completion, all trial pits were backfilled with arisings.

Hand Pits

4.5.6 Two hand pits HP01 and HP02 were advanced in the heavily vegetated area outside and to the west of the garden belonging to Arborfield Mill House. The hand pits were dug to between 0.35m and 0.40m depth and backfilled with arisings on completion.

4.5.7 Details of the soils encountered, samples taken, trial pit sidewall stability and groundwater strikes are recorded on the exploratory hole logs included in Appendix A, along with a photographic record of each location.

4.6 Volatile Organic Hydrocarbon (VOCs) Screening

4.6.1 During the intrusive investigation works, samples were taken from each exploratory hole location, at roughly 1.00 m intervals, to screen for Volatile Organic Hydrocarbons (VOCs). Screening was undertaken using handheld Photo Ionising detector (PID) apparatus at each location.

4.7 Laboratory Chemical Analysis

4.7.1 Soil and groundwater samples for chemical analysis were forwarded to Element Materials Technology (Element), at their Deeside Laboratory. Element is a UKAS accredited (Element: UKAS number 4225) and part of the Monitoring Certification Scheme (MCERTS). Chemical analysis was undertaken in accordance with in-house methods.

Soil Chemical Analysis

4.7.2 In total 18 No. soil samples were submitted for the following laboratory chemical analysis:

- Heavy Metals (As, Cd, Cr, Cr(VI), Hg, Pb, Cu, Ni, Zn, Se);
- Total Phenols;
- Total Cyanide;
- Speciated Polycyclic Aromatic Hydrocarbons (PAHs);
- Total Petroleum Hydrocarbons (TPH CWG) plus BTEX and MTBE;
- Sulphide;
- Water Soluble (2:1) Sulphate;
- Soil Organic Matter;
- pH; and
- Asbestos in soils screening.

4.7.3 A full list of determinants analysed along with the UKAS accreditation for each individual testing method are shown on the laboratory test certificates included in Appendix C.

4.7.4 The results are summarised in Section 6 and discussed in Section 7.

Water Chemical Analysis

4.7.5 Following the fieldworks, 5 No. groundwater samples were collected from boreholes WS02 to WS05 and WS08 on 16th May 2025 and submitted for the following chemical analysis:

- Heavy Metals: AS, Cd, Cr, CR (VI), Cu, HG, Ni, Pb, Se & Zn);
- Total Phenols;
- Total Cyanide;
- Speciated PAHs;
- Total Petroleum Hydrocarbons (TPH CWG) plus BTEX and MTBE;
- Sulphide;
- Sulphate;
- Total Organic Carbon;

- Total Hardness; and
- pH.

4.7.6 The installations for boreholes WS01 and WS09 contained insufficient groundwater to enable samples to be recovered, during the sampling round, or groundwater levels to be re-purged during subsequent monitoring visits.

4.7.7 A full list of determinants analysed along with the UKAS accreditation for each individual testing method are shown on the laboratory test certificates included in Appendix D.

4.7.8 The results are summarised in Section 6 and discussed in Section 8.

4.8 Groundwater and Ground Gas Monitoring

4.8.1 Following the intrusive investigation works, 3 No. groundwater and ground gas monitoring rounds were undertaken over a three-week period on 23rd and 27th May and 9th June 2025. No water level readings were taken during the second visit (27th of May) due to the dip meter malfunction.

4.8.2 During the first monitoring round, groundwater samples were collected for chemical analysis.

4.8.3 At each borehole location, the following measurements were made:

- The groundwater level (from ground level); and
- The depth to the base of the monitoring well (from ground level).

4.8.4 Ground gas measurements were undertaken using a Gas Analyser (GFM 430) and a handheld PID for the following parameters:

- Oxygen (O_2);
- Carbon Dioxide (CO_2);
- Methane (CH_4);
- Carbon Monoxide (CO);
- Hydrogen Sulphide (H_2S);
- Lower Explosive Limit (LEL);
- Volatile Organic Compounds (VOCs);
- Atmospheric Pressure (mb)
- Differential Pressure (mb); and
- Gas Flow.

4.8.5 Peak and stabilised gas concentrations and flow rates were recorded. Tables summarising the groundwater and ground gas monitoring results are presented in Appendix B. The groundwater monitoring results are discussed further in Section 5.8 and the ground gas results in Section 9.

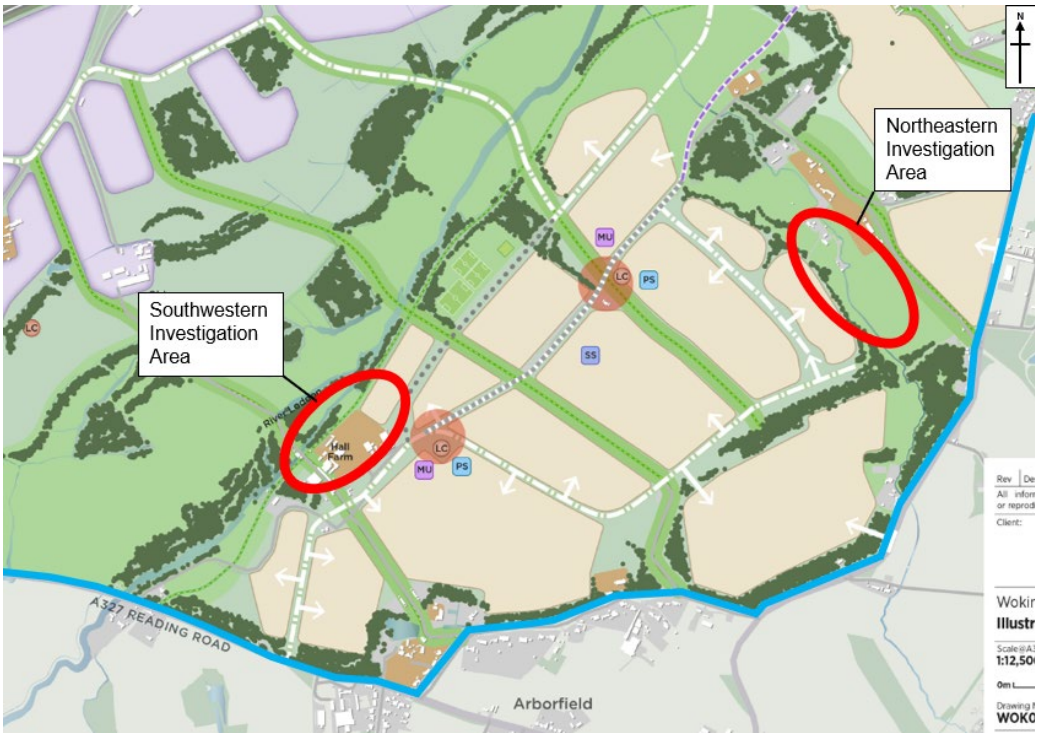
5 GROUND CONDITIONS

5.1 Introduction

5.1.1 This section provides a summary of the ground conditions encountered during the intrusive ground investigation works. In general, the ground conditions encountered during the investigation works agreed with those anticipated from the published geological information. These included a Topsoil, Made Ground Topsoil and Made Ground cover overlying superficial Alluvial and River Terrace Deposits and clay rich strata belonging to the London Clay Formation.

5.1.2 Details of the various stratigraphic units encountered are presented on the exploratory hole logs, included in Appendix A, and are discussed further in the following sections. The conditions have been described with respects to the Northwestern Investigation area and Southwestern Investigation. These areas are detailed upon Figure 1.

Figure 1: Investigation Areas



5.2 Artificial Ground

Northwestern Investigation Area

5.2.1 No artificial ground was identified in the northwestern area.

Southwester Investigation Area

5.2.2 Concrete hardstanding was encountered in WS03 from surface to 0.16 m depth.

5.3 Topsoil and Made Ground Topsoil

Northeastern Investigation Area

5.3.1 Topsoil only was encountered in all three boreholes in the northwestern investigation area (boreholes WS01, WS02 and WS09), to between 0.06 m (WS09) and 0.25 m (WS01) depth. This material was generally described as soft brown and grey brown silty slightly sandy and gravelly organic rich Topsoil with abundant roots and rootlets.

Southwestern Investigation Area

5.3.2 Topsoil was encountered in 4 No. trial pits (TP02 to TP04 and TP06) located within the Southwestern Investigation Area, in the fields situated away from the Hall Farm buildings. Recorded to between 0.12 m and 0.20 m depth, this material was generally described as Grass over dark brown clayey gravelly sandy organic rich Topsoil with abundant roots and rootlets.

5.3.3 Made Ground Topsoil was encountered in 2 No. windowless sample boreholes, WS05 and WS08, within the Southwestern Investigation Area. In WS05, Made Ground Topsoil was recorded to 0.10 m depth and in WS08 to 0.20 m depth. This material was generally described as grass over black or brown gravelly organic rich sand that included flint, quartzite and brick with occasional to many roots and rootlets.

5.3.4 No visual or olfactory evidence of contamination was recorded within the Topsoil or Made Ground Topsoil layers encountered.

5.4 Made Ground

Northeastern Investigation Area

5.4.1 No Made Ground was encountered in the boreholes (WS01, WS02 and WS09) undertaken within the Northeastern Investigation Area.

Southwestern Investigation Area

5.4.2 In and around Arborfield Hall Farm, Made Ground was encountered in 6 No. exploratory Holes, (WS03, WS04, WS08, TP07, HP01 and HP02) to depths between 0.20 m bgl and 1.60 m bgl.

5.4.3 In borehole WS03, located to investigate an old tank, Made Ground was encountered underlying the concrete, to 0.60m depth, and was described as dark brown and black gravelly sand that included quartz and flint.

5.4.4 Made Ground encountered in borehole WS04 situated within the current International Cocoa Quarantine Centre compound, to 0.20 m depth, was described as flint and quartzite gravel over greyish brown clayey sandy gravel. This material also included quartzite, limestone and brick.

5.4.5 In borehole WS08 Made Ground was encountered comprising reddish brown and dark brown gravelly sand that included flint and brick. This material was recorded to 1.20 m depth.

5.4.6 In TP07, situated within the ‘Old Gravel Pit, there were two distinct Made Ground layers and with a possible further layer of Made Ground at depth. The upper Made Ground layer generally comprised light grey and brown very gravelly sand that included flint, limestone, concrete, brick, quartzite, tile and metal/wire fragments which was recorded to 0.20 m depth. The second underlying Made Ground layer was described as dark grey brown gravelly sand that included flint, quartzite, brick and concrete, which was recorded to 0.70 m depth. Underlying this layer was dark grey/black gravelly SAND, including flint, quartz and quartzite, that was recorded to 1.60 m and has been interpreted as Possible Made Ground.

5.4.7 In hand pits HP01 and HP02, located to the west of Arborfield Mill House, the Made Ground encountered was generally described as dark brown slightly sandy gravelly silt. Encountered to the full depth of the hand pit, between 0.35m and 0.40m depth, this material also included flint and brick with occasional to many roots and rootlets.

5.4.8 No visual or olfactory evidence of contamination was recorded within the Made Ground layers encountered.

5.4.9 Made Ground was not identified in the remaining trial pits (TP02, TP03 and TP06) targeting the former gravel pits.

5.5 Superficial - Alluvial Deposits

Northeastern Investigation Area

5.5.1 No superficial Alluvial Deposits was encountered in the boreholes undertaken within the Northeastern Investigation Area of the Assessment Site.

Southwestern Investigation Area

5.5.2 Alluvial Deposits were recorded in a single borehole (WS08) located within the Southwestern Investigation Area, to the west of the River Loddon and Arborfield Hall Farm. These deposits included a soft mottled reddish brown and dark grey sandy clay rich layer underlying the Made Ground to 1.75 m depth. Below the clay rich Alluvial layer, at between 1.75 m and 2.00 m depth, granular arisings comprising saturated grey medium to coarse sand and gravel were encountered. It is anticipated that these deposits mark a transition from granular Alluvial Deposits into granular River Terrace Deposits. Below 2.00 m depth there was no sample recovery within the borehole.

5.5.3 No visual or olfactory evidence of contamination was recorded within the Alluvial Deposits encountered.

5.6 Superficial - River Terrace Deposits

Northeastern Investigation Area

5.6.1 Within the Northeastern Investigation Area, superficial River Terrace Deposits were encountered in a single borehole (WS02) underlying the Topsoil to 1.20 m depth. These deposits generally comprised a layer of red brown silty gravelly medium to coarse sand, to 0.70m depth, overlying grey mottled reddish brown very gravelly medium to coarse sand.

Southwestern Investigation Area

5.6.2 Trial pits TP02 to TP04, TP06 and TP07 and windowless sample boreholes WS03 to WS05, undertaken within the Southwestern Investigation Area, all encountered superficial River Terrace Deposits to between 0.40 m (TP03) and 2.10 m (WS05) depth. The deposits were very variable in nature from soft to firm red brown sandy gravelly clay to orange and reddish brown occasionally mottled grey gravelly medium to coarse sand or sand and gravel.

5.6.3 In trial pit TP02, a couple of loose whole red bricks were encountered at between 0.20m and 0.70 m depth within the north east trial pit wall.

5.6.4 No visual or olfactory evidence of contamination was recorded within the River Terrace Deposits encountered.

5.7 Bedrock – London Clay Formation

Northeastern Investigation Area

5.7.1 The London Clay Formation bedrock was encountered in all three boreholes undertaken within the Northeastern Investigation Area, underlying the Topsoil and superficial River Terrace Deposits, to the maximum investigation depth at 4.00 m bgl. In WS01, between 0.25 m and 2.00 m depth, this stratum appeared to have been naturally reworked and was generally described as soft to firm mottled orange and reddish brown slightly sandy slightly gravelly clay. Generally, the London Clay Formation was described as soft rapidly becoming firm to stiff mottled orange and reddish brown and bluish grey clay.

Southwestern Investigation Area

5.7.2 With the exception of windowless sample borehole WS08, the London Clay Formation stratum was encounter in all exploratory hole locations, within the Southwestern Investigation Area, to the maximum investigation depth at 4.00m bgl. This stratum was generally described as soft rapidly becoming firm to stiff mottled orange and reddish brown and bluish grey clay.

5.7.3 No visual or olfactory evidence of contamination was recorded within the London Clay Formation encountered.

5.8 Groundwater

Northeastern Investigation Area

5.8.1 During the intrusive investigation works, groundwater within the Northeastern Investigation Area was encountered in borehole WS02 at 1.20 m depth. Considered to be perched, the groundwater was associated with the River Terrace Deposits and sat on top of the less permeable underlying London Clay Formation clay rich stratum.

5.8.2 Post fieldwork groundwater monitoring rounds were undertaken between 23rd May and 9th June 2025 within the Northeastern Investigation Area. Groundwater levels in boreholes WS01 and WS09 were recorded at between 1.40 m and 3.39 m depth, associated with the London Clay, and in WS02 at between 0.87 m and 0.90 m, associated with the River Terrace Deposits. Where water has been identified within the London Clay this is considered to be where the boreholes are acting as a sump, and is not considered indicative of a consistent water table in deposits.

Southwestern Investigation Area

5.8.3 In the Southwestern Investigation Area, groundwater was encountered in trial pit TP02, as a rapid inflow at 1.40m depth, and in boreholes WS02, WS04 and WS08, at between 1.00m and 1.75m depth, associated with the Alluvial and River Terrace Deposits. It is expected that the London Clay Formation will underlie the Alluvial Deposits and that where groundwater is encountered in these and the River Terrace Deposits, it will be perched and in hydraulic continuity with the River Loddon.

Post fieldwork groundwater monitoring rounds were undertaken in the Southwestern Investigation Area between 23rd May and 9th June 2025. Recorded groundwater levels in boreholes WS03 to WS05 were between 0.63 m and 1.83 m, associated with the River Terrace Deposits. Recorded groundwater levels in borehole WS08 were 1.39 m to 1.46 m and associated with granular Alluvial Deposits.

5.9 Ground Gas Monitoring

5.9.1 Ground gas monitoring rounds were undertaken on three occasions, a weekly basis by RPS following completion of the ground investigation. Tabulated ground gas monitoring results are included in Appendix B and a preliminary assessment of potential ground gas risks posed to the development of the Assessment Site is detailed in Section 9.

6 RESULTS OF LABORATORY RESULTS

6.1 Introduction

6.1.1 The following section summarises the laboratory chemical analysis undertaken on soil samples collected during the ground investigation and groundwater samples collected during follow-on monitoring rounds. Full laboratory analysis reports are presented within Appendix C and Appendix D respectively.

6.2 Soil Chemical Analysis Results

Chemical Analysis

6.2.1 In total 18 No. samples were submitted for laboratory chemical analysis for various suites of chemical determinants, as set out in Section 4.11. These samples were recovered from the Made Ground, River Terrace Deposits and London Clay Formation. The remainder of this section presents a summary of the chemical analysis data for each soil type analysed. The results are discussed in Section 7.

6.2.2 The following tables summarise the chemical data for each soil type and only includes results where contaminants are recorded above their respective Laboratory Limits of Detection (LLOD).

Made Ground

6.2.3 The chemical results for 7 No Made Ground samples collected during the ground investigation works are presented in Table 6-1, below. Where all of the results for a determinand fall below the LLOD, these determinands have not been included in the table.

Table 6-1 - Chemical Soil Results Summary for Made Ground

Determinant	No. of Tests	Limit Of Detection	Min	Max	Location of Max Value (and Depth)
Metals (mg/kg) and Other Inorganics					
Arsenic	7	<0.5	9.4	34.5	HP01 (0.30 m)
Cadmium	7	<0.1	<0.1	0.4	WS04 (0.10 m)
Chromium	7	<0.5	34.4	106.3	WS08 (0.50 m)
Copper	7	<1	9	39	HP02 (0.30 m)
Lead	7	<5	43	181	HP01 (0.30 m)
Mercury	7	<0.1	<0.1	0.5	WS05 (0.25 m)
Nickel	7	<0.7	9.5	86.7	WS08 (0.50 m)
Selenium	7	<1	<1	7	HP02 (0.30 m)
Sulphate	7	<50	2.8	70.8	WS08 (0.50 m)
Zinc	7	<5	42	169	HP01 (0.30 m) HP02 (0.30 m)
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)					
Naphthalene	7	<0.04	<0.04	2.93	WS08 (0.50 m)
Acenaphthylene	7	<0.03	0.08	15.11	WS08 (0.50 m)
Acenaphthene	7	<0.05	<0.05	8.15	WS08 (0.50 m)
Anthracene	7	<0.04	0.06	29.95	WS08 (0.50 m)
Benzo(a)anthracene	7	<0.06	0.43	56.90	WS08 (0.50 m)
Benzo(a)pyrene	7	<0.04	0.42	68.92	WS08 (0.50 m)
Benzo(b)fluoranthene	7	<0.05	0.55	70.10	WS08 (0.50 m)

Determinant	No. of Tests	Limit Of Detection	Min	Max	Location of Max Value (and Depth)
Benzo(k)fluoranthene	7	<0.02	0.21	27.26	WS08 (0.50 m)
Benzo(ghi)perylene	7	<0.04	0.20	34.90	WS08 (0.50 m)
Chrysene	7	<0.02	0.44	54.73	WS08 (0.50 m)
Dibenzo(ah)anthracene	7	<0.04	0.09	7.74	WS08 (0.50 m)
Fluoranthene	7	<0.03	0.46	139.29	WS08 (0.50 m)
Fluorene	7	<0.04	<0.04	8.26	WS08 (0.50 m)
Indeno(123cd)pyrene	7	<0.04	0.20	42.05	WS08 (0.50 m)
Phenanthrene	7	<0.03	0.13	92.33	WS08 (0.50 m)
Pyrene	7	<0.03	0.44	115.24	WS08 (0.50 m)
Total Petroleum Hydrocarbons (TPHs)					
Ali >EC6-EC8	7	<0.10	<0.10	0.20	HP01 (0.30 m)
Ali >EC8-EC10	7	<0.10	<0.10	0.10	HP01 (0.30 m)
Ali >EC10-EC12	7	<0.2	<0.2	10	HP02 (0.30 m)
Ali >EC12-EC16	7	<4	<4	30	HP02 (0.30 m)
Ali >EC16-E21	7	<7	<7	44	HP02 (0.30 m)
Ali >EC21-EC35	7	<7	<7	211	HP02 (0.30 m)
Total Ali C5-C35	7	<19	<19	295	HP02 (0.30 m)
Aro >EC10-EC12	7	<0.2	<0.2	9.3	HP02 (0.30 m)
Aro >EC12-EC16	7	<4	<4	95	HP02 (0.30 m)
Aro >EC16-EC21	7	<7	<7	574	HP02 (0.30 m)
Aro >EC21-EC35	7	<7	<7	1,509	HP02 (0.30 m)
Total aro C5-C35	7	<38	<38	2,187	HP02 (0.30 m)

River Terrace Deposits

6.2.4 The chemical results for 9 No. River Terrace Deposit samples collected during the ground investigation works are presented in Table 6-2, below. Where all of the results for a determinand fall below the LLOD, these determinands have not been included in the table.

Table 6-2 - Chemical Soil Results Summary for River Terrace Deposits

Determinant	No. of Tests	Limit Of Detection	Min	Max	Location of Max Value (and Depth)
Metals and Other Inorganics (mg/kg)					
Arsenic	9	<0.5	4.7	14.5	TP06 (0.50 m)
Chromium	9	<0.5	54.3	99.2	TP02 (0.80 m)
Copper	9	<1	2	26	TP03 (0.30 m)
Lead	9	<5	<5	54	WS05 (0.60 m)
Mercury	9	<0.1	<0.1	0.5	WS05 (0.60 m)
Nickel	9	<0.7	5.1	12.8	WS03 (0.70 m)
Selenium	9	<1	<1	1	TP02 (0.50 m) TP06 (0.50 m) TP07 (1.80 m)
Sulphate	9	<50	1.5	16.7	WS03 (0.70 m)
Zinc	9	<5	7	50	TP03 (0.30 m)
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)					
Benzo(a)anthracene	9	<0.06	<0.06	0.16	WS05 (0.60 m)

Determinant	No. of Tests	Limit Of Detection	Min	Max	Location of Max Value (and Depth)
Benzo(a)pyrene	9	<0.04	<0.04	0.13	WS05 (0.60 m)
Benzo(b)fluoranthene	9	<0.05	<0.05	0.17	WS05 (0.60 m)
Benzo(k)fluoranthene	9	<0.02	<0.02	0.06	WS05 (0.60 m)
Benzo(bk)fluoranthene	9	<0.07	<0.07	0.23	WS05 (0.60 m)
Benzo(ghi)perylene	9	<0.04	<0.04	0.07	WS05 (0.60 m)
Chrysene	9	<0.02	<0.02	0.15	WS05 (0.60 m)
Fluoranthene	9	<0.03	0.03	0.21	WS05 (0.60 m)
Indeno(123cd)pyrene	9	<0.04	<0.04	0.09	WS05 (0.60 m
Phenanthrene	9	<0.03	<0.03	0.09	WS05 (0.60 m)
Pyrene	9	<0.03	<0.03	0.18	WS05 (0.60 m)
Total Petroleum Hydrocarbons (TPHs)					
Aro >EC21-EC35	9	<7	<7	9	TP03 (0.30 m)

London Clay Formation

6.2.5 The chemical results for London Clay Formation samples collected during the ground investigation works are presented in Table 6-3, below. Where all of the results for a determinand fall below the LLOD, these determinands have not been included in the table.

Table 6-3 - Chemical Soil Results Summary for London Clay Formation

Determinant	No. of Tests	Limit Of Detection	Min	Max	Location of Max Value (and Depth)
Metals and Other Inorganics (mg/kg)					
Arsenic	2	<0.5	12	13.8	WS09 (0.70 m)
Chromium	2	<0.5	64.4	65.9	WS09 (0.70 m)
Copper	2	<1	9	17	WS09 (0.70 m)
Lead	2	<5	11	13	WS09 (0.70 m)
Nickel	2	<0.7	15.2	30.4	WS09 (0.70 m)
Sulphate	2	<50	26.3	9.8	WS01 (0.50 m)
Zinc	2	<5	41	61	WS09 (0.70 m)

6.3 Asbestos Results

6.3.1 In total of 18 No. Made Ground, River Terrace Deposits and London Clay Formation samples were taken for asbestos in soils identification.

6.3.2 For the samples analysed, no asbestos in soils was detected for the Made Ground, River Terrace Deposits and London Clay Formation.

6.4 Groundwater Chemical Analysis Results

6.4.1 Following completion of the intrusive works, groundwater samples were collected, on 16th May 2025, for laboratory chemical analysis from the River Terrace and Alluvial Deposits. The results are summarised in Table 6-5 and Table 6-6, below. Where all of the results for a determinand fall below the LLOD, these determinands have not been included in the table.

6.4.2 Groundwater samples were collected from boreholes WS02 to WS05 and WS08. Boreholes WS01 and WS09 contained insufficient groundwater to enable samples to be recovered, during the sampling round, or groundwater levels to be re-purged during subsequent monitoring visits.

River Terrace Deposits

6.4.3 The results for groundwater analysis within the River Terrace Deposits are summarised in Table 6-5 below, where results are recorded above the LLOD.

Table 6-4 - Chemical Groundwater Results Summary for River Terrace Deposits Above LLOD

Determinant	No. of Tests	Limit Of Detection	Result	Location of Max Value (and Depth)
Metals and Other Inorganics (ug/l)				
Dissolved Arsenic	4	<2.5	38.8	WS04
Total Dissolved Chromium	4	<1.5	3.4	WS04
Dissolved Nickel	4	<2	12	WS02 WS04
Dissolved Zinc	4	<1	59	WS02
Sulphate	4	<0.5	115,600	WS04
Total Cyanide	4	<0.01	20	WS04
Polycyclic Aromatic Hydrocarbons (PAHs) (ug/l)				
Fluoranthene	4	<0.005	0.005	WS02

Alluvial Deposits

6.4.4 The results for groundwater analysis within the Alluvial Deposits are summarised in Table 6-6 below, where results are recorded above LLOD.

Table 6-5 - Chemical Groundwater Results Summary for Alluvial Deposits Above LLOD

Determinant	No. of Tests	Limit Of Detection	Max Result	Location of Max Value (and Depth)
Metals and Other Inorganics (ug/l)				
Dissolved Arsenic	1	<2.5	35.2	WS08
Dissolved Nickel	1	<2	6	WS08
Dissolved Zinc	1	<3	12	WS08
Sulphate as SO4	1	<0.5	74,800	WS08
Total Cyanide	1	<0.01	80	WS08
Polycyclic Aromatic Hydrocarbons (PAHs) (ug/l)				
Acenaphthene	1	<0.005	0.146	WS08
Acenaphthylene	1	<0.005	0.016	WS08
Anthracene	1	<0.005	0.049	WS08
Benzo(a)anthracene	1	<0.005	0.034	WS08
Benzo(a)pyrene	1	<0.005	0.043	WS08
Benzo(b)fluoranthene	1	<0.008	0.046	WS08
Benzo(k)fluoranthene	1	<0.008	0.018	WS08
Benzo(bk)fluoranthene	1	<0.008	0.064	WS08
Benzo(ghi)perylene	1	<0.005	0.020	WS08
Chrysene	1	<0.005	0.032	WS08
Dibenzo(ah)anthracene	1	<0.005	0.005	WS08
Fluoranthene	1	<0.005	0.088	WS08
Fluorene	1	<0.005	0.097	WS08
Indeno(123cd)pyrene	1	<0.005	0.025	WS08
Naphthalene	1	<0.005	0.300	WS08

Determinant	No. of Tests	Limit Of Detection	Max Result	Location of Max Value (and Depth)
Phenanthrene	1	<0.005	0.223	WS08
Pyrene	1	<0.005	0.074	WS08

7 HUMAN HEALTH RISK ASSESSMENT

7.1 Introduction

7.1.1 Based upon the Assessment Site's predominantly historical agricultural use, the risk from contamination across the Assessment Site is considered low. As previously set out this phase of targeted ground investigation focuses on areas of increased contamination risk, namely:

- Former Arborfield Paper Mill
- Gravel Pit 3Ai
- Gravel Pit 3Aii
- Gravel Pit 3Bi
- Gravel Pit 3Bii
- Former tank
- Gas Consultation Zone partially within the Assessment Site near Carters Hill Farm

7.1.2 This human health risk assessment considers if there is potential for contamination risks to human health from the above contamination sources that may require remediation to facilitate site redevelopment.

7.2 Risk Assessment Methodology

7.2.1 The assessment of risks posed to human health by the presence of soil contaminants is based upon the guidelines outlined in LCMR (EA, 2025), which provides a framework for risk assessment and follows a tiered process, with each subsequent tier involving a higher degree of input into the assessment should risks be identified.

Tier 1 – Qualitative Risk Assessment

7.2.2 This stage qualitatively identifies each of the Source-Pathway-Receptors components that are present on the Assessment Site, which forms the basis of the UK risk assessment approach. The Tier 1 assessment is presented in the Phase One DTS and PRS (RPS, 2022) report and a revised CSM specific to the Assessment Site is presented in Section 3.19.

Tier 2 – Generic Quantitative Risk Assessment (GQRA)

7.2.3 The Tier 2 risk assessment aims to identify contaminants of concern and their spatial distribution and requires benchmarks against which to compare the concentrations of soil contaminants. This requires the comparison of contaminant concentrations with Suitable 4 Use Levels (S4ULs) that have been derived by Land Quality Management Ltd (LQM) using the Contaminated Land Exposure Assessment (CLEA) framework. Contaminant concentrations below the respective S4UL criteria represent a tolerable or minimal risk level to human health. Where contaminant concentrations are above S4UL criteria, further risk assessment and possibly remediation may be required.

7.2.4 It is recognised that Category 4 Screening Levels (C4SLs), first published in 2014, for a limited number of contaminants have been developed by CL:AIRE in an attempt to align with the updated Part IIA guidance, by defining a level of contamination that would not be considered as contaminated land under Part IIA (HMSO, 1990). However, given the continued debate about the applicability of the C4SLs in determining remedial requirements under the planning regime, the C4SLs have not been applied within this risk assessment and instead S4ULs have been adopted.

7.2.5 Where S4ULs have been derived by LQM, these have been used for comparison with Assessment Site ground investigation data. For those contaminants where no S4ULs have been derived, data

is compared against relevant C4ULs or Generic Assessment Criteria (GAC) published by CL:AIRE (CL:AIRE, 2010).

7.2.6 Where no S4UL, C4UL or GAC is available, such as for PCBs, the former Soil Guideline Values (SGVs) have been used.

7.2.7 The Tier 2 risk assessment presented within this section is based upon the generic commercial scenario under the CLEA methodology using relevant screening criteria for those contaminants for which laboratory analysis is available.

Tier 3 – Detailed Quantitative Risk Assessment (DQRA)

7.2.8 Where a screening value is exceeded, a detailed human health risk assessment may be required to further quantify the potential risk posed and determine whether there is a requirement for remediation. The Tier 3 assessment considers the toxicological characteristics, migration mechanisms and exposure pathways to derive Site Specific Assessment Criteria (SSAC) using the CLEA computer model. A literature search is undertaken to obtain the most recent relevant toxicological information, and this is inputted into the model. Exceedance of the SSAC may suggest that remediation is required to mitigate risks posed to human health.

7.2.9 A Tier 3 assessment is outside the scope of this report and has not been undertaken.

7.3 Tier 2 – Generic Quantitative Risk Assessment

Introduction

7.3.1 This section provides a comparison of soil analysis data derived from the RPS intrusive ground investigation works at the Assessment Site, against appropriate screening criteria for a residential end use.

7.3.2 For inorganic contaminants principally comprising heavy metals, the laboratory analysis results have initially been compared against the relevant screening criteria to identify any exceedances of the criteria that would warrant further consideration. Where exceedances of a particular contaminant are identified, the statistical 95% Upper Confidence Limit (UCL) of the true mean concentration has been calculated for all data available and compared against the relevant screening criteria, in line with UK best practice.

7.3.3 For all PAH and TPH contaminants, the laboratory analysis results have been compared directly against the appropriate screening criteria, as the most likely source of this contamination is considered to be from point sources. Therefore, the statistical assessment of data is not considered valid in the first instance and this approach is considered to be in line with UK best practice.

7.3.4 The Tier 2 risk assessment has been undertaken on soil analysis data from each identified strata at the Assessment Site: Made Ground, River Terrace Deposits and London Clay Formation.

7.3.5 It should be noted that asbestos is considered separately within Section 7.4.

Made Ground

7.3.6 Table 7-1 below summarises the chemical laboratory results for 7 No. Made Ground, as presented within Table 6-1, above. Only those results found to exceed the relevant GAC values for a residential end use have been included in the table.

Table 7-1 - Summary of Chemical Soil Data Analysis for Made Ground

Contaminant	No. of Tests	Screening Criteria (S4ULs)	Min	Max	No. of Exceedances	Location of Exceedances
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)						
Benzo(a)anthracene	7	13	<0.08	56.90	1	WS08 (0.50 m)
Benzo(a)pyrene	7	3	<0.04	68.92	2	WS08 (0.50 m) HP02 (0.30 m)
Benzo(b)fluoranthene	7	3.7	<0.05	70.10	2	WS08 (0.50 m) HP02 (0.30 m)
Chrysene	7	27	<0.06	54.73	1	WS08 (0.50 m)
Dibenzo(ah)anthracene	7	0.3	<0.04	7.74	2	WS08 (0.50 m) HP02 (0.30 m)
Indeno(123cd)pyrene	7	41	<0.04	42.05	1	WS08 (0.50 m)
Total Petroleum Hydrocarbons (TPHs) (mg/kg)						
Aro >EC16-EC21	7	160	<7	1,754	1	WS08 (0.50 m)

7.3.7 The results indicate that for most potential contaminants in Made Ground, summarised in Table 6 1, including heavy metals and non-metallic compounds, BTEX and MTBE do not exceeded the relevant GAC values for a residential end use. The exception to this relates to PAHs and TPS as detailed below.

7.3.8 Elevated PAHs were recorded within Made Ground samples from 2 No. locations including HP02, at 0.30 m depth, and WS08, at 0.50 m depth, where the highest concentrations were recorded. Elevated TPH concentrations for Aromatic carbon fractions EC16-EC21, were also recorded in the Made Ground sample taken from WS08.

7.3.9 In hand pit HP02, elevated PAHs concentrations were recorded for Benzo(a)pyrene (9.4 mg/kg), Benzo(b)fluoranthene (9.96 mg/kg) and Dibenzo(ah)anthracene (1.3 mg/kg). All three compounds are recognised as originating from the incomplete combustion of organic garden waste, in bonfires, fuels and vehicle exhausts. Given the hand pit location, immediately adjacent to the gardens belonging to Arborfield Mill House, it is anticipated that the elevated PAH concentrations recorded may have come from burnt garden waste. There occurrence is likely to be limited in extent and is expected to pose a low risk to human health.

7.3.10 In borehole WS08, the range of elevated PAH concentrations summarised in Table 7-1 are recognised as originating from incompletely combusted fuel and vehicle exhausts. The elevated TPH fraction and concentrations recorded are typical of dense phase hydrocarbons, such as diesel. This would support the origin of the recorded PAH concentrations coming from incompletely combusted fuel and vehicle exhausts. It should be noted that the clay rich Alluvial layer, recorded in borehole WS08 at between 1.75 m and 2.00 m depth, is expected to inhibit the downward migration of contaminants from the overlying Made Ground to the underlying granular deposits.

7.3.11 The dense phase hydrocarbon fractions recorded are generally considered to have low reactivity, mobility and volatility. Therefore, it is anticipated that the recorded PAH and TPH concentrations have likely originated from a vehicle or farm machinery parked at this location. These are expected to be limited in extent and pose little or no risk to human health.

River Terrace Deposits

7.3.12 For those chemical results recorded above LLOD, for the River Terrace Deposits, and summarised in Table 6-2, none were found to exceed the relevant GAC values for a residential end use.

London Clay Formation

7.3.13 For those chemical results recorded above LLOD, for the London Clay Formation, and summarised in Table 6-3, none were found to exceed the relevant GAC values for a residential end use.

7.4 Asbestos Analysis

7.4.1 The asbestos results returned show that no asbestos in soils, or Asbestos Containing Materials (ACMs), was present in the Made Ground, River Terrace Deposits and London Clay Formation samples tested.

7.4.2 Should any hitherto undiscovered asbestos, or ACMs, be encountered during construction works specialist advice should be informed immediately so that appropriate measures can be taken. The potential for the presence of significant undiscovered contamination at this site is considered to be low.

7.5 Summary of Risks to Human Health

Chemical Contamination

7.5.1 The Tier 2 human health risk assessment has shown that the River Terrace Deposits and London Clay Formation all recorded contaminant concentrations generally fall below the respective GACs for the proposed residential end use.

7.5.2 No asbestos, or ACMs, was recorded in the Made Ground, River Terrace Deposits or London Clay Formation samples tested.

7.5.3 In the Made Ground contaminant concentrations for heavy metals and non-metallic compounds, BTEX and MTBE all generally fall below the respective GACs for the proposed residential end use.

7.5.4 Elevated PAH and TPH has been identified at 2 of the 7 no number locations tested. The PAHs and dense phase TPH carbon fraction recorded are generally considered to have low reactivity, mobility and volatility. The investigation indicates that these contaminants are localised. Therefore, this can be easily remediated for by either employing a soil cap or excavating and disposing of the impacted Made Ground off-site.

8 CONTROLLED WATERS RISK ASSESSMENT

8.1 Introduction

Overview

8.1.1 A generic quantitative risk assessment has been undertaken to determine potential risks and impact to controlled waters from the presence of chemical contamination within the groundwater at the Assessment Site.

8.1.2 This section provides a summary of potential chemical contaminant concentrations encountered within groundwater samples collected following the ground investigation works and undertaken by RPS on 16th May 2025. The chemical concentrations recorded have been assessed to determine whether potential contamination risks are posed to controlled waters.

8.2 Generic Quantitative Risk Assessment

Introduction

8.2.1 The generic quantitative risk assessment involves the comparison of tabulated analytical results for groundwater samples taken from the Assessment Site with published Assessment Criteria (AC).

8.2.2 Groundwater chemical data collected by RPS, at the Assessment Site, has been screened against Environmental Quality Standards (EQS) for a freshwater scenario. These are as set out in the Water Framework Directive and are used for the protection of surface water bodies. UK Drinking Water Standards (DWS), applied in the context of potable water supply and aquifer protection, have been utilised where EQS are not available. For some parameters where no freshwater EQS are available, brackish / saltwater EQS have been used.

8.2.3 The controlled water receptors that have been identified at the Assessment Site are:

- Perched groundwater within the superficial River Terrace and Alluvial Deposits; and
- Water courses i.e. the River Loddon, Barkham Brook and two unnamed watercourses

8.2.4 Perched groundwater present within the River Terrace and Alluvial Deposits has been classed as a Secondary A Aquifer and the Assessment Site is located within a groundwater Source Protection Zone (SPZ). Groundwater abstractions have been recorded within the vicinity, associated with Arborfield Hall Farm. Perched groundwater within the River Terrace and Alluvial Deposits is likely to be in hydraulic continuity with the River Loddon. The groundwater table itself, is considered to be at depth within fractured / granular strata underlying the London Clay Formation. Therefore, both the perched groundwater and the River Loddon have been assessed as being receptors to contamination in on-site soils.

Groundwater Sampling Summary

8.2.5 During the recent ground investigation, 7 No. monitoring wells were installed across the Northeastern and Southwestern investigation Areas Assessment Site with installations within the River Terrace Deposits (WS02 to WS05), Made Ground/Alluvial Deposits (WS08) and the London Clay Formation (WS01 and WS09).

8.2.6 Following completion of the RPS intrusive investigation works, three groundwater monitoring rounds were undertaken, and samples taken (where possible) from WS02 to WS05 and WS08, across the Assessment Site.

8.2.7 The groundwater samples were analysed for a range of inorganic and organic contaminants and the laboratory analysis results are included within Appendix D. The results of the groundwater sampling for the Alluvial and River Terrace Deposits are summarised in the following sections.

8.2.8 In boreholes WS01 and WS09, within the London Clay Formation, insufficient groundwater was present to enable samples to be recovered, during the sampling round, or groundwater levels to be re-purged during subsequent monitoring visits.

River Terrace Deposits

8.2.9 Table 8-1 presents the groundwater data as outlined in Section 6 (Table 6-5) and is screened using appropriate criteria as summarised above. Only those results found to exceed the relevant screening values for the protection of controlled waters have been included in the table.

Table 8-1 - Summary of Chemical Groundwater Data Analysis Above LOD – River Terrace Deposits

Determinant	No. of Tests	DWS	EQS	Min Result	Max Result	Exceedance?	Location of Exceedances
Metals and Other Inorganics (ug/l)							
Dissolved Arsenic	**4**	**10**	50	<2.5	**38.8**	**1**	**WS04**
Dissolved Nickel	**4**	20	**4**	**10**	**12**	**4**	**WS02** **WS03** **WS04** **WS05**
Dissolved Zinc	**4**	-	**10.9**	**12**	**59**	**4**	**WS02** **WS03** **WS04** **WS05**
Total Cyanide	**4**	50	**1**	**<10**	**20**	**1**	**WS04**

8.2.10 Table 8-1 identifies exceedances against the EQS value for dissolved nickel, zinc and total cyanide for groundwater within the River Terrace Deposits. However, these concentrations do not exceed the value for DWS. Whilst the maximum concentration recorded for arsenic does not exceed the value for EQS, it does exceed the value for DWS.

8.2.11 The River Terrace Deposits are not being used for potable water abstractions and therefore the exceedance of dissolved arsenic against the DWS can be discounted. The single exceedance of total cyanide at WS04 is considered indicative of localised issue, likely relating to the overlying Made Ground at this location. It is not considered to be indictive of a plume that could impact the local water courses. The exceedances of Dissolved zinc and nickel are considered widespread and diffuse and are present in both the northeastern and southwestern investigation areas and are considered likely to be related the general use of pesticides and fertilisers for the wider farming activities at the Assessment Site. These exceedances are not considered to warrant specific remediation.

Alluvial Deposits

8.2.12 Table 8-2 presents the groundwater data as outlined in Section 6 (Table 6-6) and is screened using appropriate criteria as summarised above. Only those results found to exceed the relevant screening values for the protection of controlled waters have been included in the table.

Table 8-2 - Summary of Chemical Groundwater Data Analysis Data Above LOD – Alluvial Deposits

Determinant	No. of Tests	DWS	EQS	Result	Exceedance?	Location of Exceedance
Metals and Other Inorganics (ug/l)						
Dissolved Arsenic	**1**	**10**	50	**35.2**	**1**	**WS08**
Dissolved Nickel	**1**	20	**4**	**6**	**1**	WS08
Dissolved Zinc	**1**	-	**10.9**	**12**	**1**	**WS08**

Determinant	No. of Tests	DWS	EQS	Result	Exceedance?	Location of Exceedance
Total Cyanide	**1**	**50**	**1**	**80**	**1**	**WS08**
Polycyclic Aromatic Hydrocarbons (PAHs) (ug/l)						
Benzo(a)pyrene	**1**	**0.01**	**0.00017**	**0.043**	**1**	**WS08**

8.2.13 Table 8-2 identifies exceedances against the EQS value for dissolved nickel and zinc, which do not exceed the DWS for groundwater within the Alluvial Deposits. The recorded concentration for arsenic exceeds the DWS and not the EQS and for total cyanide exceeds both the EQS and DWS value. Slightly elevated concentrations were recorded for PAHs with the result for benzo(a)pyrene exceeding both the EQS and DWS.

8.2.14 The identified concentrations indicate a relatively low level of impact to groundwater at this location on the River Loddon floodplain (WS08). The source for these elevated concentrations is unknown, however, the chemicals recorded are commonly associated with fertilizers, pesticides and manure used in general agricultural practice. PAHs can also occur as a biproduct from burning organic waste.

8.3 Summary of Risks to Controlled Waters

8.3.1 The assessment of risk to controlled waters has identified that perched groundwater within the Alluvial and River Terrace Deposits beneath the Assessment Site should be considered a potential receptor. A review of contaminant concentrations within the perched groundwater has identified slightly elevated contaminant concentrations for dissolved arsenic, nickel and zinc, total cyanide and PAHs, for these deposits. Maximum recorded concentrations for nickel and zinc exceed the EQS and for arsenic the DWS whilst for total cyanide and benzo(a)pyrene, the results exceed both the EQS and DWS.

8.3.2 The recorded chemicals are commonly associated with fertilizers, pesticides and manure used in general agricultural practice and PAHs also occur as biproducts from burning organic waste. The chemical concentrations identified indicate a relatively low level and sporadic impact to the perched groundwater beneath the Assessment Site and potentially a limited impact on surface waters, i.e. the River Loddon.

8.3.3 It is expected that redevelopment of the Assessment Site will lead to the removal of the contaminant source recorded, which will likely diffuse over time. Therefore, it is considered that contaminant concentrations identified do not pose an unacceptable risk to controlled waters and no specific remediation is proposed.

9 GROUND GAS RISK ASSESSMENT

9.1 Introduction

9.1.1 This section provides a semi-quantitative assessment of ground gas risks, in particular carbon dioxide and methane, in line with UK best practice to determine the requirement for ground gas protection measures within the retained structures at the Assessment Site. The results of the gas monitoring rounds are discussed in the following section.

9.2 Risk Assessment

9.2.1 CIRIA Report C665 (CIRIA, 2007) and BS 8485 (BSI, 2019) represents the current best practice guidance in relation to ground gas assessment. It proposed a holistic approach to gas risk assessment, which takes account of the following factors:

- Nature of source and migration pathway;
- Borehole flow rate and surface emission rate;
- Frequency and distribution of elevated gas concentrations;
- Nature of proposed development; and
- Confidence and reliability of results.

9.2.2 These factors are described in the remainder of this section.

9.3 Gas Regime

9.3.1 Follow-on ground gas monitoring was undertaken over a three-week period between 23rd May and 9th June 2025.

9.3.2 A description of the gas regime at the Assessment Site is presented in the following sections.

Methane Concentration

Methane Peak Concentrations

9.3.3 No elevated methane concentrations were recorded above the limit of detection during the monitoring rounds.

Methane Steady Concentrations

9.3.4 No elevated methane concentrations were recorded above the limit of detection during the monitoring rounds.

Carbon Dioxide Concentrations

Carbon Dioxide Peak Concentrations

9.3.5 Recorded peak carbon dioxide concentrations ranged 0.9% v/v (WS04) and 7.1% v/v (WS08) over the monitoring period. Maximum carbon dioxide concentrations were recorded during round three.

Carbon Dioxide Steady Concentrations

9.3.6 Recorded stabilised carbon dioxide concentrations ranged between 0.1% v/v (WS04) and 7.1% v/v (WS08) over the monitoring period with the maximum steady readings being recorded during round three.

9.3.7 measured within wells during the four monitoring events ranged between 0.5 % v/v and 4.2 % v/v in WS06 and WS02 respectively. The maximum concentration was recorded during round three.

Flow Rate

Peak Flow Rates

9.3.8 Recorded peak flow rates were all at 0.0 l/h during the monitoring period.

Steady Flow Rates

9.3.9 Recorded steady flow rates were all at 0.0 l/h during the monitoring period.

Volatile Organic Compounds (VOC)

VOC Peak Concentrations

9.3.10 No elevated concentrations for VOCs were recorded during the monitoring period.

VOC Steady Concentrations

9.3.11 No elevated concentrations for VOCs were recorded during the monitoring period.

Other Gases

9.3.12 A peak and steady carbon monoxide concentration of 29.0 parts per million by volume (ppmv) was recorded in borehole WS09 during the first monitoring visit. However, during the remaining visits, no elevated carbon monoxide concentrations were recorded. No elevated carbon monoxide concentrations were recorded for the other borehole locations during the monitoring period.

9.3.13 A peak hydrogen sulphide concentration of 28.0 ppmv was recorded in borehole WS09 during the first monitoring visit with a corresponding steady value of 0.0 ppmv. During the remaining visits, no elevated hydrogen sulphide concentrations were recorded. No elevated hydrogen sulphide concentrations were recorded for the other borehole locations during the monitoring period.

9.3.14 It is considered that the carbon monoxide and hydrogen sulphide concentrations recorded in borehole WS09 during the first monitoring are not representative of the monitoring rounds as a whole.

Potential Gas Sources and Migration Pathways

Northeastern Investigation Area

9.3.15 Boreholes WS01, WS02 and WS09, undertaken within the Northeastern Investigation Area, were sunk to investigate the ground conditions and potential for migrating ground gas from a former landfill, adjacent to Carters Hill Farm. This area lies within the Gas Consultation Zone identified by Wokingham Borough Council.

9.3.16 In boreholes WS01 and WS09, a thin Topsoil cover was recorded to between 0.06 m and 0.25 m depth overlying clay rich strata belonging to the London Clay Formation, to the maximum borehole depths at 4.00 m bgl.

9.3.17 In borehole WS02, a Topsoil cover was recorded, to 0.20 m depth, overlying granular River Terrace Deposits to 1.20 m bgl. The River Terrace Deposits included a red brown silty gravelly medium to coarse sand layer, to 0.70 m depth, overlying grey mottled reddish brown very gravelly medium to coarse sand. Below 1.20 m depth, clay rich strata belonging to the to the London Clay Formation was encountered to the full borehole depth at 4.00 m bgl.

9.3.18 Recorded perched groundwater levels, within the River Terrace Deposits, in borehole WS02 ranged between 0.87 m and 0.90 m.

9.3.19 No evidence for visual or olfactory contamination was recorded within the soils collected from the boreholes during the intrusive investigation works. Screening for VOCs, whilst sinking the boreholes, did not reveal any volatile vapours within the retrieved soil arisings.

9.3.20 It is considered that the presence of clay rich strata (boreholes WS01, WS02 and WS09) and perched groundwater within the River Terrace Deposits (WS02) will act to inhibit the lateral migration of ground gases, through the ground, beneath this part of the Assessment Site.

Southwestern Investigation Area

9.3.21 Boreholes WS03 to WS05 and WS08 were sunk within the Southwestern Investigation Area, around Arborfield Hall Farm to investigate the presence for Made Ground associated with infilled former gravel pits, a historical tank and the former Arborfield (paper) Mill.

9.3.22 Made Ground was encountered in borehole WS03, at between 0.16 m and 0.60 m depth, in WS04, between the surface and 0.20 m depth and in WS08, at between 0.20 m and 1.20 m depth. Where encountered in boreholes, the Made Ground was typically described as dark brown and reddish brown or black gravelly sand or sandy gravel that included quartz, quartzite, limestone and brick.

9.3.23 In borehole WS05, at between the surface and 0.10 m depth, and WS08, to 0.20 m depth, Made Ground Topsoil was recorded that generally comprised brown gravelly organic rich sand. This material also included flint and brick and occasional roots and rootlets.

9.3.24 Made Ground was also recorded in trial pit TP07, located within the 'Old Quarry', to 1.60 m depth and in hand pits HP01 and HP02, located outside the Arborfield Mill House gardens, to between 0.35 m and 0.40 m depth. This material was generally described as light grey and brown to grey/black very gravelly sand and dark brown sandy gravelly silt that also included quartz, quartzite, brick and concrete.

9.3.25 No visual or olfactory evidence of contamination was recorded within the Made Ground or natural soils within these exploratory holes and no significantly deleterious organic material was identified in the Made Ground. Screening for VOCs, whilst sinking these exploratory holes, did not reveal any volatile vapours for the soil arisings retrieved.

9.3.26 Underlying the Made Ground and in other trial pits sunk within this area, granular River Terrace Deposits were recorded to between 0.40 m (TP03) and 2.10 m depth (WS05). In borehole WS08, granular soils interpreted as Alluvial Deposits were recorded below 1.75m depth.

9.3.27 Recorded perched groundwater levels, within the granular Alluvial and River Terrace Deposits ranged between 0.63 m (WS04) and 1.83 m (WS05).

9.3.28 The Made Ground thickness and its discontinuous nature encountered, beneath the Arborfield Hall Farm area, and the absence of putrescible materials within would suggest that ground gas production within the Made Ground is unlikely to be significant. Groundwater within the granular Alluvial/River Terrace Deposits is also likely to inhibit lateral ground gas migration through these deposits.

9.4 Defensibility of Gas Data

9.4.1 CIRIA C665, assessing risks posed by hazardous ground gases to buildings (CIRIA 2007), recommends that four readings are taken over one month at low sensitivity (commercial) sites where a very low gas source is identified.

9.4.2 A programme of three gas monitoring has been completed on site between the 23rd May and 9th June 2025. The monitoring works were undertaken during a period of sustained high pressures and 'worst-case' conditions as recommended by CIRIA guidance C665 have not been measured.

9.5 Gas Risk Assessment

9.5.1 The classification of a site's gas regime is governed by the concentration of the ground gas and the flow rate. This is reflected by the Gas Screening Value (GSV), which is calculated as the concentration of gas (expressed as a volumetric fraction) multiplied by the borehole flow rate, as per CIRIA C665 (CIRIA, 2007) and BS 8485 (BSI, 2019).

9.5.2 Given the proposed end-use as a mixed resident and commercial development, the modified Wilson & Card Classification method (Situation A) has been used to calculate GSV's to assess the risks to humans from methane and carbon dioxide, in line with guidance issued by CIRIA C665, as detailed in Table 9-1 below.

Table 9-1 - Modified Wilson and Card Classification

Characteristic Situation	Comparable Partners in Technology gas regime	Risk classification	Gas screening value (CH4 or CO2 (l/hr)	Additional Limiting Factors	Typical Source of Gas Generation
1	A	Very low risk	<0.07	Methane <1% and Carbon Dioxide <5% Otherwise consider increase to Situation 2.	Natural soils with low organic content
2	B	Low risk	<0.7	Borehole air flow rate >70l/hr increase to Characteristic Situation 3	Natural soil, high peat/organic content
3	C	Moderate risk	<3.5		Old landfill, inert waste, mineworking flooded
4	D	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protection measures	Mineworking susceptible to flooding, completed landfill, inert waste (WMP 26B criteria*)
5	E	High risk	<70		Mineworking unflooded inactive
6	F	Very high risk	>70		Recent landfill site

9.5.3 Table 9-2 provides a summary of the maximum peak gas concentration and maximum stabilised flow rates within each borehole identified during the monitoring programme and the Borehole hazardous gas flux (Borehole Qhg). The borehole Qhg does not represent the GSV for the Assessment Site.

9.5.4 Table 9-2 table also summarises the geology adjacent to the response zone at each location. Further details are included in the exploratory hole logs within Appendix A.

Table 9-2: Ground Gas Monitoring Results

Borehole	Screened Strata	Depth range of screen (m BGL)	Max Steady Flow Rate	Maximum CO2 % (v/v)	Maximum CH4 % (v/v)	Borehole hazardous gas flux (Q_{hg}) CO_2	Borehole hazardous gas flux (Q_{hg}) CH_4
WS01	London Clay Formation	0.50 – 4.00	0	3.7	0	0.000	0.000
WS02	River Terrace Deposits and London Clay Formation	0.50 – 1.50	0	4.6	0	0.000	0.000
WS03	River Terrace Deposits	0.50 – 2.00	0	7.0	0	0.000	0.000
WS04	River Terrace Deposits	0.50 – 1.00	0	2.2	0	0.000	0.000
WS05	River Terrace Deposits	0.50 – 2.00	0	2.3	0	0.007	0.000
WS08	Made Ground and Alluvial Deposits	0.50 – 2.00	0	7.1	0	0.000	0.000
WS09	London Clay Formation	0.50 – 4.00	0	2.4	0	0.000	0.000

9.5.5 As required by BS8485 a Worse Case hazardous gas flux has been calculated (Worse Case Qhg) for each gas generating unit of the Assessment Site (Made Ground and Natural Ground). The Worse Case Qhg has been calculated using the maximum peak gas concentrations and maximum stabilised flow rate within each stratum beneath the Assessment Site considered as a whole. As borehole slotted sections transitioned between Made Ground and the natural deposits the following units are presented:

- Made Ground and Alluvial Deposits;
- River Terrace Deposits;
- River Terrace Deposits and London Clay Formation; and
- London Clay Formation.

9.5.6 This is presented within Table 9-3.

Table 9-3 Modified Gas Monitoring Results Summary

Strata	Peak Flow (l/h)	Maximum CH4 (%v/v)	Maximum Gas Screening Value (CH4) (l/h)	Maximum CO2 (%v/v)	Maximum Gas Screening Value (CO2) (l/h)
Made Ground and Alluvial Deposits	0	0	0.000	7.1	0.000
River Terrace Deposits	0	0	0.000	7.0	0.007
River Terrace Deposits and London Clay Formation	0	0	0.000	4.6	0.000
London Clay Formation	0	0	0.000	3.7	0.000

9.5.7 Representative worst case scenarios for the Assessment Site have been calculated for both methane and carbon dioxide, based on maximum steady flow concentrations and maximum gas flow rates.

9.5.8 Comparing GSVs with borehole gas volume flow rates, calculated on the basis of maximum steady concentrations and flow rates, indicates a Characteristic Situation 1 (CS 1) for all Made Ground and natural soil scenarios.

9.5.9 However, it should be noted that around Arborfield Hall Farm, during the first and third monitoring rounds, elevated carbon dioxide concentrations were recorded, in boreholes WS03 (at 6.0% v/v and 7.0% v/v) and WS08 (5.3% v/v and 7.1% v/v), above the 5% threshold value. Where this situation arises, CIRIA C665 recommends that consideration should be given to increasing the Characteristic Situation up a level, i.e. to CS 2.

9.6 Summary of Ground Gas Risks

9.6.1 Identified gas concentrations, flow rates and the gas risk indicate that the Assessment Site is likely to fall within CS 1. However, elevated carbon dioxide concentrations, above the 5% threshold limit, indicate that the Characteristic Situation CS2 may be appropriate in the area around Arborfield Hall Farm, in the Southwestern Investigation Area.

9.6.2 Undertaking further monitoring rounds, targeting periods of low and falling atmospheric pressure, would help to confirm this.

10 CONCLUSION AND RECOMMENDATIONS

10.1.1 RPS Consulting Services Ltd (RPS) was commissioned by the University of Reading (the Client) to undertake a preliminary phase of targeted intrusive ground investigation works on land belonging to the University of Reading (UoR), south of the M4 motorway in support of a planning application for a mixed use development.

10.1.2 The intrusive ground investigation works are required to provide an initial assessment of a small number of areas within the Assessment Site boundary where previous uses indicate the potential for localised areas of contamination.

10.1.3 The ground investigation works included sinking 7 No. shallow windowless sample boreholes, 5 No. trial pits and 2 No. hand pits across two areas identified as the Northeastern Investigation Area, associated with a Gas Consultation Zone, and the Southwestern Investigation Area, around Arborfield Hall Farm. During the ground investigation works, soil samples were collected for logging purposes and chemical analysis and samples were screened for VOCs. Following the investigation works, perched groundwater samples were collected for chemical analysis, and groundwater and ground gas was monitored over a three-week period.

10.1.4 The Tier 2 human health risk assessment has shown that the River Terrace Deposits and London Clay Formation all recorded contaminant concentrations generally fall below the respective GACs for the proposed residential end use. Within the Made Ground there were localised areas where contaminants exceeded the GACs and mitigation in the form of capping and / or source removal would be required.

10.1.5 No asbestos, or ACMs, was recorded in the Made Ground, River Terrace Deposits or London Clay Formation samples tested.

10.1.6 The assessment of risk to controlled waters has identified that perched groundwater within the Alluvial and River Terrace Deposits beneath the Assessments Site should be considered a potential receptor. A review of contaminant concentrations within the perched groundwater has identified slightly elevated contaminant concentrations for dissolved arsenic, nickel and zinc, total cyanide and PAHs, for these deposits. Maximum recorded concentrations for nickel and zinc exceed the EQS and for arsenic the DWS whilst for total cyanide and benzo(a)pyrene, the results exceed both the EQS and DWS.

10.1.7 The recorded chemicals are commonly associated with fertilizers, pesticides and manure used in general agricultural practice and PAHs also occur as biproducts from burning organic waste. The chemical concentrations identified indicate a relatively low level and sporadic impact to the perched groundwater beneath the Assessment Site and potentially a limited impact on surface waters, i.e. the River Loddon.

10.1.8 It is expected that redevelopment of the Assessment Site will lead to the removal of the contaminant source recorded, which will likely diffuse over time. Therefore, it is considered that contaminant concentrations identified do not pose an unacceptable risk to controlled waters and no specific remediation is proposed.

10.1.9 Identified gas concentrations, flow rates and the gas risk indicate that the Assessment Site is likely to fall within CS 1. However, elevated carbon dioxide concentrations, above the 5% threshold limit, indicate that the Characteristic Situation should be increased to CS2 around Arborfield Hall Farm, in the Southwestern Investigation Area. Undertaking further monitoring rounds, targeting periods of low and falling atmospheric pressure, would help to confirm this.

Drawings

Drawing 1 **794-ENV-GDE-21850, DWG-002: Exploratory Hole Location Plan**

Appendices

Appendix A

Exploratory Hole Logs

Appendix B

Monitoring Results

Appendix C

Soil Chemical Results

Appendix D

Groundwater Chemical Results