

Technical Note

Project: 816 Oxford Road, Reading

SMA Ref: 6799

Subject: Surface Water Drainage Strategy & Statement Doc Ref. 6799 – DSTN Issue 02

Prepared by: MLP

Date: November 2021

Checked by: JOK

Date: November 2021

1.0 INTRODUCTION

- 1.1 Stuart Michael Associates has been instructed by John Filbee Properties Ltd to provide a surface water drainage strategy for 816 Oxford Road, Reading, RG30 1EL, which is approximately 0.23 hectares.
- 1.2 The planning is for the redevelopment of the site from commercial/light industrial buildings and associated hardstanding to two residential blocks, one three-storeys in height and one six-storeys in height, to provide 24 residential dwellings, associated car parking, cycle and bin storage and landscaping.
- 1.3 The Ordnance Survey national grid reference for the approximate centre of the site is 468804E, 174093N.
- 1.4 This Technical Note has been produced in accordance with the Reading Borough Council Sustainable Design and Construction Supplementary Planning Document adopted December 2019, Reading Borough Council Local Plan adopted November 2019, and CIRIA SuDS Manual C753.
- 1.5 The proposed site layout is included as **Appendix A**.

2.0 EXISTING DRAINAGE

- 2.1. The topographical survey indicates a number of existing manhole covers to the front and back of the site.
- 2.2. The topographical survey undertaken by Peter J.H.Roberts and Associates is included as **Appendix B**.

3.0 SURFACE WATER DRAINAGE STRATEGY

- 3.1. The destination for surface water runoff should be prioritised as set out in Requirement H3 Part 3 of the Building Regulations Approved Document H (2002 Edition), which states:

Rainwater should discharge to one of the following listed in order of priority:

- (a) An adequate soakaway or some adequate infiltration system; or, where this is not reasonably practicable,
- (b) A watercourse; or, where that is not reasonably practicable,
- (c) A sewer

- 3.2. There are no watercourses within the vicinity of the site.

- 3.3. British Geological Survey (BGS) mapping indicates that the site is underlain by superficial deposits of Taplow Gravel Member (sand and gravel), and bedrock geology of chalk consisting of the Seaford Chalk Formation and Newhaven Chalk Formation (undifferentiated).
- 3.4. A ground investigation of the site was undertaken by Ground and Water Limited with 3 Trial Pits (TP) and 4 Windowless Sampler Boreholes (WS).
- 3.5. All 3 Trial Pits consisted of 'made ground' from 0m to 0.5m. For TP1, this was concrete from 0m to 0.15m and for TP2 and TP3 this was tarmac from 0m-0.1m. Below the 'made ground', all 3 trial pits consisted of 'Orangish brown gravelly clayey fine to medium sand. Gravel if sub-angular fine to medium flint (Taplow Gravel Member)'.
- 3.6. WS4 terminated at 0.8m due to encountering an unknown solid surface. All boreholes began with 'made ground' from 0m to 0.4m at WS1, to 0.5m at WS2, to 0.6m at WS3. WS2 and WS3 both encountered Undifferentiated Seahaven Chalk and Newhaven Chalk Formations at 4.8m to 5m and 4.3m to 5m respectively. Below the 'made ground' to the end of the borehole at WS1 variants of the Taplow Gravel Member were found. Between the 'made ground' and chalk formations at WS2 and WS3, variations of the Taplow Gravel Member were also encountered.
- 3.7. Infiltration testing was undertaken in accordance with BRE365 at the site as part of the ground investigation study. **Table 1** shows the results of the infiltration testing undertaken at the site.

Trial Pit	Test	Infiltration Rate (m/s)
TP1	Test 1	1.971 x 10 ⁻⁵
	Test 2	2.451 x 10 ⁻⁵
	Test 3	2.080 x 10 ⁻⁵
TP2	Test 1	1.747 x 10 ⁻⁵
	Test 2	1.077 x 10 ⁻⁵
TP3	Test 1	1.180 x 10 ⁻⁵
	Test 2	9.563 x 10 ⁻⁶

Table 1: Infiltration testing results.

- 3.8. Groundwater was encountered at 3.1m bgl at WS1, and at 0.7m bgl at WS4 and WS4a but these are considered to be perched groundwater.
- 3.9. A copy of the ground investigation and soakaway tests has been included in **Appendix C**.
- 3.10. Due to the geology underlying the site and the infiltration rates found through soakaway testing, it is considered that infiltration methods will be feasible for the disposal of surface water runoff from the proposed development.
- 3.11. **Table 2** shows that the proposed development will lead to a 24% decrease in impermeable area for the site.

Areas	Existing (ha)	Proposed (ha)
Impermeable Area	0.23	0.17

Table 2: Pre and Post-Development Impermeable Areas

- 3.12. Reading Borough Council SuDS guidance states that all major developments must incorporate SuDS as appropriate (outlined in Policy EN18: Flooding and Sustainable Drainage Systems)

and in line with the Government's Technical Standards. Smaller schemes are encouraged to incorporate SuDS where possible.

3.13. Policy EN18:

“Development will be directed to areas at lowest risk of flooding in the first instance, following the Sequential and Exceptions Test set out in the NPPF, and taking into account the effects of climate change. It will consider flooding from all sources, including fluvial, surface water, groundwater and sewer flooding. Where development in areas at risk of flooding is necessary, it will not reduce the capacity of the flood plain to store floodwater, impede the flow of floodwater or in any way increase the risks to life and property arising from flooding. Wherever possible, development should be designed to reduce flood risk, both on-and off-site”.

- 3.14. It is proposed that all surface water from the redevelopment will infiltrate into the ground through porous pavements in the access road. Crate soakaways are proposed to be provided beneath a section of the pervious pavement to provide further storage of surface water runoff before infiltration into the ground.
- 3.15. Surface water runoff from hardstanding areas will run towards the permeable paving and infiltrate into the ground, and runoff from roof areas will be collected by surface water drains and discharged into the sub-base of the pervious paving, where all surface water will infiltrate into the ground.
- 3.16. Primary attenuation storage will provided within the porous paving on the access road and in the crate soakaways beneath the porous paving which will provide attenuation storage for all storm events up to and including the 1 in 100 year plus 40% climate change event.
- 3.17. The surface water drainage strategy is included as **Appendix D**.
- 3.18. Surface water calculations are included as **Appendix E**.

4.0 WATER QUALITY MANAGEMENT

- 4.1. Appropriate pollution control measures will be included in the surface water drainage system to minimise the risk of contamination or pollution entering the receiving groundwater from surface water runoff from the development.
- 4.2. **Table 3** details the pollution hazard indices for the site as stated by CIRIA C753. The indices range from 0 (no pollution hazard for this contaminant type) to 1 (high pollution hazard for this contaminant type).

Land Use	Pollution Hazard	Total Suspended solids (TSS)	Metals	Hydro-carbons
Individual property driveways, residential car parks, low traffic roads and non-residential car parking with infrequent change	Low	0.5	0.4	0.4

Table 3: Pollution Hazard indices for land use classification

- 4.3. In accordance with CIRIA Report C753: The SuDS Manual, a “SuDS Management Train” process will be undertaken to assure that the proposed drainage strategy provides appropriate levels of risk management for the receiving sewer, as shown in **Table 4**.

SuDS Component	Interception	Primary Treatment	Secondary Treatment
Pervious pavements	Y	Y	

Table 4: Indicative suitability of SuDS components within the Management Train

- 4.4. To deliver adequate treatment, selected SuDS components must have a total pollution index (for each contaminant type) that equals or exceeds the pollution hazard index. The proposed SuDS components for the site, and their mitigation indices, are produced in **Table 5**.

SuDS Component	Total Suspended solids (TSS)	Metals	Hydro-carbons
Constructed permeable pavement (where a suitable filtration layer is included that provides treatment, and including a geotextile at the base separating the foundation from the subgrade) underlain by a soil with good containment attenuation potential of at least 300mm in depth.	0.7	0.6	0.7

Table 5: Indicative SuDS mitigation indices for discharges to groundwater.

- 4.5. For the redevelopment of the site into residential dwelling, it is considered that sufficient pollution treatment is provided within the proposed SuDS Management Train to surface water before infiltrating into the ground, minimising risk to water quality.
- 4.6. The porous paving will also be able to deal with the ‘first flush’ from short rainfall events.
- 4.7. A typical maintenance schedule for porous pavements and crate soakaways in line with The SuDS Manual C753 is included as **Appendix F**.

Appendix A

Proposed Layout

Rev.	Date	Note	Author	Checked
-	-	-	-	-



Appendix B

Topographical Survey



Survey Notes
Insertion Point to OS
Stn.1 468798.977 174057.569

Survey Co-Ords
 Stn.1 8798.977 4057.569 41.603
 Stn.2 8771.057 4074.682 41.493
 Stn.3 8742.750 4096.150 41.344
 Stn.4 8817.706 4087.962 40.469

A0 sheet 1:200

Peter J. H. Roberts

Peter J.H. Roberts
& Associates
LAND & MEASURED BUILDING SURVEYS
 14, Falstaff Avenue, Earley
 Reading, Berkshire, RG6 5TQ
 Tel: 01189 871966 Mobile: 07970 457986
 Email: pjroberts@btinternet.com

Client	JOHN FILBEE PROPERTIES LTD
--------	----------------------------

Project	816 OXFORD ROAD,READING
---------	-------------------------

Drawing Title	SITE SURVEY
---------------	-------------

Scale	1:200	Date	23/8/2017
Survey Notes			
Grid & Levels Related to OS bt survey grade GPS			

Drawing No.	Revisi
-------------	--------

023821.DWG		ISS	
Drawn	ACAD	Operator	PJHR
Plotted	HP600	Issued	1/9/2

Appendix C

Ground Investigation

Phase 2 Site Investigation Report

816 Oxford Road, Reading, Berkshire, RG30 1EL

On behalf of John Filbee Properties Ltd

Report Reference: GWPR4463/SIR/December 2021			Status: Final
Issue	Prepared By	Checked By	Verified By
v.1.01			
	Emily Sillence MSc Engineer	Miltiadis Mellios MSc(Eng) GMICE Principal Engineer	Francis Williams MGeol (Hons) FGS CEnv AGS CGeol Director

Site Investigations | Environmental Consultants | Geotechnical Engineers

2 The Long Barn, Norton Farm, Selborne Road, Alton, Hampshire GU34 3NB
0333 600 1221 enquiries@groundandwater.co.uk groundandwater.co.uk

Registered Office: Kineton House, 31 Horse Fair, Banbury, Oxfordshire OX16 0AE Registered in England No. 07032001

Table of Contents

Table of Contents.....	i
EXECUTIVE SUMMARY	iii
1. INTRODUCTION.....	1
1.1. General.....	1
1.2. Aims of the Investigation	1
1.3. Conditions and Limitations	1
2. SITE SETTING	2
2.1. Site Location.....	2
2.2. Site Description	2
2.3. Proposed Development	2
2.4. Geology	2
2.4.1. On-site Geological Formations.....	2
2.4.2. Off-site Geological Formations	3
2.5. Hydrogeology and Hydrology.....	4
2.6. Radon	5
2.7. Internet Search (Site Setting).....	5
2.7.1. Available Unexploded Ordnance (UXO) Map Review	5
2.7.2. Historical Landfill Tool Review	5
2.8. Preliminary Risk Assessment.....	5
3. SITE WORKS.....	10
3.1. Scope of Works	10
3.2. Sampling Procedures	10
4. ENCOUNTERED GROUND CONDITIONS	11
4.1. Soil Conditions.....	11
4.2. Roots Encountered.....	11
4.3. Groundwater Conditions.....	12
4.4. Obstructions.....	12
5. ENGINEERING CONSIDERATIONS.....	13
5.1. Surface Water Disposal	13
6. CONTAMINATION RISK ASSESSMENT	15
6.1. Results of the Phase I Risk Assessment.....	15
6.2. Sampling Locations	16
6.3. Soil Risk Assessment	17

6.3.1.	Soil Assessment Criteria and Results	18
6.3.2.	Soil Assessment.....	20
6.3.3.	Sub-surface Concrete Design	21
6.3.4.	Water Supply Pipe Risk Assessment	21
6.4.	Groundwater Risk Assessment	22
6.5.	Ground Gas Risk Assessment	23
6.5.1.	Pragmatic Approach.....	23
6.5.2.	Data Quality	24
6.5.3.	Risk Assessment	24
6.5.1.	Vapours	25
6.6.	Updated Conceptual Site Model.....	25
6.7.	Recommendations and Remediation Strategy	29
6.7.1.	Soils	29
6.7.1.1.	Change in Level	29
6.7.1.2.	Geotextile Marker Membrane.....	30
6.7.1.3.	490mm Clean Capping of Soil	30
6.7.1.4.	Validation	30
6.7.1.5.	Water Supply Pipes.....	30
6.7.2.	Groundwater.....	30
6.7.3.	Ground Gas	30
6.8.	Discovery Strategy	31
6.9.	Imported Material.....	31
6.10.	Waste Disposal.....	31
6.11.	Duty of Care	32
FIGURES.....		
APPENDIX A: Conditions and Limitations.....		
APPENDIX B: Trial Hole Logs		
APPENDIX C: Chemical Laboratory Testing.....		
APPENDIX D: Soil Assessment Criteria		
APPENDIX E: Asbestos Risk Assessment		
APPENDIX F: Hazard Waste Assessment.....		

EXECUTIVE SUMMARY

PROPOSED DEVELOPMENT	At the time of reporting, December 2021, the proposed development was understood to comprise the demolition of existing light industrial buildings and site clearance followed by construction of 25No. residential dwellings in two blocks of flats with associated amenity space, car parking, bin and cycle storage. Block A (six-storey structure) was located in the south of the site facing Oxford Road, with Block B (three-storey structure) located in the north of the site and space for 25No. parking spaces between the two blocks. Bin stores and bike stores were associated with each block. Areas of soft landscaping were proposed to the north-east and south-west of Block A, with private gardens proposed to the north-east of Block B.
GEOLOGY	The British Geological Survey Solid and Drift Geology Map for the Reading area (Reading Sheet No. 268) revealed that the site was underlain by the superficial Taplow Gravel Member and bedrock deposits of the Undifferentiated Seaford Chalk Formation and Newhaven Chalk Formation. Superficial Head Deposits were noted ~30m south and east of the site, Alluvium ~100m north-east, and the Langley Silt Member ~150m north-east of the site. Bedrock deposits of the Lambeth Group were located 100m south of the site. No other superficial deposits, outcrops of bedrock deposits or areas of Made/Worked Ground were noted within a 250m radius of the site.
HYDROGEOLOGY	A study of the aquifer maps on the DEFRA website revealed the site was underlain by a Secondary A Aquifer comprising the superficial Taplow Gravel member, underlain by Principal Aquifer comprising bedrock deposits of the Undifferentiated Seaford Chalk and Newhaven Chalk Formations. Examination of the Environment Agency records showed that the site did not fall within a Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater. No surface water features were present within a 250m radius of the site. The nearest surface water feature the River Thames located approximately 530m north of the site flowing in a west to east direction. From analysis of hydrogeological and topographical maps the actual groundwater table was anticipated to be encountered at shallow depths within the Taplow Gravel Member. Some amounts of groundwater however may be present at shallower depths within Made Ground. It was considered that groundwater was flowing in a northerly direction toward the River Thames in line with local topography. Examination of the Environment Agency records showed that the site was located within a Flood Zone 1, i.e. an area with a low probability of flooding. A flood zone 2 is located within 50m of the site to the north.
SUB-SURFACE CONCRETE	According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Class of DS-1 could be used for sub-surface concrete in contact with the soils beneath the site. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.

CONTAMINATION	Based on the results of the intrusive works, chemical analyses and risk assessments undertaken, the following has been identified that requires further action: • Five contaminants (Asbestos, Lead, Benzo(a)pyrene, Benzo(b)fluoranthene, and Dibenzo(a,h)anthracene) have been found at an unacceptable concentrations within the soils across the site. • Elevated TPHs identified indicate that barrier pipes may be required. An Asbestos Management Strategy should be put in place so that any potentially asbestos containing materials are identified and removed from site in a suitable manner to prevent cross-contamination. It was proposed that the following remedial methodology should be undertaken within all garden areas, including soft landscaping: • The removal of Made Ground in the vicinity of WS3; • A 490mm clean capping of soils overlying a geotextile marker membrane; • Validation of the geotextile marker membrane and clean capping system by a suitably trained Ground and Water Limited engineer.
----------------------	--

1. INTRODUCTION

1.1. General

Ground and Water Limited were instructed by John Filbee Properties Ltd, on the 29th September 2021, to conduct a Ground Investigation on the site at 816 Oxford Road, Reading, Berkshire, RG30 1EL. The scope of the investigation was detailed within a fee proposal GWQ6826, dated 22nd September 2021.

1.2. Aims of the Investigation

The aim of the investigation was understood to be to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development with special reference to former and present day potential contaminative uses and their impact on sensitive receptors, these being human health, controlled waters, buildings, building materials and services.

The scope of this report did not include comments / recommendations on geotechnical related aspects / foundation design.

A contamination assessment was to be undertaken following chemical laboratory testing on soil samples recovered from the site to enable recommendations for the safe redevelopment of the site and the protection of site workers, end-users and the public from any potential contamination identified.

The techniques adopted for the investigation were chosen considering the anticipated ground conditions and development proposals on-site, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3. Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

This Ground Investigation Report must be read in conjunction with the Desk Study Report referenced GWPR4463/DS/November 2021.

2. SITE SETTING

2.1. Site Location

The site comprised a ~2300m² approximately rectangular-shaped plot of land, orientated in a north-east to south-west direction, along the north-eastern side of Oxford Road (A329). The site was located in the western portion of Reading, Berkshire.

The national grid reference for the centre of the site was approximately SU 68804 74093. A site location plan is given within Figure 1. A plan showing the site area is given within Figure 2.

2.2. Site Description

The site was occupied by detached one- and two-storey industrial buildings located in the north-west and southern half of the site with a tarmac and concrete car park occupying the north-eastern portion of the site, joined to Oxford Road by an access road to the south-east. A partially covered yard was located in the south-west of the site. The covering of the site was noted to be entirely hardstanding, with the exception of a small strip of dense vegetation in the northern corner of the site.

An aerial view of the site showing an approximate site boundary is given within Figure 3.

2.3. Proposed Development

At the time of reporting, December 2021, the proposed development was understood to comprise the demolition of existing light industrial buildings and site clearance followed by construction of 25No. residential dwellings in two blocks of flats with associated amenity space, car parking, bin and cycle storage. Block A (six-storey structure) was located in the south of the site facing Oxford Road, with Block B (three-storey structure) located in the north of the site and space for 25No. parking spaces between the two blocks. Bin stores and bike stores were associated with each block. Areas of soft landscaping were proposed to the north-east and south-west of Block A, with private gardens proposed to the north-east of Block B.

The proposed development plan can be seen within Figure 4.

2.4. Geology

The British Geological Survey Solid and Drift Geology Map for the Reading area (Reading Sheet No. 268) revealed that the site was underlain by the superficial Taplow Gravel Member and bedrock deposits of the Undifferentiated Seaford Chalk Formation and Newhaven Chalk Formation. Superficial Head Deposits were noted ~30m south and east of the site, Alluvium ~100m north-east, and the Langley Silt Member ~150m north-east of the site. Bedrock deposits of the Lambeth Group were located 100m south of the site. No other superficial deposits, outcrops of bedrock deposits or areas of Made/Worked Ground were noted within a 250m radius of the site.

Superficial deposits (Drift) are the youngest geological deposits formed during the most recent period of geological time. They rest on older deposits or rocks referred to as bedrock (Solid), which are the main mass forming the Earth. Bedrock is present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

2.4.1. On-site Geological Formations

Taplow Gravel Formation

The rivers of the south-east of England, including the River Thames and its tributaries, have been subject to at least three changes of level since Pleistocene times. One result has been the formation of a complex series of River Terrace Gravels. These terraces represent ancient floodplain deposits that became isolated as the river cut downwards to lower levels. The Lower River Terraces are numbered one to four, the lowest and most recent being number one. The composition of the River Terrace Gravel varies greatly, depending on the source material available in the river's catchment. Deposits generally consist of sand and gravel of roughly bedded flint or chert commonly in a matrix of silt and clay.

Seaford Chalk Formation

The Seaford Chalk Formation is composed mainly of soft white chalk with seams of large nodular and semi-tabular flints. Near the base, thin harder nodular chalks also occur, associated with seams of carious flints. The Seaford Chalk Formation is 40 – 65m thick. High in the sequence, the flints are black and bluish black, mottled grey with a thin white cortex and commonly contain shell fragments.

Occasional erosional features, such as pipes, swallow holes and solution cavities, usually in-filled with drift deposits; can be found in the chalk deposits. These features sometimes manifest themselves at the surface as shallow circular depressions. Solution features may be reactivated by the concentrated ingress of water from leaking drains or soakaways. Reactivation may lead to surface collapse.

Newhaven Chalk Formation

The Newhaven Chalk Formation is composed of soft to medium hard, smooth, white chalk with numerous marl seams and flint bands. Abundant zoophycos flints occur near the base and its yields a distinctive crinoids fauna. The Newhaven Chalk Formation is 45-75m thick.

Occasional erosional features, such as pipes, swallow holes and solution cavities, usually in-filled with drift deposits; can be found in the chalk deposits. These features sometimes manifest themselves at the surface as shallow circular depressions. Solution features may be reactivated by the concentrated ingress of water from leaking drains or soakaways. Reactivation may lead to surface collapse.

2.4.2. Off-site Geological Formations

Head Deposits

The majority of Head Deposits are clay-dominated, derived from the London Clay. Generally, less than 2m thick, they probably accumulated in shallow mudslides of softened brecciated bedrock in the active layer. They consist of soft, ochreous brown silty clay with blue-grey mottling in places and angular, frost-shattered fragments of flint occur sporadically throughout. At the base of these deposits and interbedded in places, there is a bed of pebbly clay, generally less than 0.2m thick, with well-rounded flint pebbles derived from nearby outcrops of 'high level' gravel such as Stanmore Gravel.

Alluvium

Most small streams in the region are bordered by narrow alluvial strips. The alluvial sequences of small streams in the district are variable in detail but typically consist of up to 1.5m of clayey sands and silty clays, locally with scattered flints, resting on up to 1.5m of flint gravel.

Langley Silt Member

The Langley Silt Member, formerly known as Brickearth, comprises a geologically recent deposit of brown structureless sandy clay of limited thickness that usually overlies River Terrace Gravels in the area of the site. Its original name is derived from its former use in the manufacture of bricks.

Lambeth Group Beds

The Lambeth Group (formerly known as the Woolwich and Reading Beds) is a sedimentary complex comprising a basal bed (the Upnor Formation also known as the Bottom Bed) composed of glauconitic sand, sandy clay and gravel (well-rounded flint pebbles), with laterally variable sand and clay above. In the eastern part of the area the basal bed is mostly overlain by a shelly grey sandy clay or silty sand and laminated beds (Woolwich Formation). At the top of the sedimentary complex is the Reading Formation, which is made up of multi-coloured mottled clays and silty clays.

A BGS borehole (SU67SE545) located ~10m south-west of the site revealed a 0.15m capping of Tarmac over Made Ground consisting of medium dense dark brown/black silty sand (Fill) with ash and stones to 0.55m bgl. From 0.55-1.60m bgl a Medium dense brown silty Sand with occasional gravel was recorded and a clayey silty sand with occasional gravel was recorded from 1.60-2.20m bgl. From 2.20-2.90 a medium dense light brown gravelly silty sand with large flints was recorded overlying the soft to firm remolded Chalk with some intact chalk with flints (Grade 5) to the base of the borehole at 3.70m bgl. No groundwater was noted.

2.5. Hydrogeology and Hydrology

A study of the aquifer maps on the DEFRA website revealed the site was underlain by a **Secondary A Aquifer** comprising the superficial Taplow Gravel member, underlain by **Principal Aquifer** comprising bedrock deposits of the Undifferentiated Seaford Chalk and Newhaven Chalk Formations.

Secondary aquifers include a wide range of drift deposits with an equally wide range of water permeability and storage capacities. **Secondary A Aquifers** consist of deposits with permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as Minor Aquifers.

A **Principal Aquifer** is a layer of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.

Examination of the Environment Agency records showed that the site **did not** fall within a Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater.

No surface water features were present within a 250m radius of the site. The nearest surface water feature the River Thames located approximately 530m north of the site flowing in a west to east direction.

From analysis of hydrogeological and topographical maps the actual groundwater table was anticipated to be encountered at shallow depths within the Taplow Gravel Member. Some amounts of groundwater however may be present at shallower depths within Made Ground. It was considered

that groundwater was flowing in a northerly direction toward the River Thames in line with local topography.

Examination of the Environment Agency records showed that the site was located within a Flood Zone 1, i.e. an area with a low probability of flooding. A flood zone 2 is located within 50m of the site to the north.

2.6. Radon

BRE 211 (2015) Map 4 of the Hampshire, Berkshire and South Oxfordshire area indicated that the site **was not** located within an area where mandatory protection measures against the ingress of radon were likely to be required.

A review of the freely available Public Health England radon database, UK Radon, indicated that the site was located within a 1km grid square, where the maximum radon potential of <1% was recorded. The neighbouring 1km grid square to the north was noted to have a maximum radon potential of 1 – 3%. Basic radon protection measures are required in areas where more than 3% of houses are at or above the Action Level.

The site was in an area where a risk assessment was not required.

2.7. Internet Search (Site Setting)

2.7.1. Available Unexploded Ordnance (UXO) Map Review

A review of the data available on www.zeticauxo.com/ revealed the site was located within a low -risk area associated with unexploded ordnance (UXO), as indicated by having <15 bombs dropped per 1000 acres. The maps show 1No. know Luftwaffe Bombing Target site located ~790m east of the site.

2.7.2. Historical Landfill Tool Review

A review of the data available on www.groundsure.io/ revealed no areas of Historical Landfills or authorised landfills within a 250m radius of the site.

2.8. Preliminary Risk Assessment

The tabulated Conceptual Site Model developed as part of the Ground and Water Ltd Desk Study (GWPR4463/DS/November 2021) is outlined overleaf. For ease of reference and understanding, the risks have been classified within this risk assessment against four possible levels / categories, summarised in the table below.

Risk Categories used in the Tabulated CSM	
Negligible	Regarding this potential SPR linkage, the site is considered suitable for the proposed end-use and there is no plausible risk. Therefore, there is no need to further assess this potential source of contamination.
Low Risk	Regarding this potential SPR linkage, the site is considered suitable for the proposed end-use and there is not considered to be an unacceptable risk to receptors. However, it is considered that further investigation to confirm this is recommended.
Moderate Risk	Regarding this potential SPR linkage, the site may not be suitable for the proposed end-use in its current condition and there may be an unacceptable risk to receptors. Further investigation is required to confirm this.

High Risk

Regarding this potential SPR linkage, the site is probably or certainly not suitable for proposed end-use and there is likely to be an unacceptable risk to receptors. Contaminants probably or certainly present and urgent action required in the short term.

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(On-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Made Ground from construction/demolition activities: - Asbestos, - PAHs, - TPHs, - VOCs, - Sulphates, and - Metals.	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Ingestion of home-grown produce, and soils attached - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public	Moderate
	- Direct uptake of groundwater - Direct uptake of determinands in the soil	Flora and Fauna Vegetation within soft landscaped areas	Moderate
	- Anthropogenic (man-made) pathways - Vertical and lateral migration in permeable strata - Surface water runoff	Controlled Waters - Secondary A Aquifer (Taplow Gravel Member); - Principal Aquifer (Seaford Chalk Formation and Newhaven Chalk Formation)	Moderate
Made Ground from former garage site and light industrial works: - Asbestos, - PAHs, - TPHs, - VOCs, - Solvents, - Sulphates, and - Metals (lead).	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Ingestion of soils attached - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public	Moderate
	- Direct uptake of groundwater - Direct uptake of determinands in the soil	Flora and Fauna Vegetation within soft landscaped areas	Moderate
	- Anthropogenic (man-made) pathways - Vertical and lateral migration in permeable strata - Surface water runoff	Controlled Waters - Secondary A Aquifer (Taplow Gravel Member); - Principal Aquifer (Seaford Chalk Formation and Newhaven Chalk Formation)	Moderate
Aggressive ground conditions with Made Ground and natural ground, including groundwater:	Direct contact with aggressive ground conditions	Building Materials and Services - Buried Concrete - Underground services (water pipes)	Low

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(On-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
- Sulphates, - PAH/TPH.			
Ground gases generated by Made Ground: - Methane, - Carbon Dioxide, - Hydrogen Sulphide, and - Carbon Monoxide.	- Migration through anthropogenic & natural pathways - Inhalation of Asphyxiating gases - Explosion (methane only)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development (especially in confined spaces) - Site operatives during maintenance works in confined spaces - Neighbours and public	Moderate
	- Migration through anthropogenic & natural pathways - Explosion (methane only)	Building Materials and Services - Buildings - Confined spaces - Underground services	Moderate

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(Off-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Made Ground from nearby works, former Iron works/gas works and other industrial land uses including garage sites: - Asbestos, - PAHs, - TPHs, - VOCs, - Sulphates, and - Metals.	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development - Site operatives during maintenance works - Public	Moderate
	Direct uptake of groundwater	Flora and Fauna Vegetation within soft landscaped areas	Low
Aggressive ground conditions associated with impacted groundwater; Sulphates,	Direct contact with aggressive ground conditions	Building Materials and Services - Buried Concrete - Underground services (water pipes)	Low

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(Off-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
PAH/TPH.			
Ground gases generated by Made Ground former Iron works/gas works and other industrial land uses including garage sites: - Methane, - Carbon Dioxide, - Hydrogen Sulphide, and - Carbon Monoxide.	- Migration through anthropogenic & natural pathways - Inhalation of Asphyxiating gases - Explosion (methane only)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development (especially in confined spaces) - Site operatives during maintenance works in confined spaces - Public	Moderate
	- Migration through anthropogenic & natural pathways - Explosion (methane only)	Building Materials and Services - Buildings - Confined spaces - Underground services	Low

3. SITE WORKS

3.1. Scope of Works

Site works were undertaken on 19th October 2021 and comprised the drilling of 3No. Windowless Sampler Boreholes (WS1 – WS3) to depths of 5.00m bgl, and 2No. Windowless Sampler Boreholes (WS4 and WS4a) to depths of 0.80m bgl. WS4 and WS4a were terminated early due to unknown obstructions in the form of hard surfaces at 0.80m bgl. Works also comprised the machine-excavation of 3No. Trial Pits (TP1 – TP3) to depths of between 0.80 – 2.00m bgl. Soakaway tests were conducted within TP1 – TP3 generally in accordance with BRE365.

The approximate location of the trial holes can be seen within Figure 4.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, the exploratory position was relocated away from these areas.

As a further precautionary measure, the positions were hand excavated to 1.20m bgl and scanned with a Cable Avoidance Tool (CAT scanner) to minimise the risk to services.

Upon completion of the drilling works, the trial holes were backfilled and made good, in relation to the surrounding area.

3.2. Sampling Procedures

Small disturbed samples were recovered from the trial holes at the depths shown on the trial hole records. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons, or where any visible or olfactory evidence of contamination was present.

A programme of chemical laboratory testing, scheduled by Ground and Water Limited and carried out by ALS Environmental Limited, was undertaken on soils samples recovered from the trial holes.

4. ENCOUNTERED GROUND CONDITIONS

4.1. Soil Conditions

The trial holes were logged by a Ground and Water Limited representative, generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'. The chalk samples were logged in accordance with CIRIA 574.

The ground conditions encountered within the trial holes constructed on the site did generally conform to that anticipated from examination of the geology map. A capping of Made Ground was noted to overlie the superficial Taplow Gravel Member and the bedrock Undifferentiated Seaford Chalk and Newhaven Chalk Formations.

The succession of conditions and description of soils encountered in the trial holes in descending order is tabulated below.

Summary of Strata Encountered (WS1 – WS4, WS4a, TP1 – TP3)			
Strata	Top Depth (m bgl)	Base Depth (m bgl)	Thickness (m)
MADE GROUND: Tarmac/concrete. (<i>All trial holes</i>)	0.00	0.10 – 0.40	0.10 – 0.40
MADE GROUND: Generally comprised an greyish brown to orangish brown gravelly clayey fine to coarse SAND or sandy sub-angular to sub-rounded fine to coarse GRAVEL of concrete/tarmac, carbonaceous material, flint, aggregate and brick. (<i>All trial holes</i>)	0.10 – 0.40	0.50 – 1.20	0.35 – 0.80
TAPLOW GRAVEL MEMBER: Generally comprised an orangish brown gravelly clayey fine to medium SAND. Gravel was sub-angular to rounded fine to coarse flint. (<i>WS1 – WS3, TP1 – TP3</i>)	0.50 – 1.20	>0.80 – >5.00	>0.30 – >4.30
UNDIFFERENTIATED SEAFORD CHALK AND NEWHAVEN CHALK FORMATIONS: A structureless CHALK composed of white and grey gravelly SILT. Gravel was very weak to weak low density white and sub-rounded to angular chalk and flint. (Grade Dm) (<i>WS2, WS3</i>)	4.30 – 4.80	>5.00	>0.20 – >0.70

For details of the composition of the soils encountered at particular points, reference must be made to the individual trial hole logs within Appendix B of this report. A trial hole location plan can also be viewed within Figure 5.

4.2. Roots Encountered

Roots were noted to a depth of 1.00m bgl within WS2. No roots were noted within the remaining trial holes.

It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

4.3. Groundwater Conditions

Groundwater was noted in both boreholes and results are tabulated below. It was understood that the water noted within WS4 and WS4a was likely perched water within the Made Ground, above the assumed-impermeable obstruction encountered.

Groundwater Observations	
Trial Hole	Water depth (m bgl)
WS1	None observed
WS2	3.10
WS3	None observed
WS4	0.70
WS4a	0.70

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site.

The site investigation was conducted in October 2021, when groundwater levels are in the process of rising from their annual minimum (lowest elevation) to their annual maximum (highest elevation). The long-term groundwater elevation might increase/decrease at some time in the future due to seasonal fluctuation in weather conditions.

4.4. Obstructions

An obstruction was noted at 0.80m bgl within WS4, therefore WS4a was attempted as an alternative location and encountered another obstruction at 0.80m bgl. It was not possible to observe the obstructions due to groundwater encountered at 0.70m bgl within WS4 and WS4a. It was assumed that obstructions occurred due to an impermeable surface such as concrete rather than due to the density of the underlying strata. The full lateral extent of this surface was unknown; however no obstructions were noted within the adjacent TP3, or nearby trial holes of TP2 and WS3.

5. ENGINEERING CONSIDERATIONS

5.1. Surface Water Disposal

Soakaway testing generally in accordance with BRE365 was undertaken within TP1 – TP3, with the results tabulated below.

Soakage Testing Results							
Strata	Trial Hole	Test Number	Depth (m bgl)	Start Depth (m bgl)	Finish Depth (m bgl)	Time Taken (mins)	Infiltration Rate (m/sec)
Taplow Gravel Member	TP1	1	0.80	0.40	0.72	120	1.971×10^{-5}
		2			0.71	110	2.451×10^{-5}
		3			0.70	120	2.080×10^{-5}
	TP2	1	1.50	0.80	1.34	190	1.747×10^{-5}
		2*	1.50		1.16	180	1.077×10^{-5}
	TP3	1*	2.00	0.90	1.51	190	1.180×10^{-5}
		2*	2.00		1.29	140	9.563×10^{-6}
*These tests were deemed incomplete (i.e. less than 75% of the volume of water drained into the soils)							

Given the relatively slow infiltration rate encountered, a third test could not be undertaken within TP2 and TP3.

Based on the infiltration rates provided above, and the shallow groundwater encountered, soakaway systems were considered appropriate for the site within the Taplow Gravel Member. It should be noted that infiltration rates were slower within TP2 at 1.50m bgl and TP3 at 2.00m bgl.

Any soakaways should be located sufficiently away from buildings and infrastructure, in order to prevent undermining of foundations.

A study of the aquifer maps on the DEFRA website revealed the site was underlain by a Secondary A Aquifer comprising the superficial Taplow Gravel member, underlain by Principal Aquifer comprising bedrock deposits of the Undifferentiated Seaford Chalk and Newhaven Chalk Formations.

Examination of the Environment Agency records showed that the site did not fall within a Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater.

No surface water features were present within a 250m radius of the site. The nearest surface water feature the River Thames located approximately 530m north of the site flowing in a west to east direction.

From analysis of hydrogeological and topographical maps the actual groundwater table was anticipated to be encountered at shallow depths within the Taplow Gravel Member. Some amounts of groundwater however may be present at shallower depths within Made Ground. It was considered that groundwater was flowing in a northerly direction toward the River Thames in line with local topography.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources, abstractions and surface water features/watercourses.

It should be noted that water discharge into the chalk may worsen / create dissolution features. Therefore, soakaways should be remote from structures and undertaken in accordance with available guidance.

A number of published information sources make reference to an appropriate distance at which a soakaway should be sited in relation to any building foundations in the vicinity:

- The British Standard BS8301 :1985 “Code of practice for building drainage” (1985), suggests that: “A soakaway is not desirable nearer to a building than about 5 metres nor in such a position that the ground below foundations is likely to be adversely affected.”
- The Building Research Establishment Digest 365 “Soakaway design” (1991), suggests that “Soakaways should not normally be constructed closer than 5m to building foundations. In chalk or other soil and fill material subject to modification or instability, the advice of a specialist geotechnologist should be sought as to the advisability and siting of a soakaway”.
- In addition, the distance a soakaway is located from any foundations can be informed by both the soakaway type and chalk density present at the site.
- The Kent County Council Soakaway Design Guide (July 2000) states that “Highway soakaways shall be situated the following minimum distances from dwellings (measured from the outside edge of the soakaway): (1) 5 metres for conventional perforated soakaway; (2) 10 metres for deep bored soakaway. In addition, adjacent soakaways of a similar type shall also be spaced a minimum of 10 metres apart.
- CIRIA 574 states that soakaways should be sited at least 5-10m away from any structure, depending on the chalk density. Where the chalk present is of low or unknown density, soakaways should be sited at least 10m from any foundations, and where the chalk is of medium density or higher, any foundations should be sited at least 5m from any foundations.

The submission of a Sustainable Urban Drainage Scheme (SUDS) is unlikely to be required for this site due to the proposed development decreasing the amounts of hardstanding.

Consultation with the Environment Agency must be sought regarding any drainage systems that may have an impact on groundwater resources.

6. CONTAMINATION RISK ASSESSMENT

6.1. Results of the Phase I Risk Assessment

The tabulated Conceptual Site Model (CSM) developed by the Ground and Water Desk Study (ref. GWPR4463/DS/November 2021) is reproduced in this section and can be seen below. This version of the CSM has omitted the assigned risk rating and any linkage classified as Negligible. For the complete information please see the Desk Study report and Section 2.8.

No additional source of contamination, pathway or receptor was identified between the desk study and the ground investigation and as such, it was not necessary to modify the CSM.

Tabulated Conceptual Site Model – Pollutant Linkage Summary		
Potential Sources	Potential Absorption Pathways	Potential Receptors
Made Ground from construction/ demolition activities: - Asbestos, - PAHs, - TPHs, - VOCs, - Sulphates, and - Metals.	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Ingestion of home-grown produce, and soils attached - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public
	- Direct uptake of groundwater - Direct uptake of determinands in the soil	Flora and Fauna Vegetation within soft landscaped areas
	- Anthropogenic (man-made) pathways - Vertical and lateral migration in permeable strata - Surface water runoff	Controlled Waters - Secondary A Aquifer (Taplow Gravel Member); - Principal Aquifer (Seaford Chalk Formation and Newhaven Chalk Formation)
Made Ground from former garage site and light industrial works: - Asbestos, - PAHs, - TPHs, - VOCs, - Solvents, - Sulphates, and - Metals (lead)	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Ingestion of soils attached - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public
	- Direct uptake of groundwater - Direct uptake of determinands in the soil	Flora and Fauna Vegetation within soft landscaped areas
	- Anthropogenic (man-made) pathways - Vertical and lateral migration in permeable strata - Surface water runoff	Controlled Waters - Secondary A Aquifer (Taplow Gravel Member); - Principal Aquifer (Seaford Chalk Formation and Newhaven Chalk Formation)

Tabulated Conceptual Site Model – Pollutant Linkage Summary		
Potential Sources	Potential Absorption Pathways	Potential Receptors
Aggressive ground conditions with Made Ground and natural ground, including groundwater: - Sulphates, - PAH/TPH.	Direct contact with aggressive ground conditions	Building Materials and Services - Buried Concrete - Underground services (water pipes)
Ground gases generated by Made Ground: - Methane, - Carbon Dioxide, - Hydrogen Sulphide, and - Carbon Monoxide.	- Migration through anthropogenic & natural pathways - Inhalation of Asphyxiating gases - Explosion (methane only)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development (especially in confined spaces) - Site operatives during maintenance works in confined spaces - Neighbours and public
	- Migration through anthropogenic & natural pathways - Explosion (methane only)	Building Materials and Services - Buildings - Confined spaces - Underground services

In the UK, the assessment of risk from contamination follows the source-pathway-receptor (SPR) approach. For a risk to be present there must be a source of contamination, a receptor or receptors, and a pathway for contaminants to migrate or be absorbed. If there is a linkage between any given source and receptor, then a quantitative risk assessment is used to assess the significance or impact of the pollutant linkage.

6.2. Sampling Locations

The synopsis for the trial hole locations and their final depth can be seen tabulated below. A trial hole location plan is provided within Figure 5. The table also indicates whether any locations targeted a source of contamination as well as the proposed end-use. The proposed development can be seen in Figure 4.

Trial Hole Location Synopsis		
Trial Hole/Final Depth	Sampling Strategy	Proposed End-Use
WS1/5.00m	Random	Soft Landscaping – Block A
WS2/5.00m	Random	Footprint of Bin Store A
WS3/5.00m	Random	Soft Landscaping – Block B
WS4/0.80m	Random	Footprint of Block B
WS4a/0.80m	Random	Footprint of Block B
TP1/0.80m	Random	Hardstanding – New Access Road
TP2/1.50m	Random	Hardstanding – New Parking
TP3/2.00m	Random	Soft Landscaping – Block B

The investigation area totals approximately 2,300m² and with eight sampling locations, given an unknown hotspot shape, the sampling density means that a hotspot with an area of approximately 430m² and a radius of approximately 11.7m would be encountered (CLR 4).

Sampling depths were chosen to reflect the receptor of concern (e.g. human health, controlled waters and vegetation) and typically comprised a surface or near surface sample and at approximately 0.5m depth increments thereafter, extending into the underlying natural soils. Any horizon where olfactory or visual evidence of contamination was present was also sampled. The receptors relevant to the sampling depths are tabulated below.

Summary of Receptors per Sample Depth	
Depth	Receptors
Shallow Samples (< 0.75m bgl)	• End Users (Residents/Future site visitors) • Construction workers during development • Site operatives during maintenance works • Neighbours and public • Vegetation within soft landscaped areas (shallow rooted) • Secondary A Aquifer (Taplow Gravel Member) • Buried Concrete • Receiving landfill

The depth of the soil samples at each trial hole location can be seen on the trial hole logs within Appendix B.

6.3. Soil Risk Assessment

Chemical laboratory testing, scheduled by Ground and Water Limited, and carried out by ALS Environmental Limited, was undertaken on six samples as tabulated below.

Sample Location Synopsis			
Sample ID	Sampling Strategy	Strata	Proposed End-Use
TP1/0.20m	Shallow Random	Made Ground	Hardstanding – New Access Road
TP2/0.20m	Shallow Random	Made Ground	Hardstanding – New Parking
TP3/0.20m	Shallow Random	Made Ground	Soft Landscaping – Block B
WS2/0.50m	Shallow Random	Made Ground	Footprint of Bin Store A
WS3/0.30m	Shallow Random	Made Ground	Soft Landscaping – Block B
WS3/0.50m	Shallow Random	Made Ground	Soft Landscaping – Block B
WS4a/0.50m	Shallow Random	Made Ground	Footprint of Block B

The samples were subjected to a combination of analysis that comprised:

- Asbestos screen;
- Semi-metals and heavy metals incl. Arsenic, Cadmium, Chromium (incl. Hexavalent Chromium), Copper, Lead, Mercury, Nickel, Selenium, Vanadium, Zinc;
- Polycyclic Aromatic Hydrocarbons (PAH's) incl. Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(ghi)perylene;
- Speciated TPH including full aliphatic/aromatic split; and
- BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE – used as marker compounds for Volatile Organic Compounds (VOCs).

A breakdown of the number of tests undertaken for each determinand is discussed in further sections. The chemical laboratory results are presented in Appendix C.

6.3.1. Soil Assessment Criteria and Results

At the time of reporting, December 2021, the proposed development was understood to comprise the demolition of existing light industrial buildings and site clearance followed by construction of 25No. residential dwellings in two blocks of flats with associated amenity space, car parking, bin and cycle storage. Block A (six-storey structure) was located in the south of the site facing Oxford Road, with Block B (three-storey structure) located in the north of the site and space for 25No. parking spaces between the two blocks. Bin stores and bike stores were associated with each block. Areas of soft landscaping were proposed to the north-east and south-west of Block A, with private gardens proposed to the north-east of Block B. The proposed development plan can be seen within Figure 4.

Based on the proposed development, the results of the chemical laboratory testing were compared to the Generic Assessment Criteria (GAC) for a **'Residential with homegrown produce'** land-use scenario, as this was considered the most appropriate land-use scenario. The derivation of Soil Assessment Criteria used within this report can be seen within Appendix D.

Where a contaminant of concern's GAC varies according to the Soil's Organic Matter (SOM), the SOM recorded for each uncontaminated soil type was used to derive the appropriate GAC for each soil type. A SOM value of 1%, the most conservative value, was utilised.

A summary of the analytical results and the comparison to the determinands adopted screening value are presented in the table below and overleaf.

Soil Contamination Test Results and Screening Values					
Determinand	Number of Samples	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Adopted Screening Value (mg/kg)	Was the adopted screening value exceeded for relevant land-use scenario?
INORGANICS					
Asbestos	6	ND	0.0025	ND	TP3/0.20m WS2/0.50m WS3/0.30m
Cyanide (total)	6	<1	<1	24	No
Phenols	6	<0.035	<0.035	280	No
METALS					
Arsenic	6	13	17	37	No
Boron	6	<1	<1	290	No
Cadmium	6	0.256	0.832	11	No
Chromium (III)	6	7.66	14.5	910	No
Chromium (Hexavalent)	6	<0.6	<0.6	6	No
Copper	6	42.9	241	2,400	No
Lead	6	49.1	646	200	TP3/0.20m
Mercury	6	<0.1	0.18	1.2	No
Nickel	6	14.7	21.8	130	No
Selenium	6	<1	<1	250	No
Vanadium	6	28.1	33.9	410	No
Zinc	6	74.2	511	3,700	No
TOTAL PETROLEUM HYDROCARBONS (TPHs)					
Aliphatic >C5 - C6	3	<0.01	<0.01	42	No
Aliphatic >C6 - C8	3	<0.01	0.0123	100	No
Aliphatic >C8 - C10	3	<0.01	0.0168	27	No

Aliphatic >C10 - C12	3	<1	1.49	130	No
Aliphatic >C12 - C16	3	<1	9.73	1,100	No
Aliphatic >C16 - C21	3	<1	18.4	65,000	No
Aliphatic >C21 - C34	3	27.4	44.8		
Aromatic >C5 - C7	3	<0.01	<0.01	70	No
Aromatic >C7 - C8	3	<0.01	<0.01	130	No
Aromatic >C8 - C10	3	<0.01	0.0112	34	No
Aromatic >C10 - C12	3	<1	<1	74	No
Aromatic >C12 - C16	3	<1	1.53	140	No
Aromatic >C16 - C21	3	2.65	12.9	260	No
Aromatic >C21 - C35	3	12.7	109	1100	No
Benzene	3	<0.009	<0.009	1,100	No
Toluene	3	<0.007	<0.007	0.087	No
Ethylbenzene	3	<0.004	<0.004	130	No
m,p-Xylene	3	<0.01	<0.01	47	No
o-Xylene	3	<0.01	<0.01	56	No
POLYCYCLIC-AROMATIC HYDROCARBONS					
Acenaphthene	6	0.0137	0.285	210	No
Acenaphthylene	6	<0.012	0.273	170	No
Anthracene	6	0.0917	0.52	2,400	No
Benzo(a)anthracene	6	0.443	2.28	7.2	No
Benzo(a)pyrene	6	0.374	2.55	2.2	TP1/0.20m TP3/0.20m
Benzo(b)fluoranthene	6	0.484	3.13	2.6	TP1/0.20m TP3/0.20m
Benzo(ghi)perylene	6	0.21	2.32	320	No
Benzo(k)fluoranthene	6	0.182	1.1	77	No
Chrysene	6	0.398	2.09	15	No
Dibenzo(a,h)anthracene	6	0.0454	0.384	0.24	TP1/0.20m TP3/0.20m
Fluoranthene	6	0.929	3.88	280	No
Fluorene	6	<0.05	0.246	170	No
Indeno(1,2,3-cd)pyrene	6	0.222	2.26	27	No
Naphthalene	6	<0.045	0.0258	2.3	No
Phenanthrene	6	0.282	1.8	95	No
Pyrene	6	0.774	3.47	620	No
MARKER FOR VOLATILE ORGANIC COMPOUND					
Methyl tert-butyl ether (MTBE)	3	<0.01	<0.01	49	No
The derivation of the Soil Assessment Criteria used within this report can be seen within Appendix D. The soil concentrations were typically compared to the LQM/CIEH Suitable for Use Levels (S4UL) (2014), based upon the assumption of 1% soil organic matter. A screening value for Lead is based on the Category 4 Screening Levels (C4SLs). Where no S4UL or C4SL is available for Cyanide, a SoBRA acute GAC is assigned. Where no S4UL or C4SL is available for MTBE, a CL:AIRE 2010 GAC is assigned. Where exceedances are noted, the trial hole and depth of sample is recorded.					

The proposed development includes areas of soft-landscaping, where shallow rooted vegetation may be exposed to aggressive ground conditions. The previous table compares the results of the laboratory analysis to GAC that is protective of Human Health and therefore different GAC is required for vegetation. The derivation of Soil Assessment Criteria used within this report can be seen within Appendix D.

Soil Contamination Test Results and Screening Value					
Determinand	Number of Samples	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Adopted Screening Value (mg/kg)	Was the adopted screening value exceeded for relevant land-use scenario?
Copper	6	42.9	241	250	No
Zinc	6	74.2	511	1,000	No
The derivation of the Soil Assessment Criteria used within this report can be seen within Appendix D. The soil concentrations were compared to the ICRL 70/90: <i>Notes on the restoration and aftercare of metalliferous mining sites for pasture and grazing</i> . Where exceedances are noted, the trial hole and depth of sample is recorded.					

6.3.2. Soil Assessment

The comparison between the laboratory analysis and the assessment criteria indicates that there is an unacceptable risk to future receptors caused by exceedances of the following determinands: Lead; Benzo(a)pyrene; Benzo(b)fluoranthene; and Dibenzo(a,h)anthracene. The remaining determinands were identified at below the adopted screening value and are not considered to represent an unacceptable risk to future receptors. Where an unacceptable risk to future receptors remains, mitigation is required.

The contaminants identified above the adopted screening values within TP1/0.20m bgl were all PAHs. Benzo(a)pyrene, Benzo(b)fluoranthene and Dibenzo(a,h)anthracene were identified up to 1.6 times the assessment criteria. Within TP3/0.20m bgl, elevated lead was also identified up to 3.2 time the assessment criteria. Asbestos was encountered within TP3/0.20m as chrysotile fragments, in WS2/0.50m as amosite fibres, and in WS3/0.30m as chrysotile and crocidolite within asbestos cement.

Due to the nature of the contamination encountered at the site, it is considered that there is an unacceptable risk to future receptors. Remediation, as outlined later within this report is required as part of any site development.

Asbestos

Asbestos was identified within WS3/0.30m as chrysotile and crocidolite within asbestos cement. Asbestos was also identified within TP3/0.20m as asbestos fragments and within WS2/0.50m as amosite fibres. Quantification was undertaken on TP3/0.20m and WS2/0.50m and indicated that asbestos was present at <0.001 – 0.0025%.

A quantification risk assessment was carried out for the concentration recorded, in accordance with the guidance within CIRIA 733. The background, considerations taken, and the calculations can be seen in Appendix E. A summary of the results is shown in the table below.

Asbestos Risk Assessment				
Sample	Mesothelioma Accumulated Risk (fibres/ml.year)	Mesothelioma Risk	Lung Cancer Accumulated Risk (fibres/ml.year)	Lung Cancer Risk
TP3/0.20m	0.00387	Insignificant	0.00276	Insignificant
WS2/0.50m	0.00202	Insignificant	0.00144	Insignificant

Based on CIRIA Table 14.1 for Mesothelioma and 14.3 for Lung Cancer, the risk for both samples was considered to be insignificant.

From a review of historical maps, it was considered that the asbestos identified within WS3 was likely due to the demolition of a historic building in this location. Asbestos in the form of cement-bound chrysotile and crocidolite is likely to be limited to this area of the site. As no quantification was undertaken on the sample within WS3/0.30m, a risk is present and further action is required in this area. A remediation plan can be seen within Figure 6.

An **Asbestos Management Strategy** should be put in place so that any potentially asbestos containing materials are identified and removed from site in a suitable manner to prevent cross-contamination.

6.3.3. Sub-surface Concrete Design

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1, 2005, 'Concrete in Aggressive Ground' considering the pH of the soils. For the classification given below, the "mobile" and "natural" case was adopted given the geology encountered and the residential use of the site.

Made Ground

The water-soluble sulphates in the Made Ground was noted to be 6.1 – 66.4mg/l, with a pH of 8.06 – 10.4, from chemical laboratory testing.

Therefore, the worst-case sulphate concentrations measured in 2:1 water/soil extracts taken from the Made Ground fell into Class **DS-1** of the BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground'. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of **AC-1**.

6.3.4. Water Supply Pipe Risk Assessment

As part of the proposed development it is expected that new water supply pipes will be installed at the site. Water supply pipes have the potential to be exposed to contaminants in the ground that can lead to unacceptable concentrations within the drinking water. If a risk is identified, specialist pipes that are protective of the drinking water are required.

A pipe selection risk assessment should be submitted to the water supply company as part of the development based on the supplier's assessment criteria. An indication of whether there is likely to be a risk can be seen tabulated below, where the PE pipe thresholds are based on *UKWIR Contaminated Land Assessment Guidance, 2014*.

Pipe Selection Risk Assessment			
Determinand	PE Pipe Threshold (mg/kg)	Laboratory Analysis Range (mg/kg)	Was the Threshold Exceeded?
Total BTEX and MTBE	0.1	< 0.1	No
Total VOCs	0.5	Not tested	-
Total SVOCs	2	Not tested	-
Phenols	2	< 0.035	No
TPH EC5 – EC10 (aliphatics and aromatics)	2	< 0.0703	No
TPH EC10 – EC16 (aliphatics and aromatics)	10	< LOD – 11.22	Yes – TP3/0.20m
TPH EC16 – EC44 (aliphatics and aromatics)	500	258.05	No
Naphthalene	5	< 0.045	No

The results indicate that the TPH EC10 – EC16 were above the threshold for the use of a PE pipe at the site. Based on these results, barrier pipes are required, or a supply pipe risk assessment must be carried out and consultation with Thames Water sought.

6.4. Groundwater Risk Assessment

In the UK, the water environment is protected under a number of regulatory regimes, mainly governed by the Environment Agency. The Environment Agency is consulted when there may be a risk to Controlled Waters, or where a pollution incident has occurred historically. The Water Framework Directive is implemented in various guises covering groundwater, surface water and drinking water supply.

The soil samples analysed as part of the risk assessments in section 6.3 have been used to undertake a Level 1 (soils) Controlled Waters risk assessment. At Level 1 (soils), the conceptual site model and the determinand concentrations of the soils are used to indicate whether the concentrations are sufficient to impact the receptor. At this stage, dilution, dispersion and attenuation along the pathway are not considered.

A study of the aquifer maps on the DEFRA website revealed the site was underlain by a **Secondary A Aquifer** comprising the superficial Taplow Gravel member, underlain by **Principal Aquifer** comprising bedrock deposits of the Undifferentiated Seaford Chalk and Newhaven Chalk Formations.

Examination of the Environment Agency records showed that the site **did not** fall within a Groundwater Source Protection Zone (SPZ) as classified in the Policy and Practice for the Protection of Groundwater.

No surface water features were present within a 250m radius of the site. The nearest surface water feature the River Thames located approximately 530m north of the site flowing in a west to east direction.

From analysis of hydrogeological and topographical maps the actual groundwater table was anticipated to be encountered at shallow depths within the Taplow Gravel Member. Some amounts of groundwater however may be present at shallower depths within Made Ground. It was considered that groundwater was flowing in a northerly direction toward the River Thames in line with local topography.

During the site investigation, Made Ground was identified to a maximum proven depth of 1.20m bgl and to an unproven depth of 0.80m bgl within WS4 and WS4a, overlying gravelly and clayey sands of the Taplow Gravel Member. These were underlain by the Undifferentiated Seaford Chalk and Newhaven Chalk Formations. No visual or olfactory evidence of contamination was noted during the investigation. A groundwater strike was recorded at 3.10m bgl within WS2. Perched water was noted within WS4 and WS4a at 0.70m bgl.

Comparison between the soil laboratory analysis and the derived Level 1 (soils) target concentrations indicate that some metals, aromatic TPHs and PAHs are elevated and have the potential to pose a risk to Controlled Waters. It should be noted that a number of determinands at laboratory limit of detection exceed the target concentration for a Level 1 (soils) risk assessment, most notably PAHs.

Where a determinand is identified at the laboratory limit of detection, no further assessment is considered necessary.

Although the values are above the level 1 values, the CSM indicates that migration through Made Ground and multiple superficial deposits over a considerable distance is required for determinands to reach the receptor. During this process, degradation, dilution, and dispersion are likely to occur and therefore it is not expected that the soils on-site represent an unacceptable risk to controlled water receptors. No further action is considered necessary.

The findings of this risk assessment should be agreed with the Environment Agency.

6.5. Ground Gas Risk Assessment

A review of Phase I desk study and available online databases did not identify any source of ground gas on-site or within influencing distance of the site that warranted investigation through ground gas monitoring. The only source of ground gases was anticipated to be limited Made Ground and therefore classified as 'Low risk', where the pragmatic approach to ground gas risk assessment presented within the CL:AIRE research bulletin RB17 and included within Annex D of BS8485:2015+A1:2019 can be considered.

6.5.1. Pragmatic Approach

The alternative approach to ground gas risk assessment considers the uncertainty from the measurement of ground gas concentrations and flow rates in monitoring wells for low-risk sites and removes the need for monitoring. Low risk sites typically comprise:

- Natural soils with high carbonate content (e.g. chalk);
- Natural soils that can produce gases (e.g. alluvium, peat etc.);
- Made Ground between 1.00m to 5.00m, with low organic content; and
- Areas of flooded mine workings, unless a building is to be within 20m of shaft or adit.

The method considers the gas generation potential of the soils from data that is not subject to external influences, for example atmospheric pressure can change the recorded flow and concentrations of ground gas during spot monitoring, or a rising groundwater level can displace ground gases in pore spaces. Determination of the characteristic situation is based on the total organic carbon (TOC) of the soils, coupled with any organic-rich material identified within the borehole logs, such as wood gravels. TOC is easily analysed by the laboratory and can also be calculated by the equation outlined below.

$$\text{Total Organic Carbon (TOC)} = 0.58 \times \text{Soil Organic Matter (SOM)} = 1.33 \times \text{Degradable Organic Carbon (DOC)}$$

As part of the ground investigation works, seven samples were submitted to the laboratory for analysis, which identified TOC to vary between 0.409 and 1.86% in the Made Ground. The trial hole logs identified the gravels within the Made Ground to comprise; flint, brick, aggregate, carbonaceous material/clinker and concrete. Made Ground was identified to a maximum proven depth of 1.20m bgl and to an unproven depth of 0.80m bgl within WS4 and WS4a.

6.5.2. Data Quality

A review was made of the quality of the available data for the site, which can be viewed in the table below. CIRIA Report C665 (2007), BS 8485:2015+A1:2019 and BS 8576:2013 stress the need for risk assessments to be based on good quality data and give guidance as to best practice in this respect.

Review of Data Quality			
Data Type	Current Understanding	UK Practice	Recommendation
Geological and hydro-geological conditions	The CSM identified the site to be located on various thicknesses of Made Ground (<1.20m), overlying both permeable and impermeable strata of the Lambeth Group. Groundwater has been encountered at shallow depth during drilling but has not been identified during monitoring.	CIRA C665 & C659, Wilson and Card (1999) and BS 8485 recommend that geology and hydrogeology be fully understood.	The geological and hydrogeological model is understood to a standard that will not comprise the findings of the risk assessment. No further action required.
Soil Laboratory Analysis	A dataset of soil analysis from 7No. samples have identified a range of TOC concentrations between 0.409% and 1.86%. All samples were from within the Made Ground.	CL:AIRE RB17 outlines an approach to ground gas risk assessment away from the influences that directly affect ground gas monitoring. It should typically be used on sites with limited sources identified in the CSM and Made Ground with average thickness <3m and maximum thickness <5m. TOC should be <6%.	The TOC concentrations are below the limit of 6% in order to use the soil derived approach for the risk assessment. No further action required.

6.5.3. Risk Assessment

The intrusive investigation has revealed a maximum proven thickness of Made Ground of 1.20m and unproven Made Ground to 0.80m bgl, overlying granular soils of the Taplow Gravel Member. These soils were underlain by the Undifferentiated Seaford Chalk and Newhaven Chalk Formations. The site has undergone previous phases of construction and limited degradable material has been identified. The introduction of oxygen to the Made Ground through redevelopment may lead to an initial increase of ground gas generation as degradable material within the soils present on-site may act as source of ground gas. The soils at the site are considered to be of variable permeability (low to high) in nature and pathways for ground gas migration will be present.

Using the soil derived method, it is considered that a TOC value of <1% within soil is unlikely to pose an unacceptable risk from ground gases and the site can be characterised as Characteristic Situation CS1. Any value between 3 and 6% warrants classification as a Characteristic Situation CS3. Any value over 6% requires investigation through ground gas monitoring. Any site with Made Ground <1.00m bgl will have a limited gas generation potential from the organic carbon present and consideration should be given to this thickness within the risk assessment.

An alternative approach for ground gas risk assessment (CL:AIRE RB17) can be considered utilising measured concentrations from soil parameters that are independent of influencing factors such as atmospheric pressure and groundwater level. Total Organic Carbon (TOC) was tested on 7No. samples with the analytical results ranging between 0.409 and 1.86%, where the majority of samples were

<1%. Furthermore, it is considered that Made Ground with a thickness of up to 1.20m would not generate sufficient ground gas to pose an unacceptable risk.

Based on the soil derived method outlined and the maximum TOC concentration encountered, the soils from site would warrant classification as **Characteristic Situation CS1**. It should be noted that this only represents the assessment from an on-site source.

6.5.1. Vapours

No odours or staining were noted during the investigation. No indicators for vapours have been identified within the soil analysis and therefore no further action is warranted. No odours or staining were noted.

6.6. Updated Conceptual Site Model

Following completion of the Phase 2 Site Investigation, the CSM, inclusive of associated risk, within Section 6.1 of this report was re-evaluated and can be seen overleaf. A diagrammatic CSM can be viewed within Figure 7.

For ease of reference and understanding, the risks have been re-assigned within this risk assessment against three possible levels / categories, summarised in the table below.

Risk Categories used in the Tabulated CSM	
Low Risk	Regarding this potential SPR linkage, the site is considered suitable for the proposed end-use and there is not considered to be an unacceptable risk to receptors.
Moderate Risk	Regarding this potential SPR linkage, the site is suitable for the proposed end-use however remediation and/or further investigation is required.
High Risk	Regarding this potential SPR linkage, the site is not suitable for proposed end-use and there is an unacceptable risk to receptors. Urgent action required in the short term.

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(On-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Made Ground from construction/demolition activities: - Asbestos, - PAHs, - TPHs, - VOCs, - Sulphates, and - Metals.	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Ingestion of home-grown produce, and soils attached - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public	Moderate Elevated Metals and PAHS have been identified at the site. Soft landscaping to require clean soils. Asbestos. Soft landscaping to require geotextile membrane, and removal of soil in the vicinity of WS3.
	- Direct uptake of groundwater - Direct uptake of determinands in the soil	Flora and Fauna Vegetation within soft landscaped areas	Low
	- Anthropogenic (man-made) pathways - Vertical and lateral migration in permeable strata - Surface water runoff	Controlled Waters - Secondary A Aquifer (Taplow Gravel Member); - Principal Aquifer (Seaford Chalk Formation and Newhaven Chalk Formation)	
Made Ground from former garage site and light industrial works: - Asbestos, - PAHs, - TPHs, - VOCs, - Solvents, - Sulphates, and - Metals (lead)	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Ingestion of soils attached - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public	Moderate Elevated Metals and PAHS have been identified at the site. Soft landscaping to require clean soils. Asbestos. Soft landscaping to require geotextile membrane, and removal of soil in the vicinity of WS3.
	- Direct uptake of groundwater - Direct uptake of determinands in the soil	Flora and Fauna Vegetation within soft landscaped areas	Low
	- Anthropogenic (man-made) pathways - Vertical and lateral migration in permeable strata - Surface water runoff	Controlled Waters - Secondary A Aquifer (Taplow Gravel Member); - Principal Aquifer (Seaford Chalk Formation and Newhaven Chalk Formation)	

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(On-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Aggressive ground conditions with Made Ground and natural ground, including groundwater: - Sulphates, - PAH/TPH.	Direct contact with aggressive ground conditions	Building Materials and Services - Buried Concrete - Underground services (water pipes)	Moderate Elevated TPHs identified. Barrier pipes required.
Ground gases generated by Made Ground: - Methane, - Carbon Dioxide, - Hydrogen Sulphide, and - Carbon Monoxide.	- Migration through anthropogenic & natural pathways - Inhalation of Asphyxiating gases - Explosion (methane only)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development (especially in confined spaces) - Site operatives during maintenance works in confined spaces - Neighbours and public	Low
	- Migration through anthropogenic & natural pathways - Explosion (methane only)	Building Materials and Services - Buildings - Confined spaces - Underground services	

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(Off-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Made Ground from nearby works, former Iron works/gas works and other industrial land uses including garage sites: - Asbestos, - PAHs, - TPHs, - VOCs, - Sulphates, and - Metals.	- Direct ingestion of soil and soil derived dust - Dermal contact of soil and soil derived dust - Inhalation of dust (indoors and outdoors) with elevated concentration of determinands - Direct ingestion of groundwater - Inhalation of volatile vapour (indoors and outdoors)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development - Site operatives during maintenance works - Public	Moderate Elevated Metals and PAHs have been identified at the site. Soft landscaping to require clean soils.
	Direct uptake of groundwater	Flora and Fauna Vegetation within soft landscaped areas	Asbestos. Soft landscaping to require geotextile membrane, and removal of soil in the vicinity of WS3.

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(Off-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Aggressive ground conditions associated with impacted groundwater; - Sulphates, - PAH/TPH.	Direct contact with aggressive ground conditions	Building Materials and Services - Buried Concrete - Underground services (water pipes)	Moderate Elevated TPHs identified. Barrier pipes required.
Ground gases generated by Made Ground former Iron works/gas works and other industrial land uses including garage sites: - Methane, - Carbon Dioxide, - Hydrogen Sulphide, and - Carbon Monoxide.	- Migration through anthropogenic & natural pathways - Inhalation of Asphyxiating gases - Explosion (methane only)	Human Health - End Users (Residents/Future site visitors) - Construction workers during development (especially in confined spaces) - Site operatives during maintenance works in confined spaces - Public	Low
	- Migration through anthropogenic & natural pathways - Explosion (methane only)	Building Materials and Services - Buildings - Confined spaces - Underground services	

6.7. Recommendations and Remediation Strategy

Based on the results of the intrusive works, chemical analyses and risk assessments undertaken, the following has been identified that requires further action:

- Five contaminants (Asbestos, Lead, Benzo(a)pyrene, Benzo(b)fluoranthene, and Dibenzo(a,h)anthracene) have been found at an unacceptable concentrations within the soils across the site.
- Elevated TPHs identified indicate that barrier pipes may be required.

An Asbestos Management Strategy should be put in place so that any potentially asbestos containing materials are identified and removed from site in a suitable manner to prevent cross-contamination.

6.7.1. Soils

The highest exceedance of contaminants has been identified as lead at ~3.2 times the assessment criteria. Since the exceedances are not considered to be significant (~5-6 times the assessment criteria), the BRE “Cover Systems for Land Generation” can be considered for the design of the cover system and is considered applicable within all soft landscaped areas.

Based on the available information within this report and the calculated thickness of clean cover required, it was proposed that the following remedial methodology should be undertaken within **all garden areas, including soft landscaping**:

- The removal of Made Ground in the vicinity of WS3;
- A 490mm clean capping of soils overlying a geotextile marker membrane;
- Validation of the geotextile marker membrane and clean capping system by a suitably trained Ground and Water Limited engineer.

Full liaison must be made with the statutory authority, prior to the implementation of this remediation strategy and/or removal of soils from the site. All works must be undertaken to meet their approval.

6.7.1.1. Change in Level

In locations where site levels are to be lowered, Made Ground should be removed from the location to allow the capping of 490mm to be placed. If natural soils are encountered, the reduce dig can be terminated with samples obtained. Materials should be removed and stockpiled on an impermeable liner with raised edges and covered at all times. This contamination stockpile destined for removal from site should be stored away from imported soils to avoid cross-contamination. The void should then be backfilled with 490mm of clean certified soil.

Materials to be removed off-site must be classified by carrying out Waste Acceptance Produce (WAP) testing. A registered contractor must undertake the removal of waste. Consignment notes for the removal of waste must be obtained and kept for inclusion within the final validation Report.

If levels are raised, the imported materials should be clean and validated, where the top 490mm within areas of soft landscaping will still need to be covered with a clean capping of soil.

In the vicinity of WS3, Made Ground should be removed for the general extent of the historic building identified in the north-east corner of the site. A remediation plan can be seen within Figure 6.

6.7.1.2. Geotextile Marker Membrane

Prior to the 490mm clean capping, a geotextile marker membrane should be placed to act as a barrier between the clean soils above and the contaminated soils below.

6.7.1.3. 490mm Clean Capping of Soil

The capping system should be at least 490mm in thickness within all garden areas and soft landscaping. It is recommended that at least the top 150mm of the clean capping should comprise suitable topsoil for use as a growing medium. It is a requirement that this should be no less than 100mm thick.

All subsoil and topsoil must be fit for purpose to ensure that the receptors cannot come into contact with determinands that could be detrimental to their health. See 'Imported Material' Section 6.9. It has been assumed that for the principal contaminant of concern (lead) a maximum concentration of 100 mg/kg will be present within the capping of soil.

The thickness of the capping system has been calculated based on a mixing zone of 600mm, assuming that they will not be implemented on a slope with a gradient in excess of 1 in 12 and are away from the influence of burrowing animals, such as rabbits and badgers.

6.7.1.4. Validation

The remediation works outlined above will need to be inspected and independently validated by a Ground and Water Limited Engineer. All excavations will need to be inspected, documented and photographed. Validation holes should prove the depth of the clean cover and enable the sampling of soils. Due to the design of the proposed development, validation should be undertaken at a rate of 1 validation trial hole per area of soft-landscaping and a sample taken equating to 1 sample per 50m³ imported.

6.7.1.5. Water Supply Pipes

The Water Supply pipe risk assessment indicated that barrier pipes are required, or a supply pipe risk assessment must be carried out and consultation with Thames Water sought.

6.7.2. Groundwater

The granular soils of the Taplow Gravel Member classified as a Secondary A Aquifer, were noted to directly underlie the site at shallow depth. The bedrock deposits of the Undifferentiated Seaford Chalk and Newhaven Chalk Formations were classified as a Principal Aquifer. Additionally, the conceptual site model shows the nearest receptors to be the River Thames, located 530m north of the site. Given the low mobility of any contaminants within the soil, and the distance to the receptors, it is not expected that the soils on-site represent an unacceptable risk to controlled water receptors. No further action is considered necessary.

6.7.3. Ground Gas

Based on risk assessment undertaken, the site warrants classification as **Characteristic Situation CS1**, where no precautions to prevent the ingress of ground-gas are necessary. Vapours

No indicators for vapours have been identified within the soil analysis and therefore no further action is warranted.

6.8. Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation. Such occurrences may be discovered during the demolition and construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Local Authority will need to be informed.

6.9. Imported Material

It is required that clean soils will be brought onto site as part of the validation works. Any soil which is to be imported onto the site must undergo chemical analysis to prove that it is suitable for the purpose for which it is intended.

The soil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, prior to placing (ideally) and after placing, to ensure that the future receptors (human health and vegetation) cannot come into contact with compounds that could be detrimental to their health. The compounds that are to be tested for are those given in the Generic Assessment Criteria, which can be viewed in Appendix D of this report.

6.10. Waste Disposal

The excavation of foundations and soils is likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal all waste must be classified as;

- Inert;
- Non-hazardous, or;
- Hazardous.

The Environment Agency's Hazardous Waste Technical Guidance (WM3) document outlines the methodology for classifying wastes. Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

Following the investigation, 6No. samples were submitted to the analytical laboratory to undergo a suite of testing for contamination testing, as discussed in the previous sections. Sampling depths were chosen to reflect the receptor of concern, human health, and typically comprised a surface or near surface sample and periodically to 1.00m bgl. Any horizon where olfactory or visual evidence of contamination was present was also sampled.

Based on a risk phase analysis of the chemical laboratory test results, in accordance with EC Hazardous Waste Directive and undertaken by Ground and Water Limited, all soil samples of Made Ground encountered on-site were **NON-HAZARDOUS**. The results of the assessment are given within Appendix F. It should be noted that the assessment included the two samples containing asbestos quantification. In the absence of quantification, the area around WS3, should be considered as **HAZARDOUS**.

It is important to note that whilst we consider our in-house assessment tool to be an accurate interpretation of the requirements of WM3, therefore producing an initial classification in accordance with the guidance, this method classifies soils as either non-hazardous or hazardous and landfill operators have their own assessment tools and can often come to different conclusions. As a result, some landfill operators could refuse to take apparently suitable waste. It is recommended that the receiving landfill views the results of this assessment and the chemical laboratory results to determine their own classification.

In addition to the samples described above, 1No. sample was scheduled to undergo Waste Acceptance Criteria (WAC) testing with single batch leachate from samples with a range of depths. The results indicate that sample conformed to the **inert waste** classification. The results can be seen in Appendix C. The locations of these samples can be seen on Figure 5.

It should be noted that the receiving landfill may see the presence of Made Ground within the soils to be indicative of a non-hazardous classification despite the presence of the WAC testing certificates indicating that it is inert. Therefore, it should be considered that all Made Ground is classified as Non-hazardous, subject to finalising with the receiving landfill.

Where contaminated soils are to be removed, they should be placed on an impermeable membrane (visqueen or similar) to ensure that no cross-contamination of soils occurs.

6.11. Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust is generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.

FIGURES

APPENDIX A: Conditions and Limitations

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The report has been prepared on the basis of information, data and materials which were available at the time of writing. Accordingly, any conclusions, opinions or judgements made in the report should not be regarded as definitive or relied upon to the exclusion of other information, opinions and judgements.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief; as such these do not necessarily address all aspects of ground behaviour at the site. No liability is accepted for any reliance placed on it by others unless specifically agreed in writing.

Any decisions made by you, or by any organisation, agency or person who has read, received or been provided with information contained in the report ("you" or "the Recipient") are decisions of the Recipient and we will not make, or be deemed to make, any decisions on behalf of any Recipient. We will not be liable for the consequences of any such decisions.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

Any Recipient must take into account any other factors apart from the Report of which they and their experts and advisers are or should be aware. The information, data, conclusions, opinions and judgements set out in the report may relate to certain contexts and may not be suitable in other contexts. It is your responsibility to ensure that you do not use the information we provide in the wrong context.

This report is based on readily available geological records, the recorded physical investigation, the strata observed in the works, together with the results of completed site and laboratory tests. Whilst skill and care has been taken to interpret these conditions likely between or below investigation points, the possibility of other characteristics not revealed cannot be discounted, for which no liability can be accepted. The impact of our assessment on other aspects of the development required evaluation by other involved parties.

The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous in ground activities. The ground conditions have been sampled or monitored in recorded locations and tests for some of the more

2 The Long Barn, Norton Farm, Selborne Road, Alton, Hampshire GU34 3NB
0333 600 1221 enquiries@groundandwater.co.uk groundandwater.co.uk

common chemicals generally expected. Other concentrations of types of chemicals may exist. It was not part of the scope of this report to comment on environment/contaminated land considerations.

The conclusions and recommendations relate to 816 Oxford Road, Reading, Berkshire, RG30 1EL.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sampler borehole implies the specific technique used to produce a trial hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

Ownership of copyright of all printed material including reports, laboratory test results, trial pit and borehole log sheets, including drillers log sheets, remain with Ground and Water Limited. Licence is for the sole use of the client and may not be assigned, transferred or given to a third party.

Only our client may rely on this report and should this report or any information contained in it be provided to any third party we accept no responsibility to the third party for the contents of this report save to the extent expressly outlined by us in writing in a reliance letter addressed from us to the third party.

Recipients are not permitted to publish this report outside of their organisation without our express written consent.



Site boundary

Not to scale

816 Oxford Road, Reading, Berkshire, RG30 1EL

John Filbee Properties Ltd

December 2021

Figure 1 – Site Location Plan

GWPR4463





◇ Site boundary



Approximately 20m

816 Oxford Road, Reading, Berkshire, RG30 1EL

John Filbee Properties Ltd

December 2021

Figure 2 – Site Development Area

GWPR4463





◇ Site boundary



Approximately 20m

816 Oxford Road, Reading, Berkshire, RG30 1EL

John Filbee Properties Ltd

December 2021

Figure 3 – Aerial View of Site

GWPR4463





Site boundary



Approximately 12m

816 Oxford Road, Reading, Berkshire, RG30 1EL

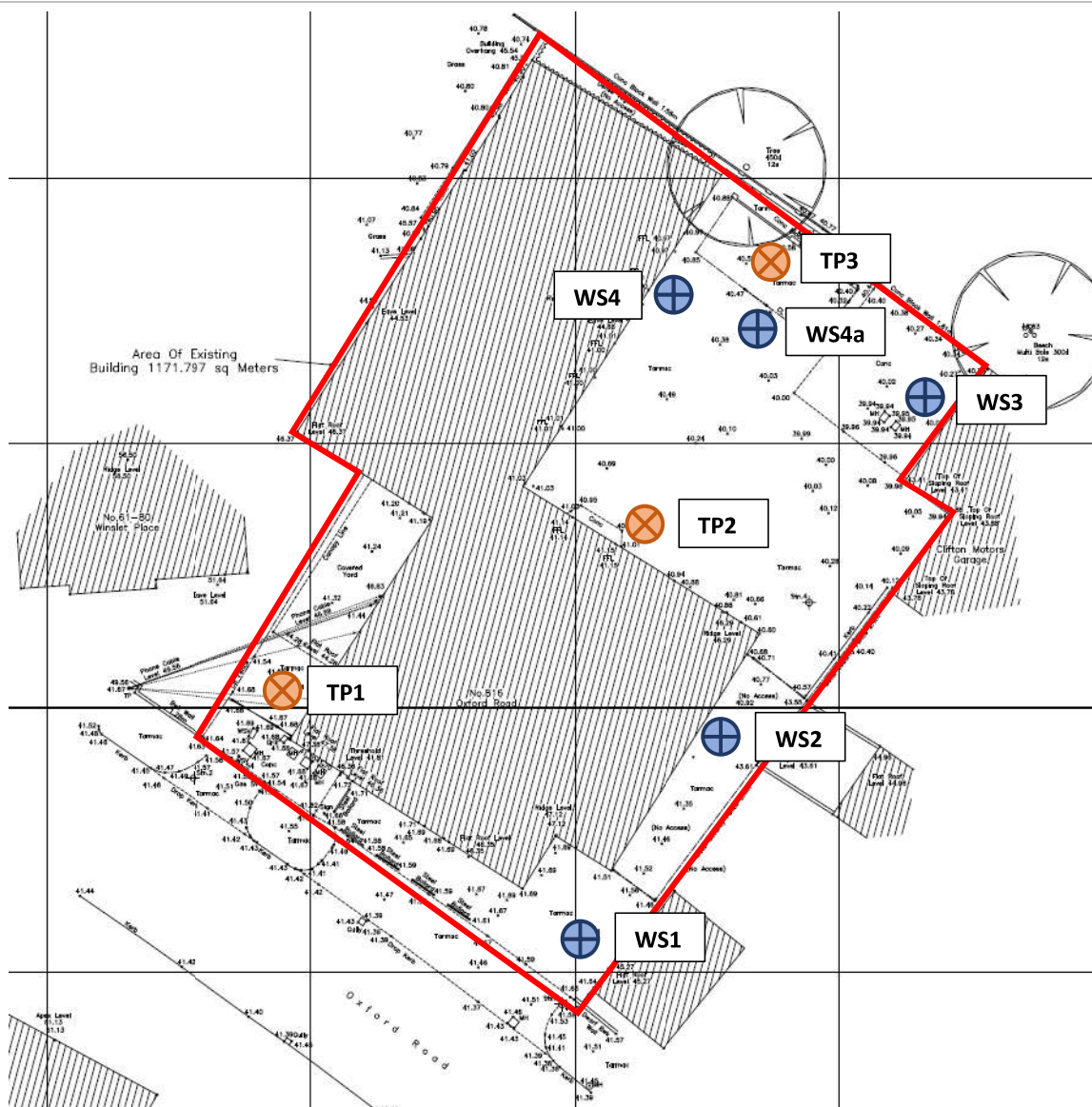
John Filbee Properties Ltd

December 2021

Figure 4 – Proposed Development – Plan View

GWPR4463





-  Site boundary
-  Machine-Excavated Soakage Trial Pit
-  Windowless Sampler Borehole



Approximately 12m

816 Oxford Road, Reading, Berkshire, RG30 1EL

John Filbee Properties Ltd

December 2021

Figure 5 – Trial Hole Location Plan

GWPR4463





-  Site boundary
-  Machine-Excavated Soakage Trial Pit
-  Windowless Sampler Borehole
-  Extent of potential cement-bound asbestos in vicinity of historic demolished building – Made Ground to be removed
-  Areas of soft landscaping requiring clean capping system

Not to scale

816 Oxford Road, Reading, Berkshire, RG30 1EL

John Filbee Properties Ltd

December 2021

Figure 6 – Remediation Plan

GWPR4463



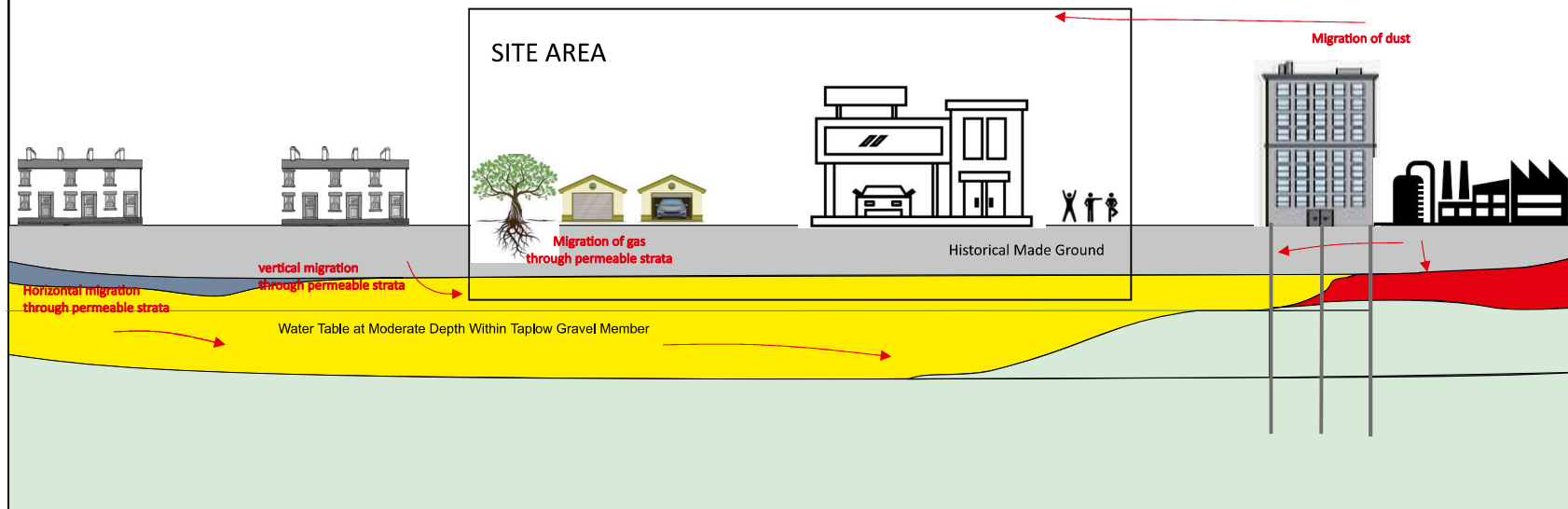
GENERAL AREA

N

S

Historical Land-use on site including: Garage Services/motor body repair works

Historical Land Use off site including: Iron works, Gas Works, Printing works, Garage Services/motor body repair works, Engineering works



KEY:

- Made Ground
- Taplow Gravel Member
- Alluvium
- Lambeth Group
- Upper Chalk

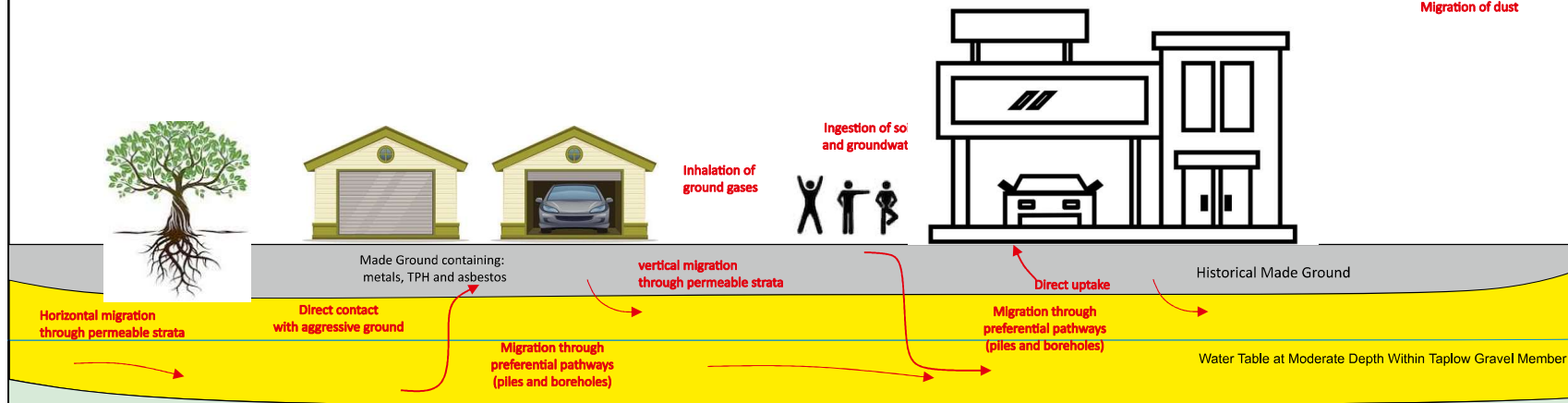
- UXO Source
- ↓ Potential Pathways
- piles Pathways

SITE AREA

Historical Land-use on site including: Garage Services/motor body repair works

Off-site source

Migration of dust



PROJECT
816 Oxford Road, Reading

CLIENT
John Filbee Properties Ltd

DRAWING TITLE
Conceptual Site Model

DRAWING NUMBER
GWPR4463 - Figure 7

DATE
December 2021

DRAWN BY
AS

CHECKED BY
MM



2 The Long Barn, Norton Farm, Selborne Road,
Selborne, Alton, Hampshire, GU34 3NB

APPENDIX B:

Trial Hole Logs



Project Name: 816 Oxford Road, Reading					Client: John Filbee Properties Ltd					Date: 19/10/2021				
Location: Berkshire, RG30 1EL					Contractor: G&W									
Project No. : GWPR4463					Crew Name: G&W					Drilling Equipment:				
Borehole Number WS1		Hole Type WLS			Level			Logged By JG		Scale 1:50		Page Number Sheet 1 of 1		
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description						
		Depth (m)	Type	Results										
		0.20	D		0.40			MADE GROUND: Tarmac and concrete.		1 –				
		0.50	D					MADE GROUND: Light brown and grey sandy sub-angular to sub-rounded fine to coarse GRAVEL of concrete (40%) carbonaceous material (30%) flint (20%) and brick (10%). MADE GROUND: Orangish brown gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse carbonaceous material (50%) and flint (50%). Orangish brown clayey fine to medium SAND. (TAPLOW GRAVEL MEMBER)						
		0.80	D											
		1.00	D		1.20			Gravelly from 2.90 - 3.10m bgl. Gravel is sub-angular to sub-rounded fine to coarse flint.		3 –				
		1.50	D											
		2.00	D											
		2.50	D		4.50			Orangish brown gravelly clayey fine to medium SAND. Gravel is sub-angular to sub-rounded fine to coarse chalk. TAPLOW GRAVEL MEMBER)		4 –				
		3.00	D											
		3.50	D											
		4.00	D		5.00			End of Borehole at 5.000m		5 –				
		4.50	D											
		5.00	D											
		Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation				
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation			
Remarks														
No roots noted. No groundwater encountered. No visible or olfactory evidence of contamination noted.														



Percussion Drilling Log

Project Name: 816 Oxford Road, Reading		Client: John Filbee Properties Ltd		Date: 19/10/2021	
Location: Berkshire, RG30 1EL		Contractor: G&W			
Project No. : GWPR4463		Crew Name: G&W		Drilling Equipment:	
Borehole Number WS2	Hole Type WLS	Level	Logged By JG	Scale 1:50	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D		0.15			MADE GROUND: Concrete.	
		0.50	D		0.50			MADE GROUND: Light orangish brown gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded flint (95%) and brick (5%).	
		0.80	D					Orangish brown slightly gravelly clayey fine to coarse SAND. Gravels are rounded fine to medium flint. (TAPLOW GRAVEL MEMBER)	1
		1.00	D						
		1.50	D		1.40			Orangish brown clayey fine to medium SAND. (TAPLOW GRAVEL MEMBER)	2
		2.00	D						
		2.50	D						
		3.00	D		3.10			Orangish brown gravelly clayey fine to medium SAND. Gravel is sub-angular fine to coarse flint. (TAPLOW GRAVEL MEMBER)	3
		3.50	D						
		4.00	D						
		4.50	D						
		5.00	D		4.80 5.00			Structureless CHALK composed of white and grey gravelly SILT. Gravel is very weak to weak low density white and sub-rounded to angular chalk and flint. (Grade Dm UNDIFFERENTIATED SEAFORD CHALK AND NEWHAVEN CHALK FORMATIONS)	5
End of Borehole at 5.000m									6
									7
									8
									9
									10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks

Roots noted to 1.00m bgl. Groundwater encountered at 3.10m bgl. No visible or olfactory evidence of contamination noted.



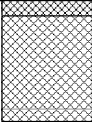






Percussion Drilling Log

Project Name: 816 Oxford Road, Reading		Client: John Filbee Properties Ltd		Date: 19/10/2021	
Location: Berkshire, RG30 1EL		Contractor: G&W			
Project No. : GWPR4463		Crew Name: G&W		Drilling Equipment:	
Borehole Number WS4a	Hole Type WLS	Level	Logged By JG	Scale 1:50	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20	D		0.10			MADE GROUND: Tarmac.	
		0.50	D					MADE GROUND: Greyish brown gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint (50%) brick (40%) and aggregate (10%).	
					0.80			End of Borehole at 0.800m	
									1
									2
									3
									4
									5
									6
									7
									8
									9
									10

Hole Diameter		Casing Diameter		Chiselling				Inclination and Orientation			
Depth Base	Diameter	Depth Base	Diameter	Depth Top	Depth Base	Duration	Tool	Depth Top	Depth Base	Inclination	Orientation

Remarks
No roots noted. Groundwater encountered at 0.70m bgl. Borehole terminated early due to an unknown solid surface encountered. No visible or olfactory evidence of contamination noted.





Project Name: 816 Oxford Road, Reading				Client: John Filbee Properties Ltd				Date: 19/10/2021				
Location: Berkshire, RG30 1EL				Contractor: G&W								
Project No. : GWPR4463				Crew Name:				Equipment:				
Location Number TP1		Location Type TP		Level		Logged By JC		Scale 1:25		Page Number Sheet 1 of 1		
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description				
		Depth (m)	Type	Results								
		0.20	D		0.15			MADE GROUND: Concrete.				
		0.50	D		0.50			MADE GROUND: Brown gravelly fine to medium SAND. Gravel is sub-angular fine to coarse flint (70%) and concrete (30%).				
		0.80	D		0.80			Orangish brown gravelly clayey fine to medium SAND. Gravel is sub-angular fine to medium flint. (TAPLOW GRAVEL MEMBER)				
End of Borehole at 0.800m												
												1
												2
												3
												4
												5
Dimensions				Trench Support and Comment				Pumping Data				
Pit Length 1.50		Pit Width 0.70		Pit Stability		Shoring Used		Remarks		Date	Rate	Remarks
Remarks												
No roots noted. No groundwater encountered.												
												





Project Name: 816 Oxford Road, Reading				Client: John Filbee Properties Ltd				Date: 19/10/2021			
Location: Berkshire, RG30 1EL				Contractor: G&W							
Project No. : GWPR4463				Crew Name:				Equipment:			
Location Number TP3		Location Type TP		Level		Logged By JC		Scale 1:25		Page Number Sheet 1 of 1	
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.20	D		0.10			MADE GROUND: Tarmac.			
		0.50	D		0.50			MADE GROUND: Brown gravelly fine to medium SAND. Gravel is sub-angular fine to coarse flint (80%) and tarmac (20%).			
		0.80	D					Orangish brown gravelly clayey fine to medium SAND. Gravel is sub-angular fine to medium flint. (TAPLOW GRAVEL MEMBER)			
		1.00	D							1	
		1.50	D								
		2.00	D		2.00			End of Borehole at 2.000m		2	
										3	
										4	
										5	
Dimensions				Trench Support and Comment				Pumping Data			
Pit Length		Pit Width		Pit Stability	Shoring Used	Remarks		Date	Rate	Remarks	
1.50		0.70									
Remarks											
No roots noted. No groundwater encountered.											
											

Appendix D

Drainage Strategy



- KEY**
- SITE BOUNDARY
 - PROPOSED SURFACE WATER DRAIN
 - POROUS PAVING
 - CELLULAR CRATE STORAGE/SOAKAWAY

- SURFACE WATER DRAINAGE STRATEGY**
- INFILTRATION TESTING SHOWED INFILTRATION POTENTIAL FOR THE SITE FOR SURFACE WATER DISCHARGE.
 - ALL SURFACE WATER RUNOFF FROM SITE TO DISCHARGE INTO THE GROUND VIA THE POROUS PAVED ACCESS.
 - INFILTRATION RATE USED FOR THE PERMEABLE PAVING AND CRATE SOAKAWAY IS 1.077x10⁻⁶m/s, BASED ON TESTING IN TRIAL PIT TP2.
 - GRATE SOAKAWAY TO BE LOCATED UNDERNEATH FORMATION OF PERMEABLE PAVING AND PROVIDE EXTRA STORAGE AT DEPTH.
 - PERMEABLE PAVING DESIGNED A 1.1m DEEP AND CRATE SOAKAWAY DESIGNED AT 0.4m DEEP FOR A TOTAL DEPTH OF 1.5m
 - MICRO DRAINAGE CALCULATIONS SHOW THAT ALL STORAGE REQUIREMENTS FOR THE SITE CAN BE ACCOMMODATED WITHIN THE PROPOSED PERMEABLE PAVING AND CRATES FOR ALL STORM EVENTS UP TO AND INCLUDING THE 1 IN 100 YEAR PLUS 40% CC EVENT.

STUART MICHAEL ASSOCIATES
CONSULTING ENGINEERS

Stuart Michael Associates Ltd
Coombe House, Coombe Square, Thatcham, Berkshire RG19 4JF

T: 01635 867 711 e: mail@stuartmichael.co.uk
F: 01635 861 715 w: www.stuartmichael.co.uk

JOB TITLE
OXFORD ROAD READING

DRAWING TITLE
SURFACE WATER DRAINAGE STRATEGY

DATE	DRAWN	CHECKED
DEC 21	JOK	
DRAWING NO.	REV	SCALE
6799.400		1:200

© This drawing is the copyright of Stuart Michael Associates Limited. It may not be reproduced or amended without the written approval of Stuart Michael Associates

Appendix E

Surface Water Calculations

Stuart Michael Associates				Page 1																																																																																																																																																																																																																			
Coombe House		6799																																																																																																																																																																																																																					
Coombe Square		Oxford Road																																																																																																																																																																																																																					
Thatcham RG19 4JF		Reading																																																																																																																																																																																																																					
Date DEC 21		Designed by JOK																																																																																																																																																																																																																					
File Permeable Paving.SRCX		Checked by																																																																																																																																																																																																																					
Micro Drainage		Source Control 2016.1																																																																																																																																																																																																																					
<u>Summary of Results for 100 year Return Period (+40%)</u> Half Drain Time : 454 minutes. <table><tr><th>Storm Event</th><th>Max Level (m)</th><th>Max Depth (m)</th><th>Max Infiltration (l/s)</th><th>Max Volume (m³)</th><th>Status</th></tr><tr><td>15 min Summer</td><td>40.664</td><td>1.164</td><td>2.2</td><td>79.7</td><td>O K</td></tr><tr><td>30 min Summer</td><td>40.731</td><td>1.231</td><td>2.2</td><td>87.4</td><td>Flood Risk</td></tr><tr><td>60 min Summer</td><td>40.796</td><td>1.296</td><td>2.2</td><td>94.8</td><td>Flood Risk</td></tr><tr><td>120 min Summer</td><td>40.850</td><td>1.350</td><td>2.2</td><td>101.0</td><td>Flood Risk</td></tr><tr><td>180 min Summer</td><td>40.868</td><td>1.368</td><td>2.2</td><td>103.2</td><td>Flood Risk</td></tr><tr><td>240 min Summer</td><td>40.871</td><td>1.371</td><td>2.2</td><td>103.5</td><td>Flood Risk</td></tr><tr><td>360 min Summer</td><td>40.855</td><td>1.355</td><td>2.2</td><td>101.7</td><td>Flood Risk</td></tr><tr><td>480 min Summer</td><td>40.838</td><td>1.338</td><td>2.2</td><td>99.7</td><td>Flood Risk</td></tr><tr><td>600 min Summer</td><td>40.822</td><td>1.322</td><td>2.2</td><td>97.8</td><td>Flood Risk</td></tr><tr><td>720 min Summer</td><td>40.805</td><td>1.305</td><td>2.2</td><td>95.9</td><td>Flood Risk</td></tr><tr><td>960 min Summer</td><td>40.775</td><td>1.275</td><td>2.2</td><td>92.4</td><td>Flood Risk</td></tr><tr><td>1440 min Summer</td><td>40.707</td><td>1.207</td><td>2.2</td><td>84.7</td><td>Flood Risk</td></tr><tr><td>2160 min Summer</td><td>40.605</td><td>1.105</td><td>2.2</td><td>73.0</td><td>O K</td></tr><tr><td>2880 min Summer</td><td>40.517</td><td>1.017</td><td>2.2</td><td>62.9</td><td>O K</td></tr><tr><td>4320 min Summer</td><td>40.404</td><td>0.904</td><td>2.1</td><td>50.0</td><td>O K</td></tr><tr><td>5760 min Summer</td><td>40.337</td><td>0.837</td><td>1.8</td><td>43.1</td><td>O K</td></tr><tr><td>7200 min Summer</td><td>40.284</td><td>0.784</td><td>1.6</td><td>38.3</td><td>O K</td></tr><tr><td>8640 min Summer</td><td>40.243</td><td>0.743</td><td>1.5</td><td>35.1</td><td>O K</td></tr><tr><td>10080 min Summer</td><td>40.208</td><td>0.708</td><td>1.3</td><td>32.6</td><td>O K</td></tr><tr><td>15 min Winter</td><td>40.750</td><td>1.250</td><td>2.2</td><td>89.6</td><td>Flood Risk</td></tr></table> <table><tr><th>Storm Event</th><th>Rain (mm/hr)</th><th>Flooded Volume (m³)</th><th>Time-Peak (mins)</th></tr><tr><td>15 min Summer</td><td>252.794</td><td>0.0</td><td>19</td></tr><tr><td>30 min Summer</td><td>139.819</td><td>0.0</td><td>33</td></tr><tr><td>60 min Summer</td><td>77.333</td><td>0.0</td><td>64</td></tr><tr><td>120 min Summer</td><td>42.772</td><td>0.0</td><td>122</td></tr><tr><td>180 min Summer</td><td>30.249</td><td>0.0</td><td>182</td></tr><tr><td>240 min Summer</td><td>23.657</td><td>0.0</td><td>240</td></tr><tr><td>360 min Summer</td><td>16.730</td><td>0.0</td><td>332</td></tr><tr><td>480 min Summer</td><td>13.085</td><td>0.0</td><td>384</td></tr><tr><td>600 min Summer</td><td>10.813</td><td>0.0</td><td>444</td></tr><tr><td>720 min Summer</td><td>9.254</td><td>0.0</td><td>506</td></tr><tr><td>960 min Summer</td><td>7.275</td><td>0.0</td><td>644</td></tr><tr><td>1440 min Summer</td><td>5.182</td><td>0.0</td><td>910</td></tr><tr><td>2160 min Summer</td><td>3.692</td><td>0.0</td><td>1296</td></tr><tr><td>2880 min Summer</td><td>2.902</td><td>0.0</td><td>1668</td></tr><tr><td>4320 min Summer</td><td>2.080</td><td>0.0</td><td>2336</td></tr><tr><td>5760 min Summer</td><td>1.642</td><td>0.0</td><td>3056</td></tr><tr><td>7200 min Summer</td><td>1.367</td><td>0.0</td><td>3752</td></tr><tr><td>8640 min Summer</td><td>1.177</td><td>0.0</td><td>4496</td></tr><tr><td>10080 min Summer</td><td>1.037</td><td>0.0</td><td>5240</td></tr><tr><td>15 min Winter</td><td>252.794</td><td>0.0</td><td>19</td></tr></table>						Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status	15 min Summer	40.664	1.164	2.2	79.7	O K	30 min Summer	40.731	1.231	2.2	87.4	Flood Risk	60 min Summer	40.796	1.296	2.2	94.8	Flood Risk	120 min Summer	40.850	1.350	2.2	101.0	Flood Risk	180 min Summer	40.868	1.368	2.2	103.2	Flood Risk	240 min Summer	40.871	1.371	2.2	103.5	Flood Risk	360 min Summer	40.855	1.355	2.2	101.7	Flood Risk	480 min Summer	40.838	1.338	2.2	99.7	Flood Risk	600 min Summer	40.822	1.322	2.2	97.8	Flood Risk	720 min Summer	40.805	1.305	2.2	95.9	Flood Risk	960 min Summer	40.775	1.275	2.2	92.4	Flood Risk	1440 min Summer	40.707	1.207	2.2	84.7	Flood Risk	2160 min Summer	40.605	1.105	2.2	73.0	O K	2880 min Summer	40.517	1.017	2.2	62.9	O K	4320 min Summer	40.404	0.904	2.1	50.0	O K	5760 min Summer	40.337	0.837	1.8	43.1	O K	7200 min Summer	40.284	0.784	1.6	38.3	O K	8640 min Summer	40.243	0.743	1.5	35.1	O K	10080 min Summer	40.208	0.708	1.3	32.6	O K	15 min Winter	40.750	1.250	2.2	89.6	Flood Risk	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)	15 min Summer	252.794	0.0	19	30 min Summer	139.819	0.0	33	60 min Summer	77.333	0.0	64	120 min Summer	42.772	0.0	122	180 min Summer	30.249	0.0	182	240 min Summer	23.657	0.0	240	360 min Summer	16.730	0.0	332	480 min Summer	13.085	0.0	384	600 min Summer	10.813	0.0	444	720 min Summer	9.254	0.0	506	960 min Summer	7.275	0.0	644	1440 min Summer	5.182	0.0	910	2160 min Summer	3.692	0.0	1296	2880 min Summer	2.902	0.0	1668	4320 min Summer	2.080	0.0	2336	5760 min Summer	1.642	0.0	3056	7200 min Summer	1.367	0.0	3752	8640 min Summer	1.177	0.0	4496	10080 min Summer	1.037	0.0	5240	15 min Winter	252.794	0.0	19
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status																																																																																																																																																																																																																		
15 min Summer	40.664	1.164	2.2	79.7	O K																																																																																																																																																																																																																		
30 min Summer	40.731	1.231	2.2	87.4	Flood Risk																																																																																																																																																																																																																		
60 min Summer	40.796	1.296	2.2	94.8	Flood Risk																																																																																																																																																																																																																		
120 min Summer	40.850	1.350	2.2	101.0	Flood Risk																																																																																																																																																																																																																		
180 min Summer	40.868	1.368	2.2	103.2	Flood Risk																																																																																																																																																																																																																		
240 min Summer	40.871	1.371	2.2	103.5	Flood Risk																																																																																																																																																																																																																		
360 min Summer	40.855	1.355	2.2	101.7	Flood Risk																																																																																																																																																																																																																		
480 min Summer	40.838	1.338	2.2	99.7	Flood Risk																																																																																																																																																																																																																		
600 min Summer	40.822	1.322	2.2	97.8	Flood Risk																																																																																																																																																																																																																		
720 min Summer	40.805	1.305	2.2	95.9	Flood Risk																																																																																																																																																																																																																		
960 min Summer	40.775	1.275	2.2	92.4	Flood Risk																																																																																																																																																																																																																		
1440 min Summer	40.707	1.207	2.2	84.7	Flood Risk																																																																																																																																																																																																																		
2160 min Summer	40.605	1.105	2.2	73.0	O K																																																																																																																																																																																																																		
2880 min Summer	40.517	1.017	2.2	62.9	O K																																																																																																																																																																																																																		
4320 min Summer	40.404	0.904	2.1	50.0	O K																																																																																																																																																																																																																		
5760 min Summer	40.337	0.837	1.8	43.1	O K																																																																																																																																																																																																																		
7200 min Summer	40.284	0.784	1.6	38.3	O K																																																																																																																																																																																																																		
8640 min Summer	40.243	0.743	1.5	35.1	O K																																																																																																																																																																																																																		
10080 min Summer	40.208	0.708	1.3	32.6	O K																																																																																																																																																																																																																		
15 min Winter	40.750	1.250	2.2	89.6	Flood Risk																																																																																																																																																																																																																		
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)																																																																																																																																																																																																																				
15 min Summer	252.794	0.0	19																																																																																																																																																																																																																				
30 min Summer	139.819	0.0	33																																																																																																																																																																																																																				
60 min Summer	77.333	0.0	64																																																																																																																																																																																																																				
120 min Summer	42.772	0.0	122																																																																																																																																																																																																																				
180 min Summer	30.249	0.0	182																																																																																																																																																																																																																				
240 min Summer	23.657	0.0	240																																																																																																																																																																																																																				
360 min Summer	16.730	0.0	332																																																																																																																																																																																																																				
480 min Summer	13.085	0.0	384																																																																																																																																																																																																																				
600 min Summer	10.813	0.0	444																																																																																																																																																																																																																				
720 min Summer	9.254	0.0	506																																																																																																																																																																																																																				
960 min Summer	7.275	0.0	644																																																																																																																																																																																																																				
1440 min Summer	5.182	0.0	910																																																																																																																																																																																																																				
2160 min Summer	3.692	0.0	1296																																																																																																																																																																																																																				
2880 min Summer	2.902	0.0	1668																																																																																																																																																																																																																				
4320 min Summer	2.080	0.0	2336																																																																																																																																																																																																																				
5760 min Summer	1.642	0.0	3056																																																																																																																																																																																																																				
7200 min Summer	1.367	0.0	3752																																																																																																																																																																																																																				
8640 min Summer	1.177	0.0	4496																																																																																																																																																																																																																				
10080 min Summer	1.037	0.0	5240																																																																																																																																																																																																																				
15 min Winter	252.794	0.0	19																																																																																																																																																																																																																				
©1982-2016 XP Solutions																																																																																																																																																																																																																							

Stuart Michael Associates					Page 2
Coombe House Coombe Square Thatcham RG19 4JF		6799 Oxford Road Reading			
Date DEC 21 File Permeable Paving.SRCX		Designed by JOK Checked by			
Micro Drainage		Source Control 2016.1			
<u>Summary of Results for 100 year Return Period (+40%)</u>					
Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	40.826	1.326		2.2 98.3	Flood Risk
60 min Winter	40.901	1.401		2.2 106.9	Flood Risk
120 min Winter	40.964	1.464		2.2 114.1	Flood Risk
180 min Winter	40.988	1.488		2.2 116.9	Flood Risk
240 min Winter	40.995	1.495		2.2 117.7	Flood Risk
360 min Winter	40.984	1.484		2.2 116.4	Flood Risk
480 min Winter	40.956	1.456		2.2 113.2	Flood Risk
600 min Winter	40.929	1.429		2.2 110.1	Flood Risk
720 min Winter	40.904	1.404		2.2 107.2	Flood Risk
960 min Winter	40.855	1.355		2.2 101.6	Flood Risk
1440 min Winter	40.748	1.248		2.2 89.3	Flood Risk
2160 min Winter	40.594	1.094		2.2 71.7	O K
2880 min Winter	40.470	0.970		2.2 57.5	O K
4320 min Winter	40.346	0.846	1.9	44.0	O K
5760 min Winter	40.267	0.767	1.6	36.9	O K
7200 min Winter	40.210	0.710	1.3	32.7	O K
8640 min Winter	40.167	0.667	1.2	30.0	O K
10080 min Winter	40.133	0.633	1.0	28.2	O K
Storm Event		Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)	
30 min Winter		139.819	0.0	33	
60 min Winter		77.333	0.0	62	
120 min Winter		42.772	0.0	120	
180 min Winter		30.249	0.0	178	
240 min Winter		23.657	0.0	236	
360 min Winter		16.730	0.0	346	
480 min Winter		13.085	0.0	446	
600 min Winter		10.813	0.0	476	
720 min Winter		9.254	0.0	550	
960 min Winter		7.275	0.0	702	
1440 min Winter		5.182	0.0	984	
2160 min Winter		3.692	0.0	1384	
2880 min Winter		2.902	0.0	1728	
4320 min Winter		2.080	0.0	2420	
5760 min Winter		1.642	0.0	3112	
7200 min Winter		1.367	0.0	3816	
8640 min Winter		1.177	0.0	4496	
10080 min Winter		1.037	0.0	5240	
©1982-2016 XP Solutions					

Stuart Michael Associates		Page 3
Coombe House Coombe Square Thatcham RG19 4JF	6799 Oxford Road Reading	
Date DEC 21 File Permeable Paving.SRCX	Designed by JOK Checked by	
Micro Drainage		Source Control 2016.1

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
Site Location	GB 469450 174000 SU 69450 74000
C (1km)	-0.029
D1 (1km)	0.279
D2 (1km)	0.297
D3 (1km)	0.312
E (1km)	0.311
F (1km)	2.581
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.175

Time (mins) Area
From: To: (ha)

0 4 0.175

Stuart Michael Associates		Page 4
Coombe House Coombe Square Thatcham RG19 4JF	6799 Oxford Road Reading	
Date DEC 21 File Permeable Paving.SRCX	Designed by JOK Checked by	
Micro Drainage Source Control 2016.1		

Model Details

Storage is Online Cover Level (m) 41.000

Complex Structure

Cellular Storage

Invert Level (m) 39.500 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.03877

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	54.0	54.0	0.500	0.0	77.2
0.400	54.0	77.2			

Porous Car Park

Infiltration Coefficient Base (m/hr)	0.03877	Width (m)	9.1
Membrane Percolation (mm/hr)	1000	Length (m)	42.0
Max Percolation (l/s)	106.2	Slope (1:X)	80.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	39.900	Membrane Depth (m)	0

©1982-2016 XP Solutions

Appendix F

SuDS Management & Maintenance

Table 20.15 Operation and maintenance requirements for pervious pavements

Maintenance Schedule	Required action	Frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface).	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations - pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying.	As required - once per year on less frequently used pavements
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required.
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material.	As required.
	Rehabilitation of surface and upper sub-structure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging).
Monitoring	Initial inspection.	Monthly for three months after installation.
	Inspect for evidence of poor operation and/or weed growth - if required, take remedial action.	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.
	Monitor inspection chambers	Annually.