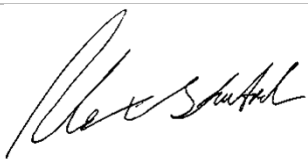


Phase II Site Investigation Report

2 - 6 Seagull Lane, Emsworth PO10 7QH

On behalf of Nyetimber Management Ltd

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Table of Contents

.....	0
Table of Contents.....	i
1. INTRODUCTION.....	1
1.1. General.....	1
1.2. Aims of the Investigation	1
1.3. Conditions and Limitations	1
1.4. Technical Glossary.....	1
2. SITE SETTING	2
2.1. Site Location.....	2
2.2. Site Description	2
2.3. Proposed Development	2
2.4. Geology	3
2.5. Hydrogeology and Hydrology.....	4
2.6. Radon	4
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.....	8
3.1. Scope of Works	8
3.2. Sampling Procedures	8
4. ENCOUNTERED GROUND CONDITIONS	9
4.1. Soil Conditions.....	9
4.2. Roots Encountered.....	9
4.3. Groundwater Conditions.....	10
4.4. Obstructions.....	10
5. IN-SITU AND LABORATORY TESTING.....	11
5.1. In-situ Strength Testing.....	11
5.2. Geotechnical Laboratory Testing	11
5.2.1. Atterberg Limit Testing	12
5.2.2. Moisture Deficit Assessment	12

5.2.3.	Particle Size Distribution Testing	12
6.	ENGINEERING CONSIDERATIONS.....	13
6.1.	Soil Characteristics and Foundation Considerations.....	13
6.2.	Shallow Foundations	13
6.3.	Piled Foundation	15
6.4.	Excavations and Stability.....	15
6.5.	Sub-Surface Concrete Design.....	15
6.6.	Roads and Hardstanding Design	16
6.6.1.	Anticipated CBR Values and Frost Susceptibility	16
6.7.	Surface Water Disposal	17
7.	CONTAMINATION RISK ASSESSMENT	18
7.1.	Results of the Preliminary Risk Assessment.....	18
7.2.	Sampling Locations	18
7.3.	Soil Risk Assessment	18
7.3.1.	Soil Assessment Criteria and Results	19
7.3.2.	Soil Assessment.....	22
7.3.3.	Water Supply Pipe Risk Assessment	22
7.4.	Groundwater Risk Assessment	23
7.5.	Ground Gas Risk Assessment	24
7.5.1.	Available Data	24
7.5.2.	Data Quality	25
7.5.3.	Risk Assessment	26
7.6.	Dissolved Ground Gases in Groundwater	28
7.6.1.	Dissolved Gases Results	28
7.6.2.	Dissolved Gases Risk Assessment	29
7.6.3.	Borehole Monitoring.....	30
7.6.4.	Ground-gas Risk Assessment Summary	30
7.7.	Vapour Risk Assessment	30
7.7.1.	Soil Assessment.....	30
7.7.2.	Borehole Monitoring.....	31
7.7.3.	Vapour Risk Assessment Summary	33
7.8.	Updated Conceptual Site Model.....	33

8. CONTAMINATION RECOMMENDATIONS AND REMEDIATION STRATEGY.....	37
8.1.1. Water Supply Pipes	37
8.2. Groundwater	37
8.3. Radon, Ground Gas and Vapours.....	38
8.3.1. Verification.....	38
8.4. Discovery Strategy	38
8.5. Imported Material.....	38
8.6. Waste Disposal.....	38
8.7. Duty of Care	39
FIGURES.....	
APPENDIX A: Conditions and Limitations.....	
APPENDIX B: Technical Glossary	
APPENDIX C: Groundsure Historical Mapping	
APPENDIX D: Trial Hole Logs	
APPENDIX E: Geotechnical Laboratory Testing.....	
APPENDIX F: Chemical Laboratory Testing	
APPENDIX G: Soil Assessment Criteria	
APPENDIX H: Waste Hazard Assessment	
APPENDIX I: BGS Radon Report	
APPENDIX J: Ground Gas Monitoring Results	
APPENDIX K: Gas Cannister and Dissolved Gasses in Groundwater results	
APPENDIX L: Vapour Assessment Methodology.....	
APPENDIX M: Vapour Assessment Criteria	

EXECUTIVE SUMMARY	
PROPOSED DEVELOPMENT	At the time of reporting, November 2023, the proposed development was understood to comprise the demolition of the majority of the existing buildings on-site and the construction of eight new commercial units varying in size from 100-120m ² with new access roads onto the site as well as new car parking spaces. A bin store was noted on the northern portion of the site near the proposed site entranceway. The existing office building located on the centre of the site is to remain.
GEOLOGY AND HYDROGEOLOGY	The British Geological Survey Solid and Drift Geology Map for the Emsworth area (Fareham Sheet No. 316) revealed that the site was underlain by superficial River Terrace Deposits on the western portion of the site, Head Deposits on the central and eastern portion of the site and possible alluvial deposits located on the eastern boundary/near the eastern boundary of the site with bedrock deposits of the London Clay Formation. No areas of Made Ground or Reworked Ground were noted within a 250m radius. A study of the aquifer maps on the DEFRA website revealed the site was underlain by a Secondary A Aquifer comprising the superficial River Terrace Deposits and Head Deposits, underlain by Unproductive Strata comprising bedrock deposits of the London Clay Formation. 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. The nearest surface water feature was the River Ems located ~50m east of the site and was flowing in a north to south direction. Emsworth harbour was noted 630m south of the site. From analysis of hydrogeological and topographical maps the actual groundwater table was anticipated to be encountered at shallow to moderate depths within the River Terrace Deposits/Head Deposits. Some amounts of groundwater however may be present at shallower depths within Made ground. It was considered that groundwater was flowing in an easterly direction toward the River Ems in line with local topography.
VOLUME CHANGE POTENTIAL	Foundations should be designed in accordance with soils of High-volume change potential.
FOUNDATION DESIGN	Within the area of WS1, WS2 and WS4 detailed geotechnical analysis was undertaken, with the results shown in section 6.2. Shallow Foundations across the rest of the site should be taken through any Made Ground and extend 300mm below root penetrated soils, before founding onto competent, moisture stable soils of the Head Deposits/River Terrace Deposits at depths of at least 1.00m bgl, subject to deepening based on trees or other factors, like soft zones. Foundations constructed at 1.00m bgl can be designed based on an allowable bearing capacity of 100 - 125kN/m². This is based on trial hole records, the results of in-situ testing, inspection of samples recovered, and referral to BS 8004:2015, Code of Practice for Foundations, and based on a 5m long by 1m wide foundation

	and a maximum settlement of 25mm. Settlements on loading are likely to be moderate.
SUB-SURFACE CONCRETE	The water-soluble sulphates in the Made Ground were noted to be 19.1 – 535mg/l, with a pH of 8.32-11.1, from chemical and geotechnical laboratory testing. The total potential sulphate (3x total sulphur) was 0.1317%, from chemical laboratory testing. According to BRE Special Digest 1, 2005, 'Concrete in Aggressive Ground' a Sulphate Design Class of DS-2 could be used for sub-surface concrete in contact with the Made Ground. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-2. The water-soluble sulphates in the Head Deposits were noted to be 194mg/l, with a pH of 8.71, from chemical laboratory testing. 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 Head Deposits. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1. The water-soluble sulphates in the London Clay Formation were noted to be 88.9mg/l, with a pH of 9, from chemical laboratory testing. The total potential sulphate (3x total sulphur) was <0.06%, from chemical laboratory testing. 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 London Clay Formation. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.
CONTAMINATION AND REMEDIATION	Based on the results of the intrusive works, chemical analyses and risk assessments undertaken, the following has been identified that requires further action: • Gas protection measures are required in line with the requirements of Characteristic Situation CS2 at this stage. • It is considered that there is a risk to groundwater on site from the site. Groundwater testing and a Level 2 risk assessment should be carried out. • Basic radon protective measures are required for the report area. This can be in alignment / covered by gas and vapour measures. • For risk to water supply pipes and concrete please see relevant sections. • A specific capping system is not required for soft landscaped areas. However, a nominal capping system of 100-150mm of topsoil should be placed in soft landscaped areas as a growing medium. • Groundworkers during the construction stage will require full personal protective equipment. If any contamination is recorded during the construction phase, works should stop and the source and extent of any contamination be further investigated by a competent and qualified person.

1. INTRODUCTION

1.1. General

Ground and Water Limited were instructed by Nyetimber Management Limited on the 27th June 2023 to conduct an updated Phase 2 Site Investigation on the site at 2 - 6 Seagull Lane, Emsworth PO10 7QH. The scope of the investigation was detailed within the fee proposal GW-2086 rev2, dated the 22nd June 2023.

1.2. Aims of the Investigation

The aim of this report was 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.

The investigation was to be undertaken to provide parameters for the design of foundations by means of in-situ and laboratory geotechnical testing undertaken on soil samples recovered from trial holes.

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.

An additional investigation and report was completed on site to determine the gas and vapour protection measures and remedial works required on site.

This Site Investigation Report must be read in conjunction with the Desk Study Report referenced GWPR5385/DS/June 2023 and the Phase 2 Site investigation report GWPR5385/SIR/June 2023.

The techniques adopted for the investigation were chosen considering the requirements of the client, anticipated ground conditions, 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 report has superseded the previously issued report GWPR5475/August 2023.

1.4. Technical Glossary

Generic technical terms and their description can be viewed within the glossary provided within Appendix B.

2. SITE SETTING

2.1. Site Location

The site comprised a ~2,800m² roughly rectangular shaped plot of land, orientated in a west to east direction, along the southern side of Seagull Lane. The site was located in the northern portion of the town of Emsworth in the county of Hampshire.

The national grid reference for the centre of the site was approximately SU 74955 06184. A site location plan is given within Figure 1. The site development plan is shown in figure 2 with an aerial photograph shown in figure 3.

2.2. Site Description

A Site Walkover was undertaken on the 12th May 2023. A description of the site, as noted during the Site Walkover, is tabulated below.

Site Description Sheet	
Use of site	At the time of the site walkover, 12th May 2023, the site comprised old abandoned warehouse and works buildings as well as an office building located on the central area of the site. The office was still in use.
Site topography	The site was sloping gently from the west to the east.
Area topography	The site environs were sloping gently from the west to the east.
Structures onsite	A mixture of office buildings (in use) and derelict warehouses, works and other buildings in varying states of repair across the entire site area.
Structures off-site	Residential flats and houses were noted to the north and west of the site, works buildings were noted to the east. The land directly to the south was undeveloped but residential houses and a works were also noted further to the south of the site.
Use of surrounding ground	Mainly residential land use with some areas of industrial land associated with works to the east and south of the site.
Boundary features	Northern Boundary: Seagull Lane with residential houses beyond. Eastern Boundary: Brick wall with works buildings beyond. Southern Boundary: Brick wall with undeveloped land directly to the south of the site. Western Boundary: Brick wall with residential houses beyond.
Site covering	The majority of the site was covered with concrete hardstanding, in some areas bushes and grass had grown in cracks of the concrete hardstanding or in corners of the site close to certain buildings.
Contamination sources onsite	An oil interceptor was noted on the south-east corner of the site. General industrial setting including fly tipped material across the western portion of the site.
Contamination sources off-site	Works buildings were noted to the east of the site. The undeveloped land to the south of the site had old foundations for a gas holder.
Vegetation onsite	Vegetation was limited on site to small bushes, weeds and small patches of grass which was overgrown and coming from cracks in the concrete hardstanding and around derelict buildings.
Vegetation off-site	Mature trees were noted to the north-east of the site. Semi-mature trees and shrubs were noted along the northern and southern boundary walls.
Services	Oil Interceptor was noted in the south-east corner of the site. Electricity and gas was noted going into the office building in the centre of the site, Electricity and water was noted to be underneath the eastern portion of the site.

2.3. Proposed Development

At the time of reporting, November 2023, the proposed development was understood to comprise the demolition of the majority of the existing buildings on-site and the construction of eight new commercial units varying in size from 100-120m² with new access roads onto the site as well as new

car parking spaces. A bin store was noted on the northern portion of the site near the proposed site entranceway. The existing office building located on the centre of the site is to remain.

The proposed development plan can be seen within Figures 4-8.

2.4. Geology

The British Geological Survey Solid and Drift Geology Map for the Emsworth area (Fareham Sheet No. 316) revealed that the site was underlain by superficial River Terrace Deposits on the western portion of the site, Head Deposits on the central and eastern portion of the site and possible alluvial deposits located on the eastern boundary/near the eastern boundary of the site with bedrock deposits of the London Clay Formation. No areas of Made Ground or Reworked Ground were noted within a 250m radius.

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.

River Terrace Deposits

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

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.

London Clay Formation

The London Clay Formation comprises stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of Gypsum (Selenite) are often found within the weathered part of the London Clay Formation, and precautions against sulphate attack to concrete are sometimes required. The lowest

part of the formation is a sandy bed with black rounded gravel and occasional layers of sandstone and is known as the Basement Bed.

A BGS borehole (SU70NE/100) located ~90m north-east of the site revealed a 0.15m capping of Topsoil over a clayey Sand and Gravel (potential Made Ground) down to 0.30m bgl. From 0.30-0.80m a soft to firm light to dark brown organic Clay, with a very soft organic peaty Clay to 1.00m bgl. A light grey Clay was recorded below to 1.90m with a loose flint gravel below to 2.20m. From 2.20-6.00m (base of the borehole) a stiff dark grey fissured silty Clay with thin partings of silt and fine sand. Groundwater was noted at 1.10m bgl.

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 River Terrace Deposits and Head Deposits, underlain by **Unproductive Strata** comprising bedrock deposits of the London Clay Formation.

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.

The nearest surface water feature was the River Ems located ~50m east of the site and was flowing in a north to south direction. Emsworth harbour was noted 630m south of the site.

From analysis of hydrogeological and topographical maps the actual groundwater table was anticipated to be encountered at shallow to moderate depths within the River Terrace Deposits/Head Deposits. Some amounts of groundwater however may be present at shallower depths within Made ground. It was considered that groundwater was flowing in an easterly direction toward the River Ems 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 fluvial/coastal flooding.

The datasheets also revealed the eastern portion of the site was at high risk of groundwater flooding, while the central and western portions had a moderate to moderate to high risk.

2.6. Radon

A review of the freely available UK Health Security Agency radon database, UK Radon, indicated that the site was located within a 1km grid square, where the maximum radon potential of 5 – 10% was recorded. 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 required.

The UKHSA advises that radon gas should be measured in all properties within radon Affected Areas and that homes with radon levels at or above the Action Level (200 Bq m⁻³) should be remediated. Householders with levels between the Target Level (100 Bq m⁻³) and Action Level should seriously consider reducing their radon level, especially if they are at greater risk, such as if they are current or ex smokers. Whether or not a home is in fact above or below the Action Level or Target Level can only be established by having the building tested.

Based on the report, the property is in a radon affected area where 5 to 10% of homes are estimated to be at or above the action level.

Basic radon protective measures are required for the report area.

The BGS Radon report can be viewed in Appendix I.

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 moderate-risk area associated with unexploded ordnance (UXO), as indicated by having 15 – 49 bombs dropped per 1000 acres.

2.7.2. Historical Landfill Tool Review

A review of the data available on www.groundsure.io/ revealed no areas of Historical or authorised Landfilling within a 500m 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 (GWPR5385/DS/June 2023) 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. Any risk deemed to be negligible within the Preliminary Risk Assessment have been excluded from this report.

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. 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, gas works, unspecified tanks, works, garage site: - 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 (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 (Head Deposits and River Terrace Deposits) - River Ems	Moderate
Electricity Sub-Station PCB oils and other cable/transformer oils	Migration through anthropogenic & natural pathways	Human Health End Users (Residents/Future site visitors)	Low
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)	Moderate
Ground gases generated by Made Ground, gas works and industrial land: - Methane, - Carbon Dioxide, - Hydrogen Sulphide, and - Carbon Monoxide.	- Migration through anthropogenic & natural pathways - Inhalation of Asphyxiating gases - Explosion (methane only)	Human Health - End Users (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	Low
Radon	Inhalation	Human Health	Moderate

		• End Users (Future site visitors) • Construction workers during development (especially in confined spaces) • Site operatives during maintenance works in confined spaces • Neighbours and public	
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Tabulated Conceptual Site Model – Pollutant Linkage Summary			(Off-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Made Ground from nearby works, Gas works: • 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 (Future site visitors) • Construction workers during development • Site operatives during maintenance works	Moderate
	• Direct uptake of groundwater	Flora and Fauna • Vegetation within soft landscaped areas	Moderate
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)	Low
Ground gases generated by Made Ground, gas works and other industrial land: • Methane, • Carbon Dioxide, • Hydrogen Sulphide, and • Carbon Monoxide.	• Migration through anthropogenic & natural pathways • Inhalation of Asphyxiating gases • Explosion (methane only)	Human Health • End Users (Future site visitors) • Construction workers during development (especially in confined spaces) • Site operatives during maintenance works in confined spaces	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 15th May 2023 and comprised the drilling of 5 No. Windowless Sampler Boreholes (WS1-WS5) to a depth of 5.00m bgl. Standard Penetration Tests were carried out at 1.00m intervals within the boreholes. A combined ground-gas/groundwater monitoring standpipe, with an internal diameter of 50mm, was installed to depths of between 3.50-5.00m bgl within WS1, WS3 and WS5, with a response zone between 1.00 – 5.00m bgl. The installation details can be viewed within the table below.

Combined Ground-gas and Groundwater Monitoring Well Construction					
Trial Hole	Depth of Installation (m bgl)	Thickness of slotted piping with gravel filter pack (m)	Depth of plain piping with bentonite seal (m bgl)	Response Zone (m bgl)	Piping internal diameter (mm)
WS1	3.50	2.50	1.00	1.00 – 3.50	50
WS3	4.50	3.50	1.00	1.00 – 4.50	50
WS5	5.00	4.00	1.00	1.00 – 5.00	50

The location of the trial hole locations can be seen within Figure 9.

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 borehole was hand excavated to 1.20m below the local ground level (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 and environmental 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.

A selection of samples were despatched to a laboratory for both geotechnical and chemical testing purposes.

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 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 Head Deposits and River Terrace Deposits and the bedrock London Clay Formation.

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

Summary of Strata Encountered (BH01 – BH02)			
Strata	Top Depth (m bgl)	Base Depth (m bgl)	Thickness (m)
MADE GROUND: Concrete	GL	0.10-0.30	0.10-0.30
MADE GROUND: Dark brown black slightly sandy gravelly CLAY/ gravelly SAND. Sand is fine to coarse. Gravel is fine to coarse sub-angular to sub-rounded flint, glass, Ash, brick and concrete. Strong hydrocarbon odour in WS1 and WS5. To see the percentage of various fragments within the Made Ground, please refer to logs found within Appendix D.	0.10-0.30	1.00 – 1.60	0.80 – 1.45
HEAD DEPOSITS (WS1, WS2, WS4, WS5): Light brown very sandy gravelly CLAY/ sandy GRAVEL. Sand is fine to coarse. Gravel is fine to coarse sub-angular to sub-rounded flint.	1.00 – 1.60	2.20->5.00	1.10->4.00
RIVER TERRACE DEPOSITS (WS3 Only): Brown, grey, orange, slightly gravelly CLAY. Gravel is fine to coarse sub-angular to sub-rounded flint.	1.10	2.50	1.40
LONDON CLAY FORMATION: Mottled grey, brown, slightly gravelly CLAY with selenite crystals. Gravel is fine sub-angular to sub-rounded flint.	2.20-3.40	>5.00	>1.60 – >2.80

For details of the composition of the soils encountered at particular points, reference must be made to the individual trial hole logs within Appendix D of this report. A trial hole location plan can also be viewed within Figure 9.

4.2. Roots Encountered

Fresh Roots were noted to a proved depth of 1.50m bgl within WS5.

Decayed roots were noted to a proved depth of 3.00m bgl within WS3 and WS4. These roots were interpreted as being decayed/dead and were therefore not likely to be uptaking moisture from the soils on-site; therefore these roots were not anticipated to cause the shrinking/swelling of soils of volume change potential and did not pose a risk to the serviceability of foundations.

A summary of the depth of root penetration can be viewed below.

Root Depth		
Trial Hole	Fresh Root Penetration (m bgl)	Decayed Root Penetration (m bgl)
WS1	None	None
WS2	None	None
WS3	None	3.00
WS4	-	3.00
WS5	1.50	-

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 strikes were noted between 0.70-1.23m bgl within WS1, WS3-WS5. It should be noted that groundwater strikes may be obscured by the drilling/excavation process. A summary of the groundwater observations during site works has been provided below.

Groundwater Depth	
Trial Hole	Groundwater Depth (m bgl)
WS1	0.90
WS2	None
WS3	1.23
WS4	0.70
WS5	1.12

Changes in groundwater level occur for a number of reasons including seasonal effects and variations in drainage. The investigation was undertaken in May 2023 when groundwater levels are likely to be falling from their annual maximum (highest elevation). Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site.

Groundwater monitoring was undertaken on two occasions to date. The results can be seen tabulated below.

Groundwater Observations			
Date	Trial Hole	Water Level	Final Well Depth
26/05/2023	WS1	0.60	3.50
	WS3	0.50	4.40
	WS5	0.30	4.60
08/06/2023	WS1	0.70	3.40
	WS3	0.90	4.40
	WS5	0.40	4.60

4.4. Obstructions

No artificial or natural sub-surface obstructions were noted during construction of the trial holes.

5. IN-SITU AND LABORATORY TESTING

5.1. In-situ Strength Testing

Standard Penetration Tests (SPTs) were undertaken as part of the site investigation. The results of the SPT's have not been amended to consider hammer efficiency, rod lengths and overburden pressure in accordance with Eurocode 7. The test results are presented on the borehole logs within Appendix D. An interpretation of the in-situ geotechnical testing results is given in the table below.

Interpretation of In-situ Geotechnical Testing Results					
Strata	SPT "N" Blow Counts and Equivalent SPT "N" Value from DP	Equivalent Undrained Shear Strength (Cu) (kPa) (Stroud (1974))	Soil Type		Trial Hole/s
			Granular (Density)	Cohesive (Cu)	
Head Deposits (Soft Spots)	4-6	20-	-	Low Cu	WS4/1.00-1.45 WS5/1.00-1.45
River Terrace Deposits (Cohesive)	19-29	95-145	-	High Cu	WS3/1.00 – 2.45
Head Deposits (Cohesive)	10	50		Medium Cu	WS5/2.00 – 2.45
	8-15	40-75	-	Medium Cu	WS2/1.00 – 5.45
	10	50	-	Medium Cu	WS5/2.00 – 2.45
London Clay Formation (Cohesive) (Soft Spots)	7	35	-	Low Cu	WS5/4.00-4.45
London Clay Formation (Cohesive)	11-12	55-60		Medium Cu	WS1/4.00 – 5.45
	11-18	55-90	-	Medium to High Cu	WS3/3.00 – 5.45
	10-11	50-55	-	Medium Cu	WS4/2.00-5.45
	9	45	-	Medium Cu	WS5/3.00-3.45 WS5/5.00-5.45

It must be noted that field measurements of undrained shear strength (Cu) are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone.

5.2. Geotechnical Laboratory Testing

A programme of geotechnical laboratory testing, scheduled by Ground and Water Limited and carried out by an accredited geotechnical testing laboratory was undertaken on samples recovered. Details of the specific tests used in each case are given below.

Standard Methodology for Laboratory Geotechnical Testing		
Test	Standard	Number of Tests
Atterberg Limit Tests	BS1377:2016:Part 2:Clauses 3.2, 4.3 & 5	7
Particle Size Distribution Tests	BS1377:2016:Part 2:Clause 9	1
Water Soluble Sulphate and pH Test	BS1377:2018:Part 3:Clause 5	1
BRE Special Digest 1 Tests	BRE Special Digest 1 "Concrete in Aggressive Ground (BRE, 2005).	2

5.2.1. Atterberg Limit Testing

A précis of Atterberg limit testing undertaken can be seen tabulated below. The test results are presented within Appendix E.

Atterberg Limit Tests Results Summary							
Stratum	Moisture Content (%)	Passing 425 µm sieve (%)	Modified PI (%)	Soil Class	Consistency Index (Ic)	Volume Change Potential	
						BRE	NHBC
Head Deposits	14-31	56-100	16.24-44.00	CI-CH and MI	Firm to Very Stiff	Low to High	Low to High
River Terrace Deposits	20	100	28.00	CI	Stiff	Medium	Medium
London Clay Formation	29-31	100	33.00-44.00	CI-CH	Firm to Stiff	Medium to High	Medium to High
- NP – Non-plastic - BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results) - Soil Classification based on British Soil Classification System. - Consistency Index (Ic) based on BS EN ISO 14688-2:2018.							

5.2.2. Moisture Deficit Assessment

The results of the Atterberg Limit tests were analysed to determine the Liquidity Index of the samples, to give an indication as to whether the samples recovered showed a moisture deficit as well assessing their degree of consolidation. Liquid Limit analyses was undertaken to assess whether there were any potentially significant moisture deficits within the samples tested.

A potential moisture deficit, caused by lithology, was noted within WS2 at 1.50m bgl and WS4/1.50m bgl.

5.2.3. Particle Size Distribution Testing

The results of particle size distribution (PSD) testing undertaken show that the sample at 2.00m within WS1 has volume change potential in accordance with BRE240 but not with NHBC Standards Chapter 4.2. The results of the PSD testing can be viewed within Appendix E, and summarised below.

Particle Size Distribution Results Summary			
Stratum	Range Passing 63µm Sieve (%)	Volume Change Potential	
		BRE	NHBC
Head Deposits (WS1/2.00m)	19	Yes	No
- Volume Change Potential refers to BRE Digest 240 (based on Grading test results). - Shrinkability refers to NHBC Standards Chapter 4.2 (based on Grading test results). - BRE 240 states that a soil has a volume change potential when the clay fraction exceeds 15%. Only the silt and clay combined fraction are determined by sieving therefore the volume change potential is estimated from the percentage passing the 63µm sieve. - NHBC Standards Chapter 4.2 states that a soil is shrinkable if the percentage of silt and clay passing the 63µm sieve is greater than 35% and the Plasticity Index is greater than 10%.			

6. ENGINEERING CONSIDERATIONS

6.1. Soil Characteristics and Foundation Considerations

A summary of the soil characteristics following the intrusive site investigation and laboratory testing and the relevant foundation considerations has been provided below. The following information from the ground investigation was considered pertinent to the design of foundations.

- Foundations should be taken through any Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.
- Foundations should be designed in accordance with soils of high-volume change potential. A single design VCP is proposed.
- Given the presence of cohesive soils at shallow depth, special foundation precautions may be required to prevent possible future shrinkage/swelling of the soils affecting the integrity of the faces of foundations (underfloor void diameter/compressible material/void formers etc.). A compressible layer must be provided to accommodate potential seasonal movement.
- The loads of proposed foundations should not exceed the allowable bearing capacity of the soils they are founding upon.
- If soft spots are encountered, they should be bypassed.
- Care should be taken not to overdig foundations as this may stress underlying soft spots, should they be present.
- Foundations must not be placed within fresh root penetrated and/or desiccated soils with volume change potential. It is recommended that foundations are taken at least 300mm into non-fresh root penetrated strata if the soils have volume change potential, or into soils of no volume change potential.
- The influence of trees on or surrounding the site will need to be taken into account in final design.
- Any water ingress must be prevented from entering foundation trenches and excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate within the excavation for even a short period of time, an increase in heave occur. The shear strength will also be reduced, resulting in lower bearing capacities, resulting in increased settlements. Instability issues may arise within the foundation trenches, in case of perched water being present.

6.2. Shallow Foundations

Based on the previous section, foundations should bypass any Made Ground/Topsoil and soft spots/loose granular soils, before extending 300mm below the proved depth of root penetration. Foundations would therefore be constructed on competent, moisture stable soils of the Head Deposits/River Terrace Deposits/London Clay Formation. A tabulated summary showing the minimum foundation depth based on each trial hole can be viewed below.

Summary of Minimum Foundation Depths			
Trial Hole	Minimum Foundation Depth (m bgl)	Founding Geological Formation	Reason
WS1	1.60	Cohesive Head Deposits	Foundations should bypass Made Ground/Topsoil before founding on competent soils at a moisture stable depth.
WS2	1.10	Cohesive Head Deposits	Foundations should bypass Made Ground/Topsoil before founding on competent soils at a moisture stable depth, also taking into consideration the volume change of the soils.
WS3	1.10	Cohesive River Terrace Deposits	Foundations should bypass Made Ground/Topsoil before founding on competent soils at a moisture stable depth, also taking into consideration the volume change of the soils. Decayed roots were noted at 3.00m bgl but no significant trees were noted on this part of the site and the risk of shrinking and swelling within the soils is considered to be low.
WS4	2.00	Cohesive Head Deposits/London Clay Formation	Foundations should bypass Made Ground/Topsoil and the soft spot at 1.00m bgl, before founding on competent soils at a moisture stable depth. Decayed roots were noted at 3.00m bgl but no significant trees were noted on this part of the site and the risk of shrinking and swelling within the soils is considered to be low.
WS5	2.00	Cohesive Head Deposits	Foundations should bypass Made Ground/Topsoil and the soft spot at 1.00m bgl, before founding on competent soils at a moisture stable depth.

The following allowable bearing capacities and load induced settlements were anticipated for foundations at varying depths across the site, based on the soil profiles within WS1, WS2 and WS4.

Allowable Bearing Capacities Calculated				
Foundation Depth (m bgl)	Foundation Type	Limit State	Serviceability State	
		Allowable Bearing Capacity (kN/m ²)	Load (kN/m ²)	Settlement (mm)
1.60 (WS1)	5.00m long by 0.75m wide strip foundation	105.59	100	13.3
	5.00m long by 1.00m wide strip foundation	107.56	100	16.45
	1.50m square pad foundation	122.35	115	17.29
1.10 (WS2)	5.00m long by 0.75m wide strip foundation	137.1	130	19.49
	5.00m long by 1.00m wide strip foundation	134.86	130	23.23
	1.50m square pad foundation	149.11	145	23.13
2.00 (WS4)	5.00m long by 0.75m wide strip foundation	107.39	100	12.44
	5.00m long by 1.00m wide strip foundation	108.32	100	14.97
	1.50m square pad foundation	121.76	115	13.62

Shallow Foundations across the rest of the site should be taken through any Made Ground and extend 300mm below root penetrated soils, before founding onto competent, moisture stable soils of the Head Deposits/River Terrace Deposits at depths of at least 1.00m bgl, subject to deepening based on trees or other factors, like soft zones.

Foundations constructed at 1.00m bgl can be designed based on an allowable bearing capacity of 100 - 125kN/m². This is based on trial hole records, the results of in-situ testing, inspection of samples

recovered, and referral to BS 8004:2015, Code of Practice for Foundations, and based on a 5m long by 1m wide foundation and a maximum settlement of 25mm. Settlements on loading are likely to be moderate.

Additional Comments

A number of comments and recommendations has been provided below.

- It is prudent to avoid having a foundation spanning across materials of different consistency, like clay and gravel, in order to avoid potential differential settlements. If unavoidable, foundations must be reinforced to allow for such potential differential movement. It should be noted that differential settlement may also occur between strip and isolated pad foundations.
- Foundation excavations must be carefully bottomed out and any loose soil or soft spots removed prior to the foundation concrete or blinding being placed. Failure to ensure that foundation excavations are suitably bottomed out could result in additional settlements.
- Inspection of foundation excavations, prior to concreting, must be made by a competent and suitably qualified person to check for soft spots and to check for the presence of roots.
- Foundations must not be cast over foundations of former structures and/or other hard spots.
- Given soils of volume change potential were encountered and Made Ground was noted to be deeper than 0.60m bgl, a suspended slab is recommended.
- Isolated Pad Foundations must be at least 1.5 times the width of the widest pad apart to keep to the anticipated settlements.
- Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the structure and the developments proximity to former, present, and proposed trees. 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.

6.3. Piled Foundation

Based on the results of the intrusive investigation, a piled foundation scheme was unlikely to be required.

6.4. Excavations and Stability

Shallow excavations in the Made Ground and Head Deposits/River Terrace Deposits are likely to be marginally stable at best. Long, deep excavations, through these strata and into the underlying London Clay Formation are likely to become unstable.

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

6.5. 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 “brownfield” case was adopted given the geology encountered and the existing use of the site. This assessment was based on the results of laboratory testing summarised within Section 5, specifically relating to sulphates, pH and other water soluble chemicals.

Made Ground

The water-soluble sulphates in the Made Ground were noted to be 19.1 – 535mg/l, with a pH of 8.32-11.1, from chemical and geotechnical laboratory testing. The total potential sulphate (3x total sulphur) was 0.1317%, from chemical laboratory testing.

According to BRE Special Digest 1, 2005, ‘Concrete in Aggressive Ground’ a Sulphate Design Class of DS-2 could be used for sub-surface concrete in contact with the Made Ground. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-2.

Head Deposits

The water-soluble sulphates in the Head Deposits were noted to be 194mg/l, with a pH of 8.71, from chemical laboratory testing.

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 Head Deposits. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.

London Clay Formation

The water-soluble sulphates in the London Clay Formation were noted to be 88.9mg/l, with a pH of 9, from chemical laboratory testing. The total potential sulphate (3x total sulphur) was <0.06%, from chemical laboratory testing.

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 London Clay Formation. Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-1.

It is prudent to note that pyrite nodules may be present within the London Clay Formation. Pyrite can oxidise to gypsum and this normally only occurs in the upper weathered layer, but excavation allows faster oxidation and water-soluble sulphate values can rapidly increase during construction. Therefore, rising sulphate values should be considered should ferruginous staining/pyrite nodules be encountered within the London Clay Formation.

6.6. Roads and Hardstanding Design

This section provides information relating to the construction of roads and hardstanding, for each strata encountered.

6.6.1. Anticipated CBR Values and Frost Susceptibility

Made Ground

Where roads and hardstanding are to be founded on Made Ground, a CBR value of 1% should be adopted, as a result of the variable nature of Made Ground in terms of consistency, strength and compressibility.

River Terrace Deposits -Cohesive

Roads and hardstanding constructed on the cohesive River Terrace Deposits should be designed based on a CBR value of 4.0%. This is based on reference to Table C1 of TRL1132 and average construction conditions. Based on wet conditions a CBR of 2.5% should be adopted, with dry conditions a CBR of 4.5% being applicable. These clay-based soils (poorly drained) with plasticity indexes generally greater 20% are likely to be non-frost susceptible. Due to their granular content however, they should be treated as frost susceptible in design.

Head Deposits -Cohesive

Roads and hardstanding constructed on the cohesive Head Deposits should be designed based on a CBR value of 4.0%. This is based on reference to Table C1 of TRL1132 and average construction conditions. Based on wet conditions a CBR of 2.5% should be adopted, with dry conditions a CBR of 4.5% being applicable. The Head Deposits samples that were tested had very low plasticity index values and were a mixture of granular/cohesive bands and therefore should be treated as frost susceptible.

6.7. Surface Water Disposal

Soakaway testing in accordance with BRE365 was beyond the scope of this investigation.

It was noted that groundwater levels were high during both the site works and during the groundwater monitoring visits. It is envisaged therefore that soakaways on site are unlikely to work due to the high groundwater levels.

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

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

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.

7. CONTAMINATION RISK ASSESSMENT

7.1. Results of the Preliminary Risk Assessment

The tabulated Conceptual Site Model (CSM) developed by the Ground and Water Desk Study (ref. GWPR5385/DS/June 2023) is reproduced in section 2.8. For the complete information please see the Desk Study report.

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.

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.

7.2. 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 9. 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 Figures 4-8.

Trial Hole Location Synopsis		
Trial Hole/Final Depth	Sampling Strategy	Proposed End-Use
WS1/5.00m	Random	Footprint of Proposed Building
WS2/5.00m	Random	Hard Landscaping
WS3/5.00m	Random	Hard Landscaping
WS4/5.00m	Random	Hard Landscaping
WS5/5.00m	Random	Hard Landscaping

The investigation area totals approximately 2,800m² and with five sampling locations, given an unknown hotspot shape, the sampling density means that a hotspot with an area of approximately 840m² and a radius of approximately 16.3m would be encountered (CLR 4).

7.3. Soil Risk Assessment

Sampling depths were chosen to reflect the receptor of concern (e.g. human health, controlled waters and vegetation). Samples where olfactory or visual evidence of contamination was present underwent targeted scheduling. The remaining samples were scheduled under a random strategy. 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 (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 (Head Deposits and River Terrace Deposits) - Buried Concrete

	• Receiving landfill
Moderate Samples (0.75 – 1.50m bgl)	• Construction workers during development • Site operatives during maintenance works • Vegetation within soft landscaped areas (deep rooted) • Secondary A Aquifer (Head Deposits and River Terrace Deposits) • Buried Concrete • Receiving landfill • Underground services (water pipes)
Deep Samples (> 1.50m bgl)	• Construction workers during development • Secondary A Aquifer (Head Deposits and River Terrace Deposits) • Buried Concrete • Receiving landfill

Chemical laboratory testing, scheduled by Ground and Water Limited, and carried out by ALS Laboratories UK Limited, was undertaken on five samples of the Made Ground. 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;
- BTEX compounds (Benzene, Toluene, Ethylbenzene, Xylene) and MTBE – used as marker compounds for Volatile Organic Compounds (VOCs);
- 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 F.

7.3.1. Soil Assessment Criteria and Results

At the time of reporting, June 2023, the proposed development was understood to comprise the demolition of the majority of the existing buildings on-site and the construction of eight new commercial units varying in size from 100-120m² with new access roads onto the site as well as new car parking spaces. A bin store was noted on the northern portion of the site near the proposed site entranceway. The existing office building located on the centre of the site is to remain.

Proposed site plans are provided as Figures 4-8.

Based on the proposed development, the results of the chemical laboratory testing were compared to the Generic Assessment Criteria (GAC) for a '**Commercial**' land-use scenario, as this was considered the most appropriate land-use scenario.

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	5	ND	ND	ND	No
Cyanide (total)	5	< 1	< 1	24	No
Phenols	5	<0.035	<0.035	760	No
METALS					
Arsenic	5	6.56	14.6	640	No
Boron	5	1.31	6.68	240000	No
Cadmium	5	0.198	0.59	190	No
Chromium (III)	5	16	37	8600	No
Chromium (Hexavalent)	5	<0.6	<0.6	33	No
Copper	5	23.4	41.5	68000	No
Lead	5	29.2	358	2300	No
Mercury	5	<0.1	0.175	58	No
Nickel	5	12.2	40.7	980	No
Selenium	5	<1	<1	12000	No
Vanadium	5	19.4	53.9	9000	No
Zinc	5	93.5	319	730000	No
TOTAL PETROLEUM HYDROCARBONS (TPHs)					
Aliphatic >C5 - C6	2	0.01	0.0175	3200	No
Aliphatic >C6 - C8	2	0.124	0.214	7800	No
Aliphatic >C8 - C10	2	0.574	1.72	2000	No
Aliphatic >C10 - C12	2	8.98	10.7	9700	No
Aliphatic >C12 - C16	2	27.6	61.9	59000	No
Aliphatic >C16 - C21	2	17.4	94.8	1600000	No
Aliphatic >C21 - C35	2	6.84	75.2		
Aliphatic >C35 - C44	2	<1	8.83	1600000	No
Aromatic >C5 - C7	2	<0.01	<0.01	56000	No
Aromatic >C7 - C8	2	0.383	1.14	3500	No
Aromatic >C8 - C10	2	<1	4.39	16000	No
Aromatic >C10 - C12	2	12.4	51.2	36000	No
Aromatic >C12 - C16	2	14.4	41.8	28000	No
Aromatic >C16 - C21	2	2.04	70.6	28000	No
Aromatic >C21 - C35	2	<0.01	<0.01	56000	No
Benzene	2	<0.009	<0.009	27	No
Toluene	2	<0.007	<0.007	56000	No
Ethylbenzene	2	<0.004	<0.004	5700	No
m,p-Xylene	2	<0.01	<0.01	5900	No

o-Xylene	2	<0.01	<0.01	6600	No
POLYCYCLIC-AROMATIC HYDROCARBONS					
Acenaphthene	5	<0.008	0.102	84000	No
Acenaphthylene	5	<0.012	0.151	83000	No
Anthracene	5	<0.016	0.41	520000	No
Benzo(a)anthracene	5	<0.014	1.3	170	No
Benzo(a)pyrene	5	<0.015	1.25	35	No
Benzo(b)fluoranthene	5	<0.015	1.67	44	No
Benzo(ghi)perylene	5	<0.024	0.752	3900	No
Benzo(k)fluoranthene	5	<0.014	0.694	1200	No
Chrysene	5	<0.01	1.48	350	No
Dibenzo(a,h)anthracene	5	<0.023	0.155	3.5	No
Fluoranthene	5	<0.017	2.59	23000	No
Fluorene	5	<0.01	0.308	63000	No
Indeno(1,2,3-cd)pyrene	5	<0.018	0.753	500	No
Naphthalene	5	<0.009	0.112	190	No
Phenanthrene	5	<0.015	1.55	22000	No
Pyrene	5	<0.015	2.18	54000	No
MARKER FOR VOLATILE ORGANIC COMPOUND					
Methyl tert-butyl ether (MTBE)	2	< 0.01	< 0.01	7900	No
The derivation of the Soil Assessment Criteria used within this report can be seen within Appendix G. 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 VOC, and SVOC results will be discussed later in the report, in the vapour section.

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.

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	5	23.4	41.5	100	No
Nickel	5	12.2	40.7	60	No
Zinc	5	93.5	319	200	Yes
The derivation of the Soil Assessment Criteria used within this report can be seen within Appendix G. The soil concentrations were compared to BS3882:2015 <i>Specification for Topsoil</i> and based on differing pH. For the purpose of conservatism, the pH of the soils have been assumed to be below 6 within this table. Where exceedances are noted, the trial hole and depth of sample is recorded.					

7.3.2. Soil Assessment

Chemical laboratory testing of the Made Ground did not reveal any elevated levels of determinands above the guideline levels for a 'Commercial' land-use scenario.

The intrusive investigation did reveal two trial holes that had olfactory evidence to suggest potential hydrocarbon-type contamination. The chemical laboratory results have verified that no elevated concentrations of aliphatic/aromatic hydrocarbons (C5-C35) or BTEX compounds are present in the soils underlying the site. The VOC and SVOC results will be discussed later in the report, in the vapour section for the vapour risk assessment.

In areas of soft landscaping where vegetation is to be planted, a 150mm growing medium of clean topsoil is required due to slightly elevated Zinc concentrations within the soils.

Given the low levels of determinands noted during the chemical laboratory testing, it was considered that no remediation was required within the soils for the end users of the site.

Asbestos

No asbestos has been identified during the testing, however, 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.

7.3.3. 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	LOD	No
Total VOCs	0.5	0.00794	No
Total SVOCs	2	0.35	No
Phenols	2	<0.035	No
TPH EC5 – EC10 (aliphatics and aromatics)	2	4.155	Yes
TPH EC10 – EC16 (aliphatics and aromatics)	10	177.17	Yes
TPH EC16 – EC40 (aliphatics and aromatics)	500	343.31	No
Naphthalene	5	0.112	No

The Water Supply pipe risk assessment indicated that the use of PE pipes is inappropriate at the site due to the concentrations of TPH within the soils.

7.4. 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 7.3 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 River Terrace Deposits and Head Deposits, underlain by **Unproductive Strata** comprising bedrock deposits of the London Clay Formation.

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.

The nearest surface water feature was the River Ems located ~50m east of the site and was flowing in a north to south direction. Emsworth harbour was noted 630m south of the site.

From analysis of hydrogeological and topographical maps the actual groundwater table was anticipated to be encountered at shallow to moderate depths within the River Terrace Deposits/Head Deposits. Some amounts of groundwater however may be present at shallower depths within Made ground. It was considered that groundwater was flowing in an easterly direction toward the River Ems in line with local topography.

During the site investigation, Made Ground was encountered to 1.60m bgl, overlying sandy clay and sandy Gravel of the Head Deposits and River Terrace Deposits with the London Clay Formation below to the base of the boreholes (5.00m bgl). A hydrocarbon odour was noted in the Made Ground in WS1 and WS5. Groundwater was recorded at depths of between 0.70-1.23m bgl.

Comparison between the soil laboratory analysis and the derived Level 1 (soils) target concentrations indicate that some determinands have the theoretical 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. Where a determinand is identified at the laboratory limit of detection, no further assessment is considered necessary.

It is considered that the Level 1 risk assessment does not consider dilution, dispersion or attenuation. However, as a result of the industrial history of the site and the immediate surrounding area, the site being on a secondary A aquifer and the nearest surface water receptor being the River Ems, 50m east of the site, there is a potential risk from the site to controlled water receptors. It is recommended that

a level 2 (groundwater) risk assessment has been undertaken on the results from the investigation and has identified numerous exceedances within the groundwater at the site.

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

7.5. Ground Gas Risk Assessment

A review of the Phase I desk study, has identified a source of ground gas on-site or within influencing distance of the site that warrants investigation through ground gas monitoring.

The investigation undertaken to date have identified the main sources of ground gases to be associated with the degradation of putrescible material within deep Made Ground both on-site and off-site, where the off-site sources include the presence of a historical gas works and general industrial use. Ground gases have the potential to migrate vertically through preferential pathways and build up within the proposed development, especially enclosed spaces on the ground floor. Based on the preceding information, ground gas monitoring was undertaken at the site.

7.5.1. Available Data

Soils

An alternative approach to ground gas risk assessment is presented within the CL:AIRE research bulletin RB17 and included within Annex D of BS8485:2015+A1:2019. 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, five samples of the Made Ground were submitted to the laboratory for analysis, which identified TOC to vary between 0.402 and 3.69% in the Made Ground. The trial hole logs identified the gravels within the Made Ground to comprise; flint, glass, bituminous material, ash brick and concrete. Made Ground was identified to a maximum depth between 1.00m and 1.60m bgl.

Gas Monitoring

In order to assess the ground-gas risk, three combined ground-gas/groundwater monitoring standpipes were installed to a maximum depth of 5.00m bgl. The construction of the wells has been tabulated below.

Monitoring Well Construction				
Trial Hole	Piping internal diameter (mm)	Depth of Installation (m bgl)	Response Zone (m bgl)	Response Zone Strata
WS1	50	3.50	1.00 – 3.50	Made Ground, Head Deposits and London Clay Formation
WS3	50	4.50	1.00 – 4.50	Made Ground, River Terrace Deposits and London Clay Formation

WS5	50	5.00	1.00 – 5.00	Made Ground, Head Deposits and London Clay Formation
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Ground-gas monitoring has been undertaken on two occasions by a representative of Ground and Water Limited using a GasData GFM436 landfill gas analyser, where monitoring was undertaken during a combination of atmospheric pressures and pressure trends. During monitoring the borehole flow, as well as concentrations of methane, carbon dioxide, carbon monoxide and hydrogen sulphide were recorded. In addition to the borehole readings, a reading was taken from the ambient air of the site to ensure that the gas analyser was functioning correctly.

The results of the ground-gas monitoring have been tabulated below and the full Ground and Water Limited monitoring results are provided within Appendix J. Where the reliability of the monitoring results will require consideration in line with CIRIA C665 and BS8485:2015+A1:2019, the table has been highlighted orange.

Ground-Gas Monitoring Results							
Trial Hole	Highest CH ₄ (% v/v)	Highest CO ₂ (% v/v)	Lowest O ₂ (% v/v)	Highest H ₂ S (ppm)	Highest CO (ppm)	Highest Flow Rate (l/hr)	Shallowest Groundwater (m BGL)
Ambient Air	0.00	0.10 ¹	20.40 ¹	0	0	n/a	n/a
WS1	31.00 ²	3.90 ²	0.10 ²	0	0	0.00	0.60 ¹
WS3	0.00	0.40 ²	19.60 ²	0	0	0.00	0.50 ¹
WS5	0.00	0.70 ^{1,2}	19.80 ¹	0	0	0.00	0.30 ¹
Notes: Number ^{1,2} etc. indicates monitoring round when recorded.							

Methane was only encountered in WS1 at concentrations of 21.20-31.00%v/v. Carbon dioxide was encountered in all boreholes at a maximum concentration of 3.90%v/v. Zero flow was encountered within all three boreholes. **All three wells however were noted to be flooded during both monitoring rounds and that may have created a piston effect.**

7.5.2. 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 Made Ground (>1.00 – 1.60m), overlying both permeable and impermeable strata of the Head Deposits and River Terrace Deposits. Groundwater has been encountered at shallow depth during drilling and during the monitoring.	CIRIA 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 compromise the findings of the risk assessment. No further action required.
Soil Laboratory Analysis	A dataset of soil analysis from 5No. samples have identified a	CL:AIRE RB17 outlines an approach to ground gas risk assessment away from the	The TOC concentrations are below the limit of 6% in order to use the soil derived

Review of Data Quality			
	range of TOC concentrations between 0.402% and 3.69%.	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%.	approach for the risk assessment. No further action required.
Monitoring period	The monitoring has been undertaken on a total of two occasions to date. Monitoring has been undertaken during periods of steady pressure.	CIRIA C665 and BS 8576 recommends monitoring over a range of weather conditions. Concentrations of ground gas are likely to be highest during falling pressures, with sharp falls providing the worst-case results. In line with BS8576 a minimum of 4No. monitoring visits are required.	Monitoring should be undertaken over a 2 month period with between weekly and fortnightly readings. Monitoring has been undertaken during atmospheric pressures of between 1013.3 and 1027.3 mbar Additional 4No. monitoring visits were proposed to be completed however consideration was given to the very shallow groundwater and it was determined that gas cannister samples and Groundwater samples be taken instead of additional ground gas readings.
Gas data sets	Methane was detected at concentrations up to 31%v/v. Carbon dioxide concentrations were recorded up to 3.90%. No hydrogen sulphide or carbon monoxide has been detected during monitoring. Monitoring did not detect any flow.	Borehole flow velocity and borehole gas volume (methane and carbon dioxide) are required for ground gas flux categorisation. Modified Wilson and Card classification, CIRIA C665 (2007), BS8485:2015+A1:2019.	2No. suitable gas datasets are available for the risk assessment, where a minimum of 4No. is deemed necessary. Additional 4No. monitoring visits were proposed to be completed however consideration was given to the very shallow groundwater and it was determined that gas cannister samples and Groundwater samples be taken instead of additional ground gas readings.

7.5.3. Risk Assessment

Soil Derived Method

The intrusive investigation has revealed a maximum thickness of Made Ground of 1.60m overlying Head Deposits and River Terrace Deposits comprising cohesive and granular soils. Site has undergone a previous phase 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.

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 5No. samples with the analytical results ranging between 0.402 and 3.69%.

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.

Based on the soil derived method outlined and the maximum TOC concentration encountered, the soils from site would warrant classification as Characteristic Situation CS3. It should be noted that Made Ground thickness was generally limited, however, therefore gas monitoring or other means may provide a more realistic classification. It should be noted that this only represents the assessment from an on-site source.

Gas Monitoring Data

The ground gas monitoring undertaken to date has been reviewed and following any omissions caused by contradiction of the UK guidance (e.g. flooded wells), is deemed suitable for use in the risk assessment. The monitoring undertaken recorded methane concentrations of up to 31.00%v/v, carbon dioxide concentrations of up to 3.90%v/v and the maximum steady-state flow rate recorded was 0.0l/hr.

Based on the documentation presented in BS 8485:2015+A1:2019 “Code of practice for the characterisation and remediation from ground gas in affected developments”, the *hazardous gas flow rate* (Q_{hg}) should be calculated for each borehole using the equation below.

$$Q_{hg} = (C_{hg}/100) * q$$

Where: Q_{hg} is the measured hazardous gas concentration (in percentage volume-by-volume);
 q is the flow rate (in litres per hour) of combined gases found by direct measurement.

The hazardous gas flow rate has been calculated for each borehole, referred to as the Gas Screening Value (GSV) using the worst-case steady-state concentration and flow, from all monitoring to date. The results are presented within the table below. Following the generation of the GSV, a ground gas

characteristic situation can be assigned to the borehole. This has also been included within the table below.

Hazardous Gas Flow Rate Assessment							
Trial Hole	CH ₄ (%v/v)	CO ₂ (%v/v)	Flow Rate (l/hr)	CH ₄ GSV (l/hr)	Characteristic Situation	CO ₂ GSV (l/hr)	Characteristic Situation
WS1	31.00	3.90	0.0 ³	0.031	CS1	0.0039	CS1
WS3	0.0 ¹	0.40	0.0 ³	0.0002	CS1	0.0004	CS1
WS5	0.0 ¹	0.70	0.0 ³	0.0002	CS1	0.0007	CS1

¹Where a value of 0.0 %v/v is detected the detection error is to be used of 0.2%v/v for methane.

²Where a value of 0.0 %v/v is detected the detection error is to be used of 0.1%v/v for carbon dioxide.

³Where a value of 0.0 l/hr is detected the detection error is to be used of 0.1 l/hr for flow.

⁴CS1 typically when <1% methane and <5% carbon dioxide otherwise *consider* an increase to CS2.

Based upon the available ground gas monitoring to date, the risk from ground gas is considered to be very low (CS1), in accordance with BS8485:2015+A1:2019, based on the flows of zero. Carbon monoxide and hydrogen sulphide was not detected at a concentration to warrant further assessment.

Consideration is required to any GSV that falls into the CS1 category, however the methane concentration is greater than 1% and/or the carbon dioxide concentration is greater than 5%. These locations are typical of sites where the hazardous gas concentration is significant, however marginal flow has been recorded during monitoring. It should be noted that consideration does not indicate that an increase is required.

With regards to the site, high methane was detected. It should be noted however that groundwater was very shallow in both rounds and results should not really be taken directly into consideration. **However, they can be used as a guide to consider other methods like testing for dissolved gasses in groundwater and gas cannisters.**

The site at this stage should be classified as CS2, meaning gas protection measures are required. Please note that these measures should also align with any other protection measures needed for radon.

Boreholes can act as preferential pathways for ground gas and therefore prior to construction, all boreholes should be suitably decommissioned in line with Environment Agency guidance. This usually comprises pumping liquid grout down a tremie pipe to the base of the borehole, raising as the borehole fills.

7.6. Dissolved Ground Gases in Groundwater

7.6.1. Dissolved Gases Results

Groundwater Dissolved Gases Test Results	
Determinand	Concentration (µg/l)
Methane Dissolved	<1-4.50
Ethene Dissolved	<1
Ethane Dissolved	<1
Carbon Dioxide Dissolved	16,700-64,300

Propane Dissolved	<1
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The Ground Gas Information Sheet No 2 Paper 2.0 31/8/2018 written by Sarah Haines and Steve Wilson suggests the following with regards to dissolved gases:

Methane is widely present in groundwater. It is present in non-polluted aquifers at relatively low concentrations (up to 1500µg/l) that are not likely to significantly influence gas monitoring results.

Elevated concentrations of dissolved methane are only likely to pose a risk if the water discharges into a confined space. The presence of high dissolved concentrations in groundwater below a building will not normally pose a risk because there is no significant change in pressure and migration to the surface is driven by diffusion. Unless the groundwater is at the underside of the building it cannot migrate quickly enough to pose a risk. There are no published cases where dissolved methane has partitioned to soil gas and migrated through soil into buildings.

It is not considered the concentration of Methane identified within the groundwater would be cause for concern given it is less than standard background levels. However, given there is no assessment value given for Carbon Dioxide and the concentration of 16,700-64,300µg/l it is considered carbon dioxide may still pose a risk.

7.6.2. Dissolved Gases Risk Assessment

Gas primarily migrates via either pressure driven (advective) flow or diffusive flow. Within Made Ground, the primary mechanism for migration of gases is generally dependent on the gas generation potential and stage of decomposition of the fill.

The direction and speed of travel will depend on the dominant migration mechanism, and the nature and location of preferential pathways. Gas migrating by diffusive flow will diffuse through the soils forming a continuum between the source and ground level, with only minor concentrations of gas reaching ground level, and no perceivable flow.

Given the use of the surrounding land comprising former gas works and the presence of Alluvial deposits to the east of the site, it is considered that the primary source of gas on this site is from dissolved gases in groundwater. The release of these gases is dependent on concentration, pressure and temperature. Once gases are released into the overlying material, it will migrate very slowly by diffusion towards the surface.

The gas monitoring visits recorded methane at concentrations of up to 31.00% and carbon dioxide up to 3.90%v/v. The gas canister test recorded 40.5% methane and carbon dioxide at 3.83%. The groundwater testing results recorded 4.5ug/l dissolved Methane and 16,700-64,300 ug/l dissolved Carbon Dioxide. It is considered likely the disparity in the results is due to the gases being dissolved within the groundwater, as carbon dioxide more readily dissolves within the groundwater than methane.

In the surrounding soil the surface tension provided by capillary water in the soils will limit the free movement of methane and carbon dioxide, and in practice the high concentrations of gas are limited

to a zone just above the groundwater. Biodegradation by methanotrophs and dilution by atmospheric oxygen quickly reduce methane concentrations in the soil above the water.

7.6.3. Borehole Monitoring

Gas cannister samples were taken from all three standpipes on the 3rd July 2023 and water samples were taken from all three boreholes on the 13th July 2023. The results for both the gas cannister and water samples can be viewed in Appendix K.

Gas Cannister Bulk Gas results	
Determinand	Concentration (µg/l)
Methane	<0.05-40.5%
Oxygen	1.41-25.8%
Nitrogen	54.2-93.8%
Carbon Dioxide	<0.05-3.83%

7.6.4. Ground-gas Risk Assessment Summary

Four methods of ground gas risk assessment have been applied to the site following site investigation, comprising a review of organic content of soils, ground gas monitoring, gas cannister sampling and dissolved gases in Groundwater.

A soil derived approach identified soils of the Made Ground was considered to pose an unacceptable ground gas risk at the site and warrant classification of Characteristic Situation CS3.

Based on the results of the dissolved gas testing, as well as the gas cannister results, a **Characteristic Situation CS2** is recommended for the site.

Boreholes can act as preferential pathways for ground gas and therefore prior to construction, all boreholes should be suitably decommissioned in line with Environment Agency guidance. This usually comprises pumping liquid grout down a tremie pipe to the base of the borehole, raising as the borehole fills.

The gas protection methods are outlined in BS8485:2015+A1:2019 and should be installed in line with CIRIA C735. The protection measures required are summarised within Section 8.3.

7.7. Vapour Risk Assessment

The CSM identified a source of contamination that may pose an unacceptable risk to receptors through vapours. Best practice is to assess multiple lines of evidence to identify any vapours that may be present.

7.7.1. Soil Assessment

In order to assess the potential for a vapour risk at the site, soil samples were sent to the laboratory for analysis (Appendix G). The testing suites included contaminants that may be present in the vapour phase (Mercury, Napthalene, TPHs and volatile Organic Compounds (VOCs)) taken within Made Ground samples. No elevated values of Mercury, Naphthalene, TPHs or BTEX were noted within all samples tested.

The samples scheduled for direct volatile testing (2No. of the Made Ground) identified the majority of the VOCs at concentrations lower than the laboratory limit of detection. Some concentrations of SVOC's were recorded in WS1/0.20m bgl, which included 2-Methynaphthalene and VOC concentrations of Isopropylbenzene, 1,2,4,-Trimethylbenzene, and sec-Butylbenzene were recorded in the same sample. The concentrations within WS1/0.20m for VOC's Isopropylbenzene 0.00794mg/kg and 1,2,4,-Trimethylbenzene 0.177mg/kg were both significantly below the commercial threshold limited of 1400mg/kg and 42mg/kg. PAHs were also noted but not elevated.

7.7.2. Borehole Monitoring

During the monitoring of the boreholes installed, an oil-water interface probe and Photoionization Detector (PID) was utilised. The interface probe did identify any dense or light non-aqueous phase liquids (DNAPL / LNAPL) during any of the monitoring visits. The highest PID reading was 412.6ppm.

It should be noted that the PID result will provide an indication on the total VOC concentration and will not speciate the determinands. The phase 2 report issued in June 2023 recommended that a gas canister sample be taken to assist the risk assessment in regards to vapours. At the time of reporting in June 2023 a risk from vapours was considered to be present and vapour protection measures are required based partially on soil samples and mainly due to PID monitoring results so far.

Direct Sampling

During the monitoring regime, VOC sampling through vacuum canisters were undertaken on 1No. occasion from WS1, WS3 and WS5 on the 3rd July 2023. Worst case falling conditions were not captured during the gas canister testing.

Samples were obtained in line with the laboratory sampling guidance and submitted within a coolbox to the laboratory. There are limited assessment criteria available for the direct comparison of volatile organic compounds in the air and ultimately posing a vapour risk. As a result, numerous sources of criteria are considered in order to provide a reflective assessment value that can be used within the vapour risk assessment. In-house assessment criteria have been generated, for various VOCs when directly measured in their vapour phases within the soil gas, from here in referred to as vGAC. This is based upon the framework for assessing the risk posed to a site's receptors outlined within CIRIA C682. The methodology for the derivation of this criteria is presented within Appendix L.

The results of the canister sampling are within Appendix M and tabulated below. Only determinands above the limit of detection and with data to derive a vGAC have been included.

Canister Risk Assessment			
Determinand	Laboratory Analysis Range (mg/m ³)	vGAC (mg/m ³)	Was the vGAC Exceeded?
Benzene	0.00561-<0.118	2.06	No
Toluene	0.00155-0.602	2060	No
Ethyl Benzene	<0.00587-0.412	109	No
m/p Xylene	0.00702-0.374	88.3	No
O-Xylene	0.00617-0.187	88.3	No
Aliphatic (C4-C6)	0.435-28.6	7358	No
Aliphatic (C6-C8)	0.30-33.7	7358	No
Aliphatic (C8-C10)	0.223-77.2	427	No

Canister Risk Assessment			
Determinand	Laboratory Analysis Range (mg/m ³)	vGAC (mg/m ³)	Was the vGAC Exceeded?
Aliphatic (C10-C12)	0.315-34.0	427	No
Aromatic (EC5-EC7)	0.00581-0.118	2215	No
Aromatic (EC7-EC8)	0.00602-0.203	2370	No
Aromatic (EC8-EC10)	0.0435-3.51	88.3	No
Aromatic (EC10-EC12)	0.0707-2.23	88.3	No
Trichloromethane (Chloroform)	0.00659-0.210	58.9	No
Tetrachloroethene	0.00920-0.293	83.9	No
Acetone + Propanol	0.0388-0.205	10.5	No
Carbon disulphide	0.256-1.15	42.1	No
1,2,3-Trimethylbenzene	0.00665-0.212	78.7	No
1,2,4-Trimethylbenzene	0.00665-0.212	3.38	No
1,2-Dichlorobenzene	0.00814-0.259	63.3	No
1,3,5-Trimethylbenzene	0.00665-0.212	78.7	No
1-Propanol	0.00332-0.106	500	No
Butanal	0.00399-0.127	5322	No
Cyclohexane	0.00465-1.31	7867	No
Hexane	0.00498-0.538	918	No
Methylene Chloride	0.00471-0.150	198	No
Naphthalene	0.00709-0.226	1.27	No
Pentane	0.00417-1.090	1311	No
Styrene	0.0157-3.09	353	No
vGAC calculated in line with methodology in Appendix J, using Health Criteria Values outline within UK guidance documents CL:AIRE GAC, CLEA 1.07 and LQM S4UL. Where UK Health Criteria Values are not available for the determinand, US EPA values have been adopted. The values are considered to be the most relevant to the proposed development.			

The results of the canister testing have identified numerous VOCs within the borehole at the site. A comparison of these against a site-specific vapour assessment criteria has indicated that all VOCs are significantly below the adopted screening value. The response zone of WS1 has targeted the Made Ground so shows a reflection of the on site and off site migration of gases affected the site. Both WS3 and WS5's response zones are within the cohesive soils. The results from the testing show that the clay is limiting the migration of gases.

One vapour GAC with a concentration above the laboratory limit of detection could not be generated due to the absence of readily available information pertinent to the Health Criteria Value (HCV), used within the calculation. The determinands (Isobutene) is not featured within the UK or US guidance / research. The HCVs are guidance levels dictated by specialists based on exposure from occupational and epidemiological studies, animal studies as well as modelling from the chemicals. Within this assessment only HCV relevant to the inhalation pathway have been considered. In the absence of HCV for the chemical the following has been identified from an internet search to aid the assessment:

- Isobutene – A hydrocarbon which is present as a colourless flammable gas that is insoluble. It's most common use is as a fuel additive. Known acute health effects include irritation to eyes, nose and throat, headache, dizziness, light-headedness and fatigue. No testing for chronic effects has been undertaken. A laboratory test undertaken on rats identified an acute toxicity effect above a concentration of 550,000 mg/m³ for 4 hours.

Although the value is not directly comparable, given the significant disparity between the measured concentration at the site (0.00324-5.36mg/m³) and the acute toxicity encountered within rats (550,000 mg/m³), the concentrations at the site are considered to have a negligible effect on human health.

7.7.3. Vapour Risk Assessment Summary

Three methods of Vapour risk assessment have been applied to the site following site investigation, comprising a review of PID readings, Soil samples and gas canister sampling.

No elevated values of Mercury, Naphthalene, TPHs or BTEX were noted within all soil samples tested. The samples scheduled for direct volatile testing (2No. of the Made Ground) identified the majority of the VOCs at concentrations lower than the laboratory limit of detection. SVOC concentrations of Isopropylbenzene, 1,2,4,-Trimethylbenzene, and sec-Butylbenzene were all noted but were not significantly elevated. The concentrations within WS1/0.20m for VOC's Isopropylbenzene 0.00794mg/kg and 1,2,4,-Trimethylbenzene 0.177mg/kg were both significantly below the commercial threshold limited of 1400mg/kg and 42mg/kg. PAHs were also noted but not elevated.

During the monitoring of the boreholes installed the interface probe did not identify any dense or light non-aqueous phase liquids (DNAPL / LNAPL) during any of the monitoring visits. The highest PID reading was 412.6ppm.

The results of the canister testing have identified numerous VOCs within the borehole at the site. A comparison of these against a site-specific vapour assessment criteria has indicated that all VOCs are significantly below the adopted screening value. The response zone of WS1 has targeted the Made Ground so shows a reflection of the on site and off site migration of gases affected the site. Both WS3 and WS5's response zones are within the cohesive soils. The results from the testing show that the clay is limiting the migration of gases.

7.8. Updated Conceptual Site Model

Following completion of the Phase 2 Site Investigation, the CSM, inclusive of associated risk, within Section 2.8 of this report was re-evaluated.

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, gas works, unspecified tanks, works, garage site: - 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 (Future site visitors) - Construction workers during development - Site operatives during maintenance works - Neighbours and public	Moderate Groundworkers require protection.
	- Direct uptake of groundwater - Direct uptake of determinands in the soil	Flora and Fauna Vegetation within soft landscaped areas	Moderate Elevated concentrations of Zinc recorded
	- Anthropogenic (man-made) pathways - Vertical and lateral migration in permeable strata - Surface water runoff	Controlled Waters - Secondary A Aquifer (Head Deposits and River Terrace Deposits) - River Ems	Moderate Groundwater monitoring recommended
Electricity Sub-Station PCB oils and other cable/transformer oils	Migration through anthropogenic & natural pathways	Human Health End Users (Residents/Future site visitors)	Low
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 DS-2 AC-2 category required
Ground gases generated by Made Ground, gas works and industrial land: - Methane, - Carbon Dioxide, - Hydrogen Sulphide, and - Carbon Monoxide.	- Migration through anthropogenic & natural pathways - Inhalation of Asphyxiating gases - Explosion (methane only)	Human Health - End Users (Future site visitors) - Construction workers during development (especially in confined spaces) - Site operatives during maintenance works in confined spaces - Neighbours and public	Moderate CS2 Gas protection measures required
	- Migration through anthropogenic & natural pathways - Explosion (methane only)	Building Materials and Services - Buildings - Confined spaces	Moderate CS2 Gas protection measures required

Radon	Inhalation	- Underground services Human Health - End Users (Future site visitors) - Construction workers during development (especially in confined spaces) - Site operatives during maintenance works in confined spaces - Neighbours and public	Moderate Basic protection against radon is required
-------	--	---	--

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(Off-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
Made Ground from nearby works, Gas works: - 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	Moderate
	Direct uptake of groundwater	Flora and Fauna Vegetation within soft landscaped areas	Moderate
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)	Low
Ground gases generated by Made Ground, gas works and other industrial land: - 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	Moderate CS2 Gas protection measures required
	- Migration through anthropogenic & natural pathways - Explosion (methane only)	Building Materials and Services Buildings	Moderate

Tabulated Conceptual Site Model – Pollutant Linkage Summary			(Off-Site Sources)
Potential Sources	Potential Absorption Pathways	Potential Receptors	Risk Classification
		• Confined spaces • Underground services	CS2 Gas protection measures required

8. CONTAMINATION 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:

- Gas protection measures are required in line with the requirements of Characteristic Situation CS2 at this stage.
- It is considered that there is a risk to groundwater from the site. It is recommended that a level 2 (groundwater) risk assessment has been undertaken on the results from the investigation and has identified numerous exceedances within the groundwater at the site.
- Basic radon protective measures are required for the report area. This can be in alignment / covered by gas measures.
- For risk to water supply pipes and concrete please see relevant sections.
- A specific capping system is not required for soft landscaped areas. However, a nominal capping system of 100-150mm of topsoil should be placed in soft landscaped areas as a growing medium.
- Groundworkers during the construction stage will require full personal protective equipment. If any contamination is recorded during the construction phase, works should stop and the source and extent of any contamination be further investigated by a competent and qualified person.

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.

The contamination testing results recorded no exceedances within the soils for the end users of the site. However, groundworkers during the construction stage will require full personal protective equipment and will need to maintain good personal hygiene, e.g. regular hand washing. If any contamination including Asbestos is recorded during the construction phase, works should stop and the source and extent of any contamination be further investigated by a competent and qualified person.

8.1.1. Water Supply Pipes

The Water Supply pipe risk assessment indicated that the use of PE pipes is inappropriate at the site due to the concentrations of TPH within the soils. It is therefore recommended that the use of Metal or Barrier pipes are implemented as part of the design in order to prevent an unacceptable risk to future receptors.

8.2. Groundwater

Comparison between the soil laboratory analysis and the derived Level 1 (soils) target concentrations indicate that some determinands have the theoretical 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. Where a determinand is identified at the laboratory limit of detection, no further assessment is considered necessary.

It is considered that the Level 1 risk assessment does not consider dilution, dispersion or attenuation. However, as a result of the industrial history of the site and the immediate surrounding area, the site

being on a secondary A aquifer and the nearest surface water receptor being the River Ems, 50m east of the site, there is a potential risk from the site to controlled water receptors. It is recommended that a level 2 (groundwater) risk assessment has been undertaken on the results from the investigation and has identified numerous exceedances within the groundwater at the site.

8.3. Radon, Ground Gas and Vapours

Based on risk assessment undertaken, the site warrants classification as **Characteristic Situation CS2**, where precautions to prevent the ingress of ground-gas are necessary. Type C buildings on CS2 classified sites require **2.5 points** worth of protection, in accordance with BS8485:2015+A1:2019. Points must be made up through a structural barrier and a membrane, where at least two methods are incorporated.

8.3.1. Verification

- Following completion of the protection system, verification should be carried out and a report should be submitted to the local authority for approval. This should include as a minimum, verification photographs of the visual checks.

Basic radon protection measures are required, it should be checked that any membrane installed will protect against both ground-gases and radon.

8.4. Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation (e.g. underground storage tanks). Such occurrences may be discovered during the 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 and then the Local Authority will need to be informed.

8.5. Imported Material

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 G of this report.

8.6. Waste Disposal

The excavation of foundations and other 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 either: 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, 5No. samples of the Made Ground 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 H.

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 of the Made Ground were scheduled to undergo Waste Acceptance Criteria (WAC) testing with single batch leachate from samples with a range of depths. The results indicate that WS1/0.20m were classified as non-inert as a result of high concentrations of Total Organic Carbon (TOC), Mineral Oil and Antimony.

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.

8.7. 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.

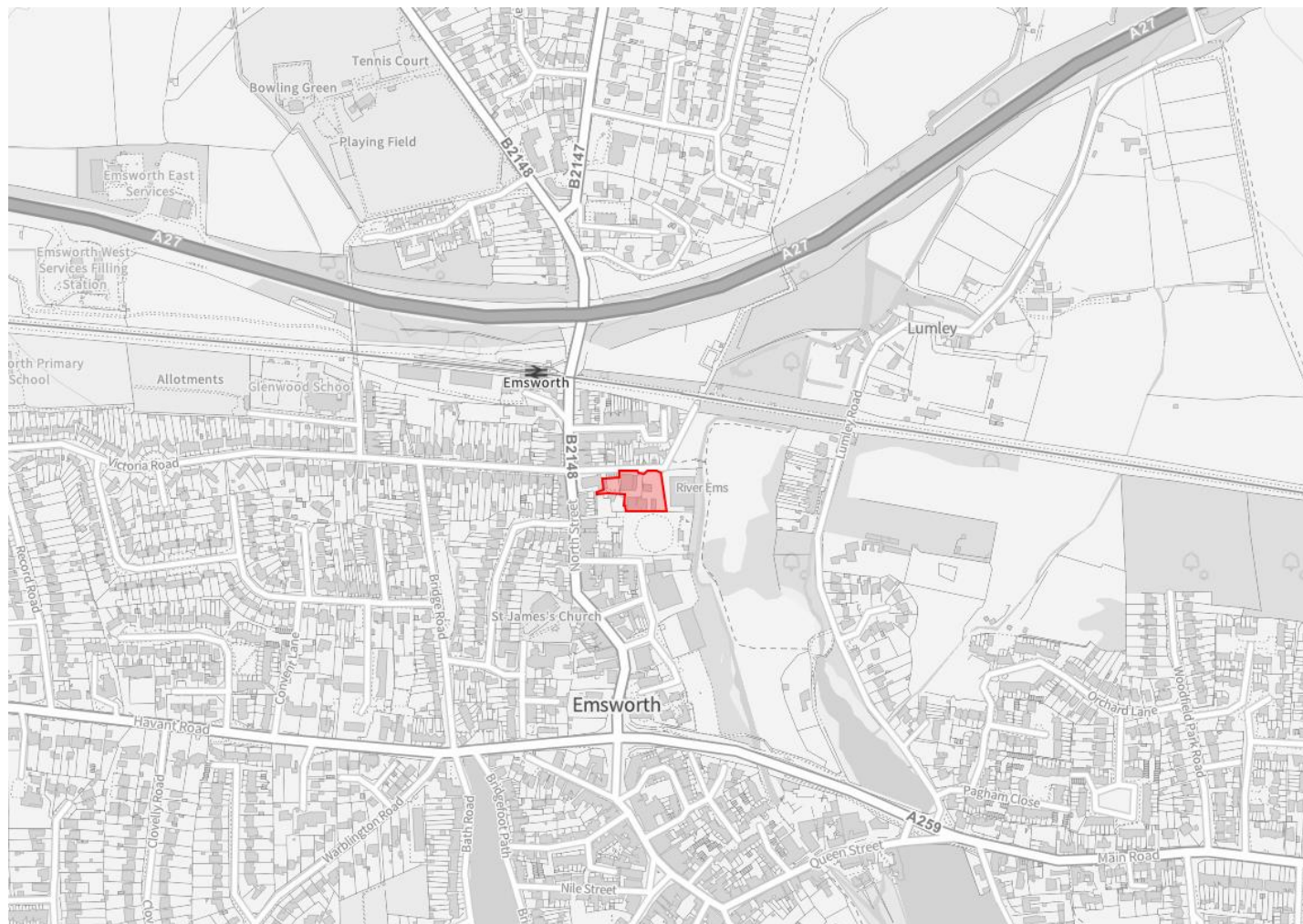
To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust would be generated as a result of construction activities.

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



Site Location



2 - 6 Seagull Lane, Emsworth PO10 7QH

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Figure 1 – Site Location Plan

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Site Boundary

2 - 6 Seagull Lane, Emsworth PO10 7QH

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Figure 2 – Site Development Area

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NTS

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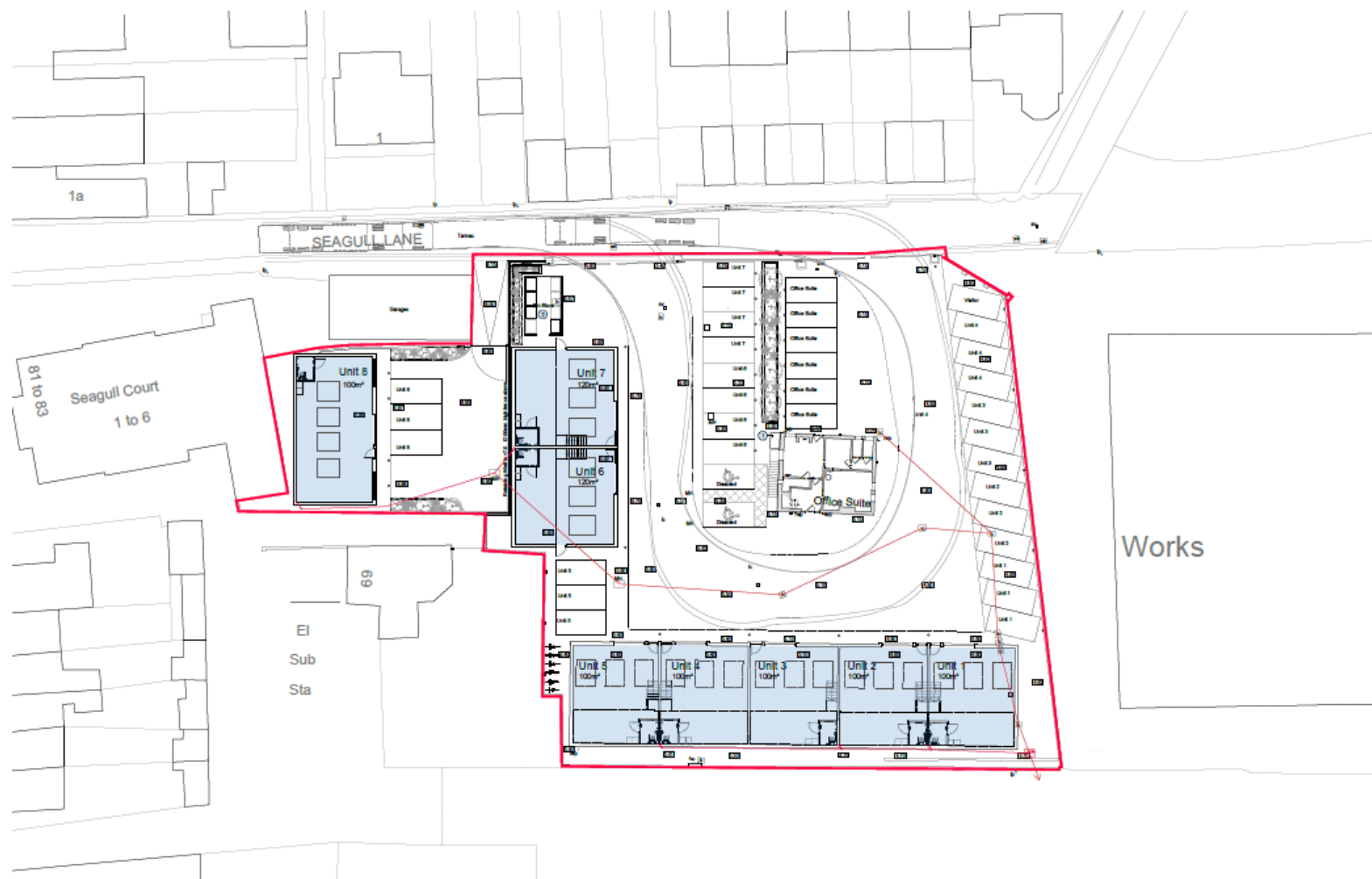
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Figure 3 – Aerial Photograph

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NTS

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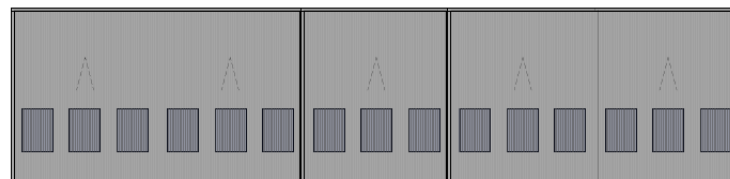
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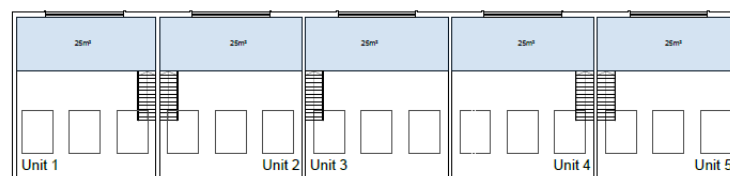
Figure 4 – Proposed site development plan

GWPR5475

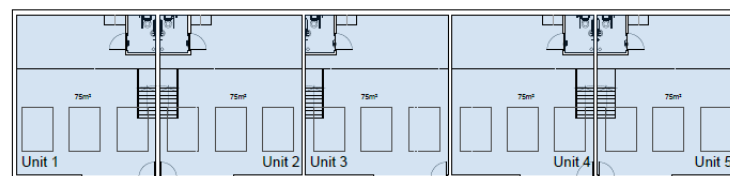




Roof Plan



Mezzanine Level



Ground Floor

NTS

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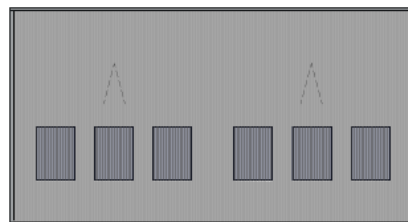
Nyetimber Management Ltd

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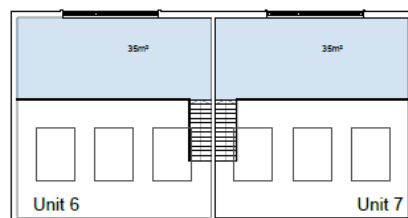
**Figure 5 – Proposed Development Plans Floor plans
Units 1-5**

GWPR5475

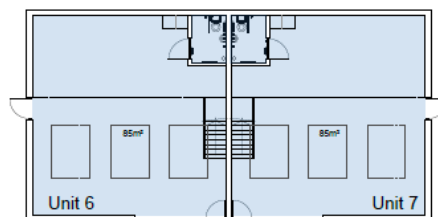




Roof Plan



Mezzanine Level



Ground Floor

NTS

2 - 6 Seagull Lane, Emsworth PO10 7QH

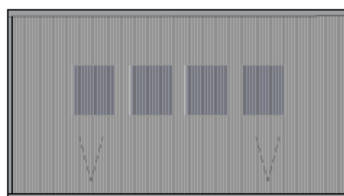
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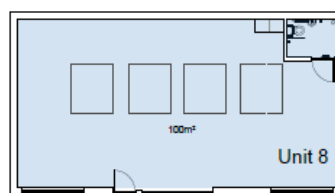
**Figure 6 – Proposed Development Plans Floor plans
Units 6-7**

GWPR5475





Roof Plan



Ground Floor

NTS

2 - 6 Seagull Lane, Emsworth PO10 7QH

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**Figure 7 – Proposed Development Plans Floor plans
Units 8**

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This architectural elevation drawing shows the building's facade. On the left is a side wing with a sloped roof. The central part features a main entrance with a gabled roof and a large window. To the right is a parking area with trees and a fence.

M&M Hall Family Pension Trust
Seagull Lane
Emsworth, Hampshire, PO10 7QH

drinking information Proposed Site
Elevations

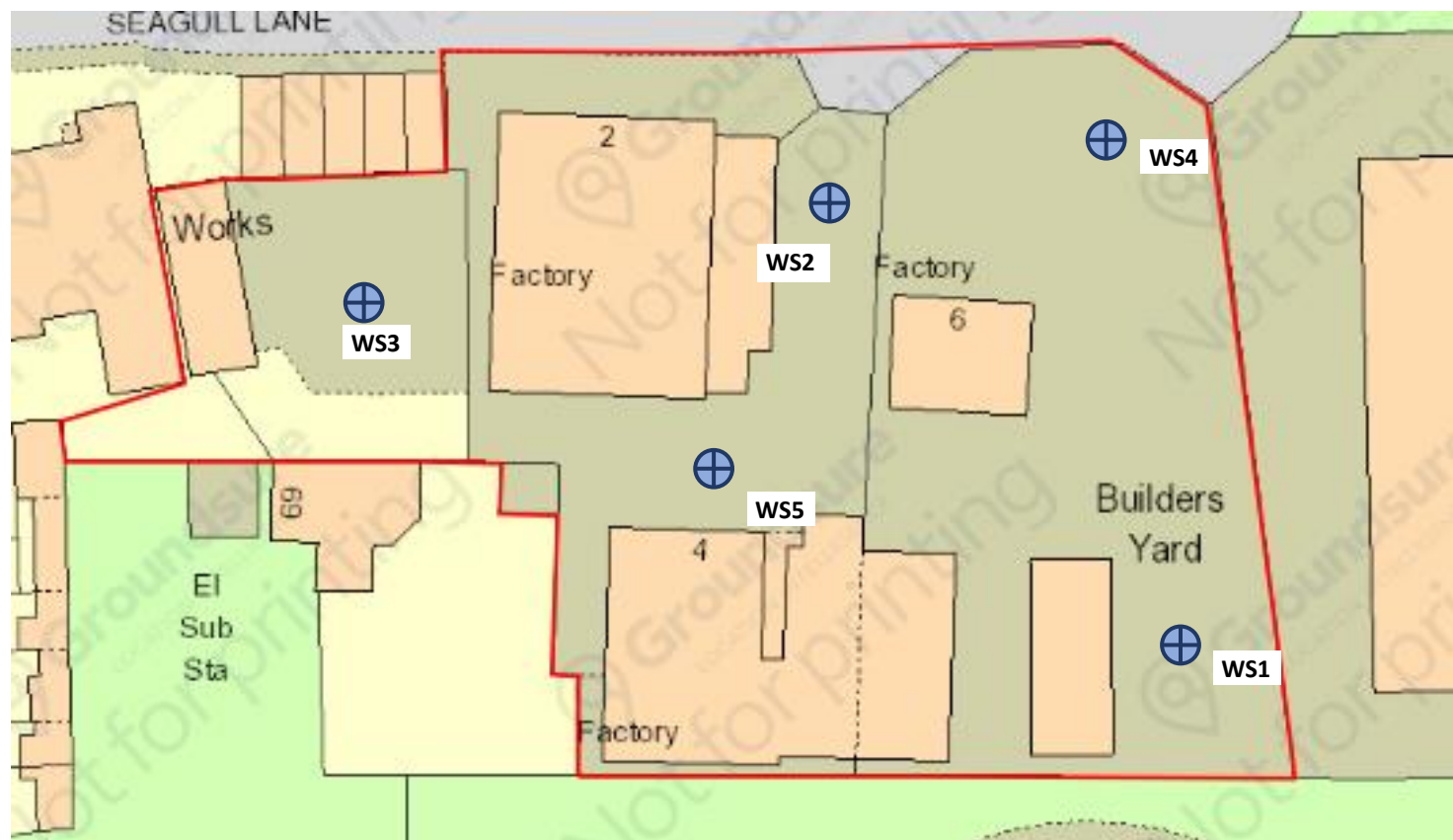
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checked : AT

Ref: 5807 3006 A

The logo for Ground & Water, featuring a stylized green 'g' and blue 'w' followed by the text 'ground&water' in a sans-serif font.



-  Site boundary
-  Windowless Sampler Borehole



2 - 6 Seagull Lane, Emsworth PO10 7QH

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Figure 9 – Trial Hole Location Plan

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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 common chemicals generally expected. Other concentrations of types of chemicals may exist.

The conclusions and recommendations relate to 2 - 6 Seagull Lane, Emsworth PO10 7QH.

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.

APPENDIX B:

Technical Glossary

TECHNICAL GLOSSARY

The list of possible definitions within the report may be seen below. Please note that some definitions may not be relevant to this report.

HYDROGEOLOGY:

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.

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.

Secondary (B) Aquifers consist of deposits with predominantly lower permeability layers with may stoke and yield limited amounts of groundwater due to localised features such as fissures, think permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.

Secondary Aquifers (Undifferentiated) are assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both a minor aquifer and non-aquifer in different locations due to the variable characteristics of the rock type.

Unproductive Strata are rock layers with low permeability that have negligible significance for water supply or river base flow. These were formerly classified as non-aquifers.

FLOOD ZONES:

Environment Agency Flood Zone 2, defined as; land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding.

Environment Agency Flood Zone 3 shows the extent of a river flood with a 1 in 100 (1% or greater chance of occurring in any year or a sea flood with a 1 in 200 (0.5%) or greater chance of occurring in any year.

Environment Agency Flood Zone 3 area that benefits from flood defences, defined as; land and property in this flood zone would have a high probability of flooding without the local flood defences. These protect the area against a river flood with a 1% chance of happening each year, or a flood from the sea with a 0.5% chance of happening each year.

GROUNDWATER SOURCE PROTECTION ZONES (SPZS):

Inner Zone (SPZ1): This zone is 50 day travel time of pollutant to source with a 50 metres default minimum radius.

Outer Zone (SPZ2): This zone is 400 day travel time of pollutant to source. This has a 250 or 500 metres minimum radius around the source depending on the amount of water taken.

Total Catchment (SPZ3): This is the area around a supply source within which all the groundwater ends up at the abstraction point. This is the point from where the water is taken. This could extend some distance from the source point.

Zone of Special Interest (SPZ4): This zone is where local conditions require additional protection.

IN-SITU STRENGTH GEOTECHNICAL TESTING:

Windowless Sample and/or Cable Percussion and/or Rotary Boreholes provide samples of the ground for assessment but they do not give any engineering data. The standard penetration test (SPT) is an in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil. The test uses a thick-walled sample tube, with an outside diameter of 50mm and an inside diameter of 35mm, and a length of around 650mm. This is driven into the ground at the bottom of a borehole by blows from a slide hammer with a weight of 63.5kg falling through a distance of 760mm. The sample tube is driven 150mm into the ground and then the number of blows needed for the tube to penetrate each 75mm up to a depth of 450mm is recorded. The sum of the number of blows is termed the "standard penetration resistance" or the "N-value".

Dynamic Probing involves the driving of a metal cone into the ground via a series of steel rods. These rods are driven from the surface by a hammer system that lifts and drops a 63.5kg (SHDP) hammer onto the top of the rods through a set height, thus ensuring a consistent energy input. The number of hammer blows that are required to drive the cone down by each 100mm increment are recorded. These blow counts then provide a comparative assessment from which correlations have been published, based on dynamic energy, which permits engineering parameters to be generated. (The Dynamic Probe 'Super Heavy' (SHDP) Tests were conducted in accordance with BS 1377; 1990; Part 9, Clause 3.2).

APPENDIX C:

Groundsure

Historical Mapping

Site Details:

2, SEAGULL LANE, EMSWORTH,
PO10 7QH

Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: County Series

Map date: 1869

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1869
Revised 1869
Edition N/A
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Map legend available at:
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Site Details:

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Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
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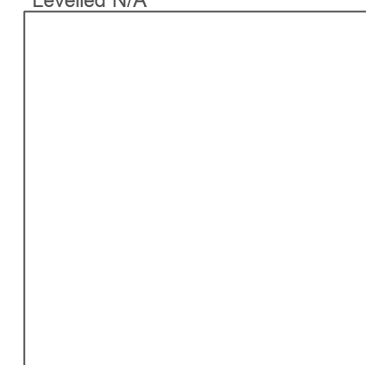
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Revised 1874
Edition N/A
Copyright N/A
Levelled N/A

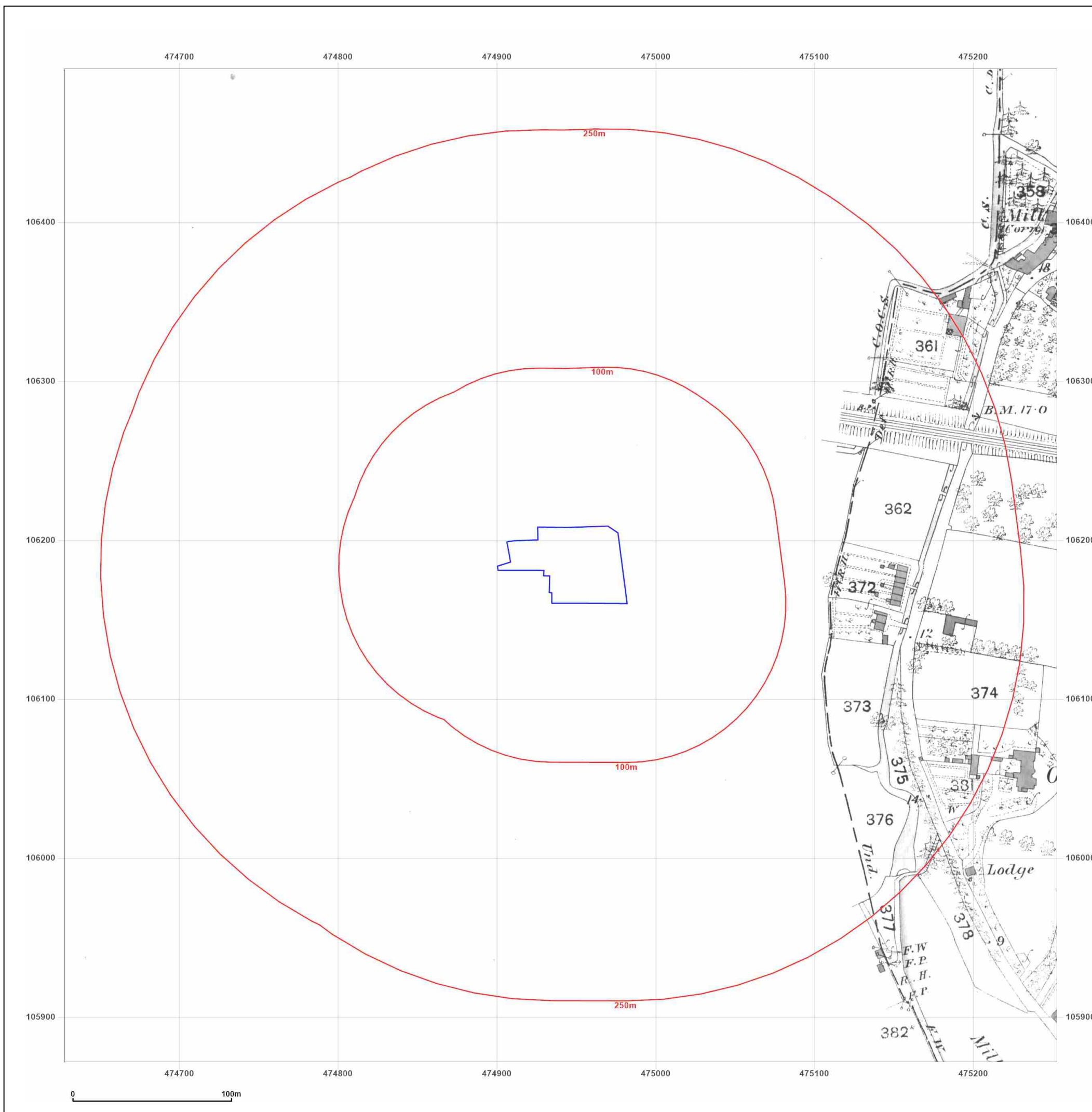


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Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: County Series

Map date: 1897

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Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: County Series

Map date: 1898

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Printed at: 1:2,500



Surveyed 1898
Revised 1898
Edition N/A
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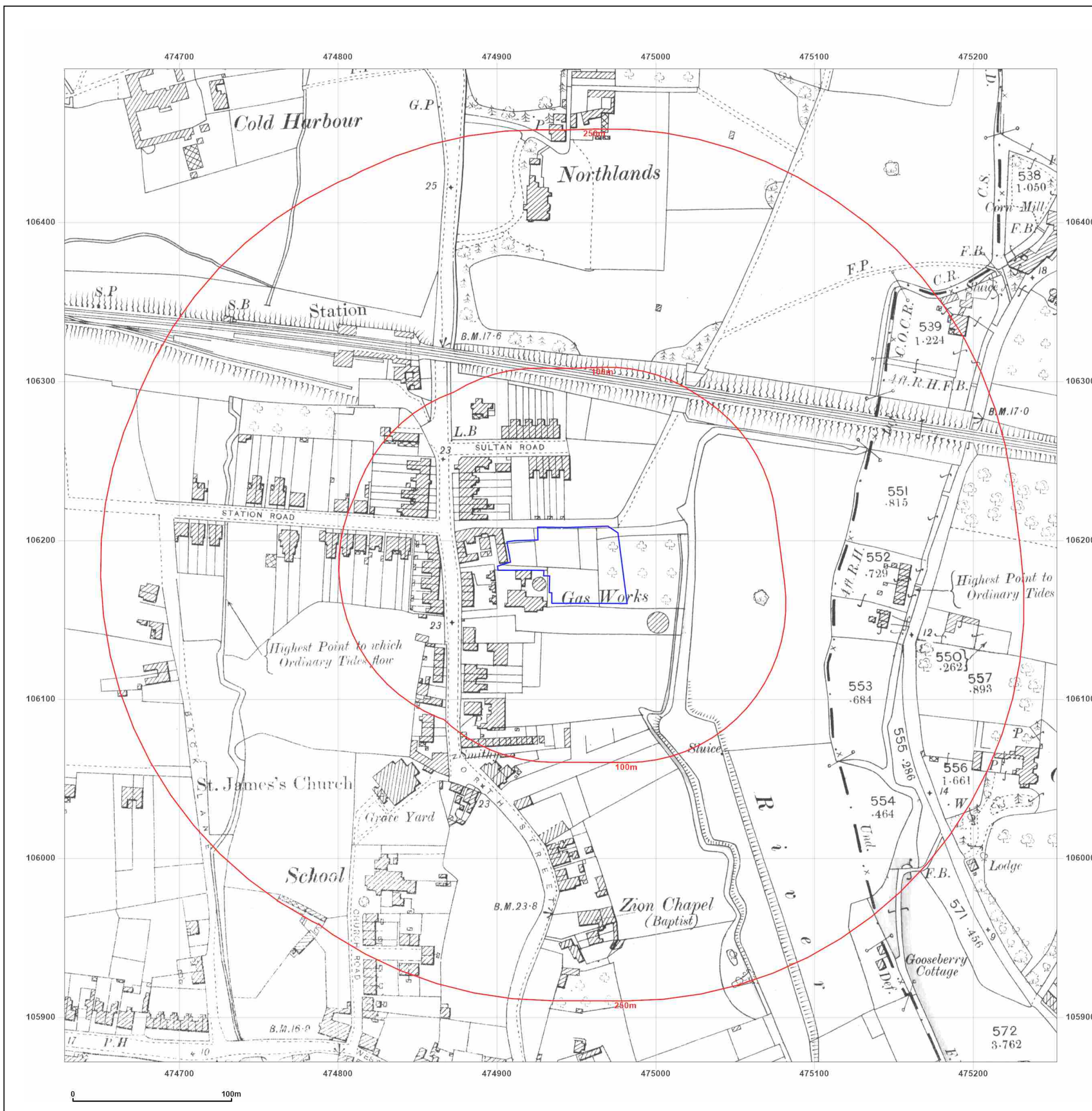


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Site Details:

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PO10 7QH

Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: County Series

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Revised 1908
Edition N/A
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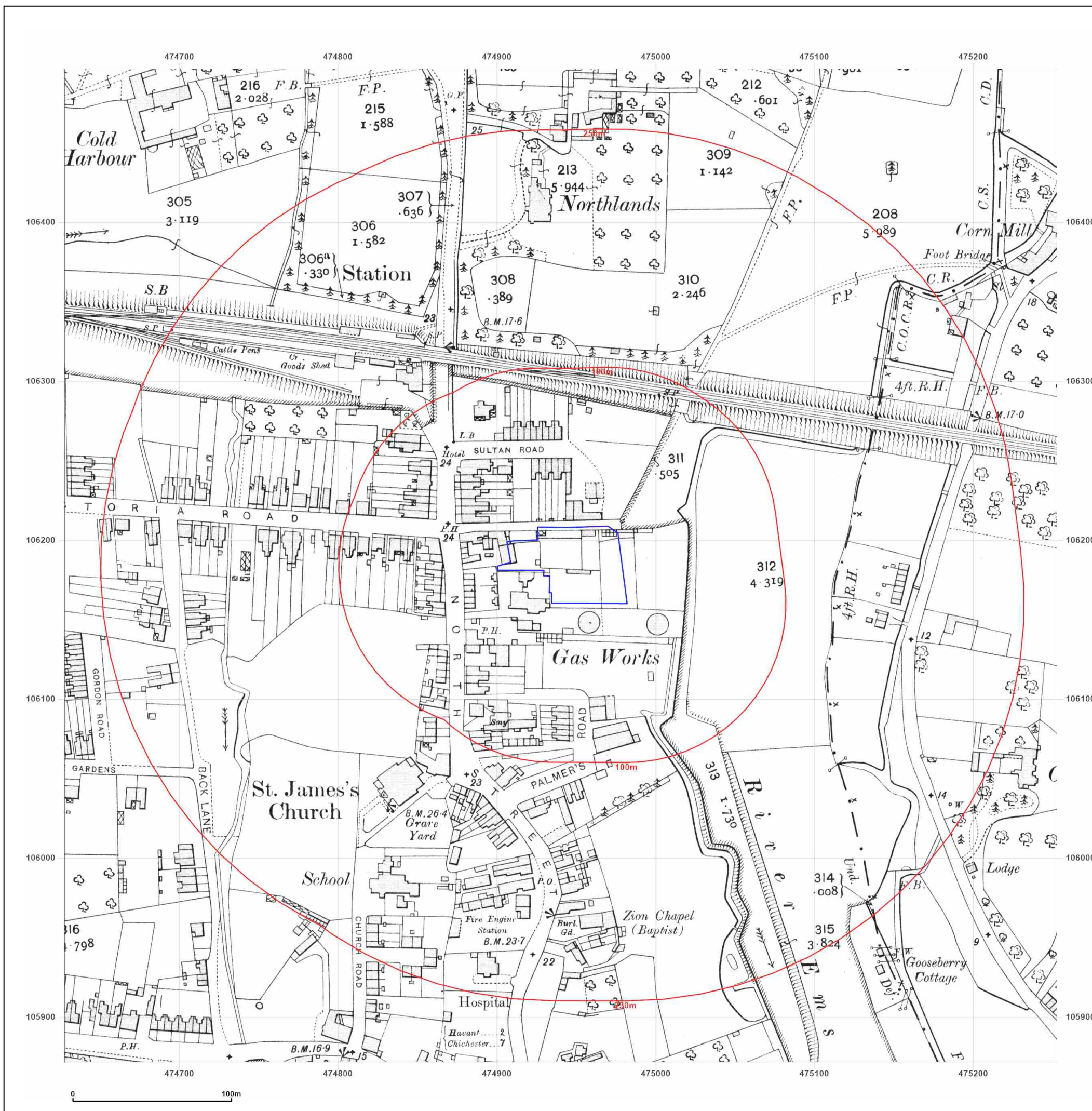


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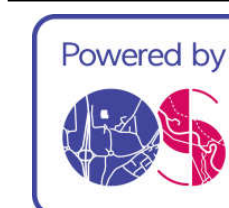
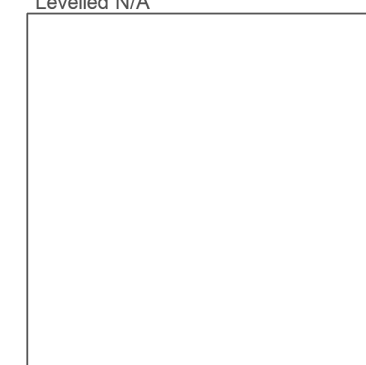
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Printed at: 1:2,500



Surveyed 1912
Revised 1912
Edition N/A
Copyright N/A
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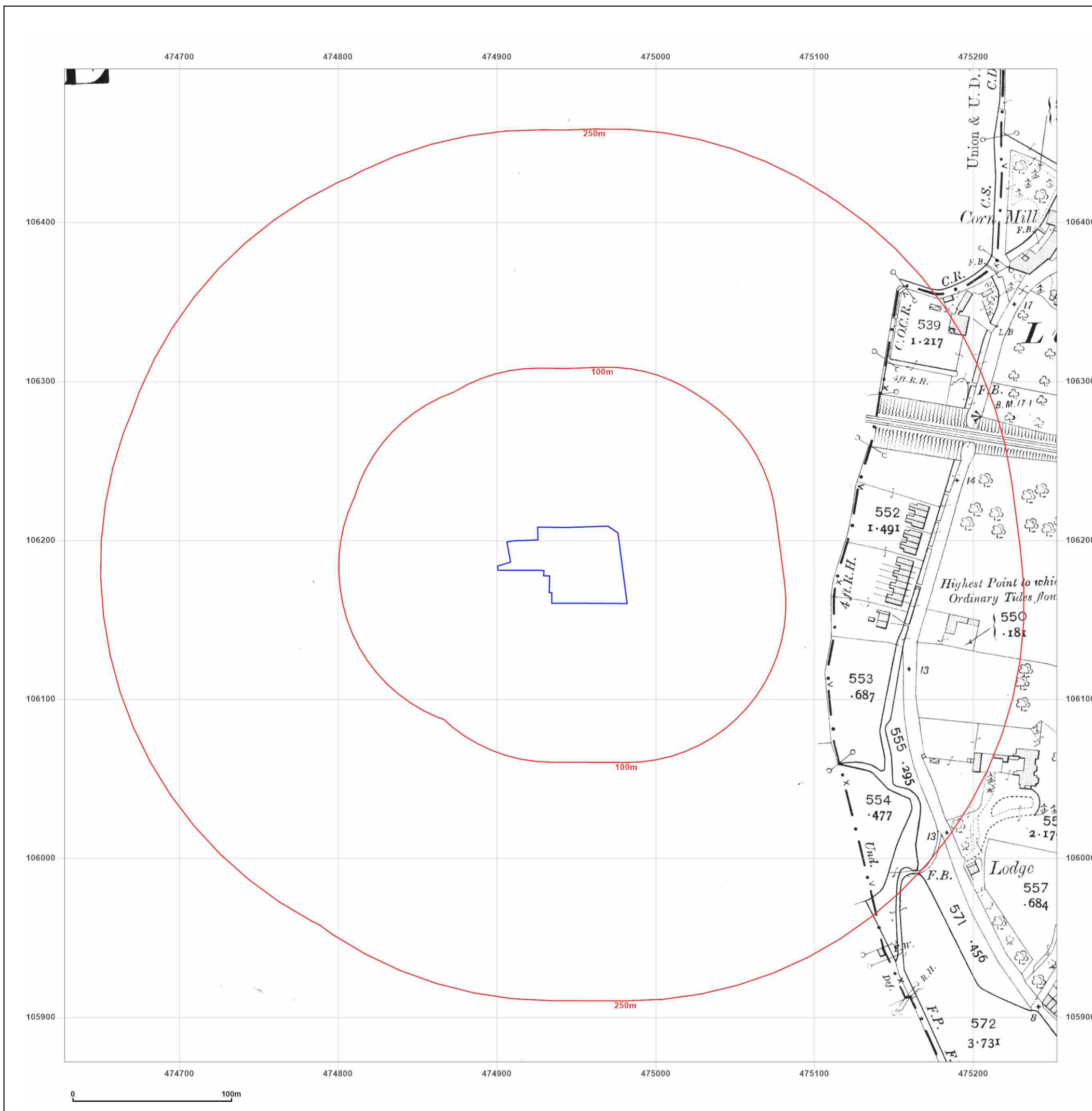


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Site Details:

2, SEAGULL LANE, EMSWORTH,
PO10 7QH

Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: County Series

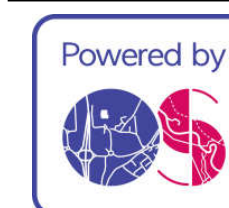
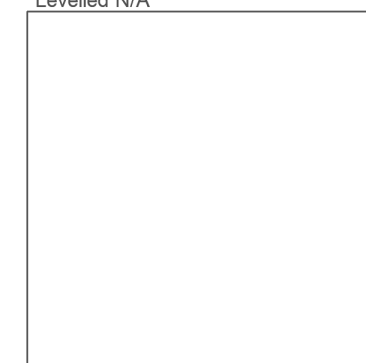
Map date: 1932

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1932
Revised 1932
Edition N/A
Copyright N/A
Levelled N/A

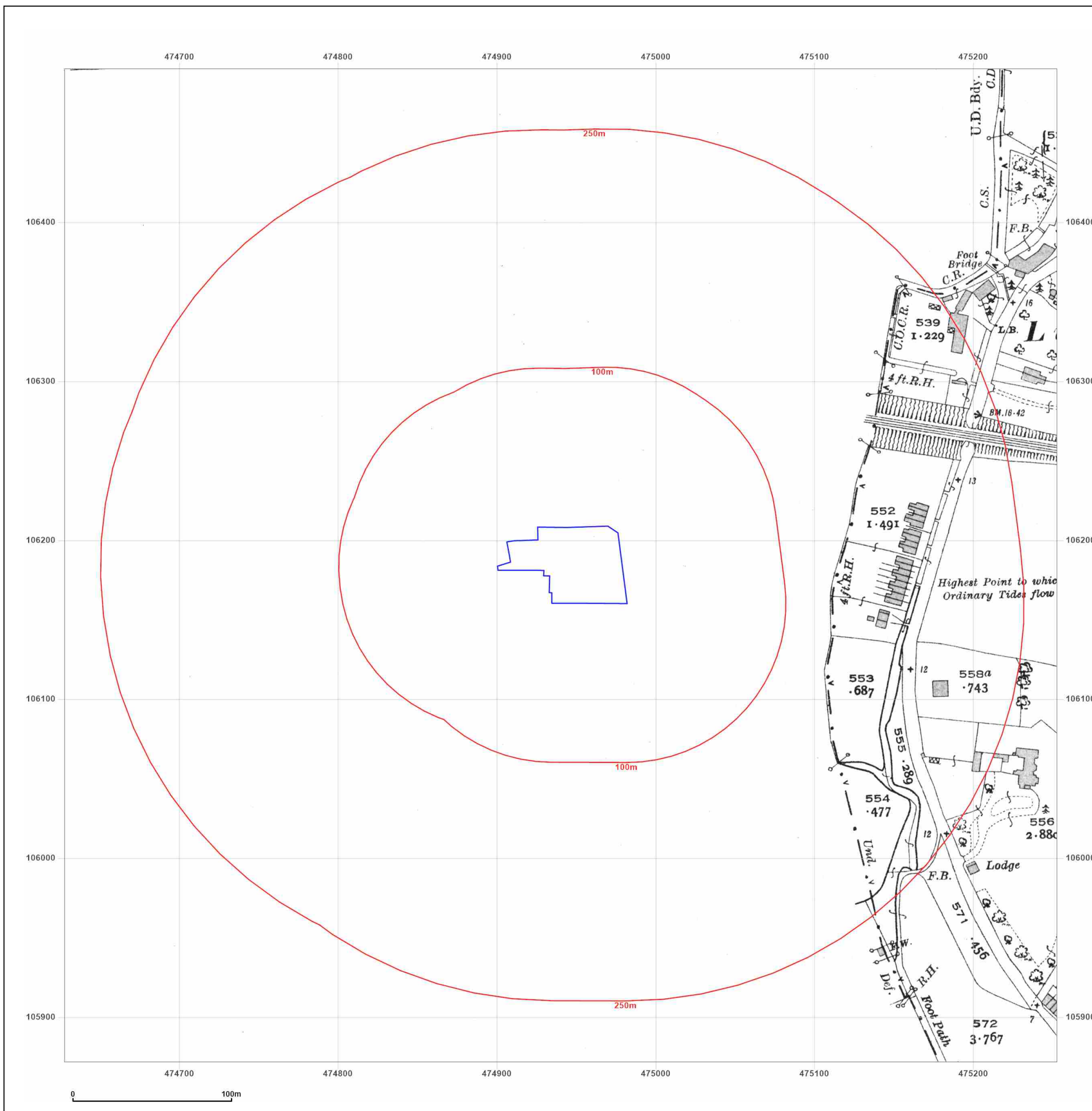


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Site Details:

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PO10 7QH

Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: County Series

Map date: 1932

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1865
Revised 1931
Edition 1932
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Site Details:

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PO10 7QH

Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: National Grid

Map date: 1952

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1952
Revised 1952
Edition N/A
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Levelled N/A

Surveyed 1952
Revised 1952
Edition N/A
Copyright N/A
Levelled 1941

Surveyed 1952
Revised 1952
Edition N/A
Copyright N/A
Levelled 1941

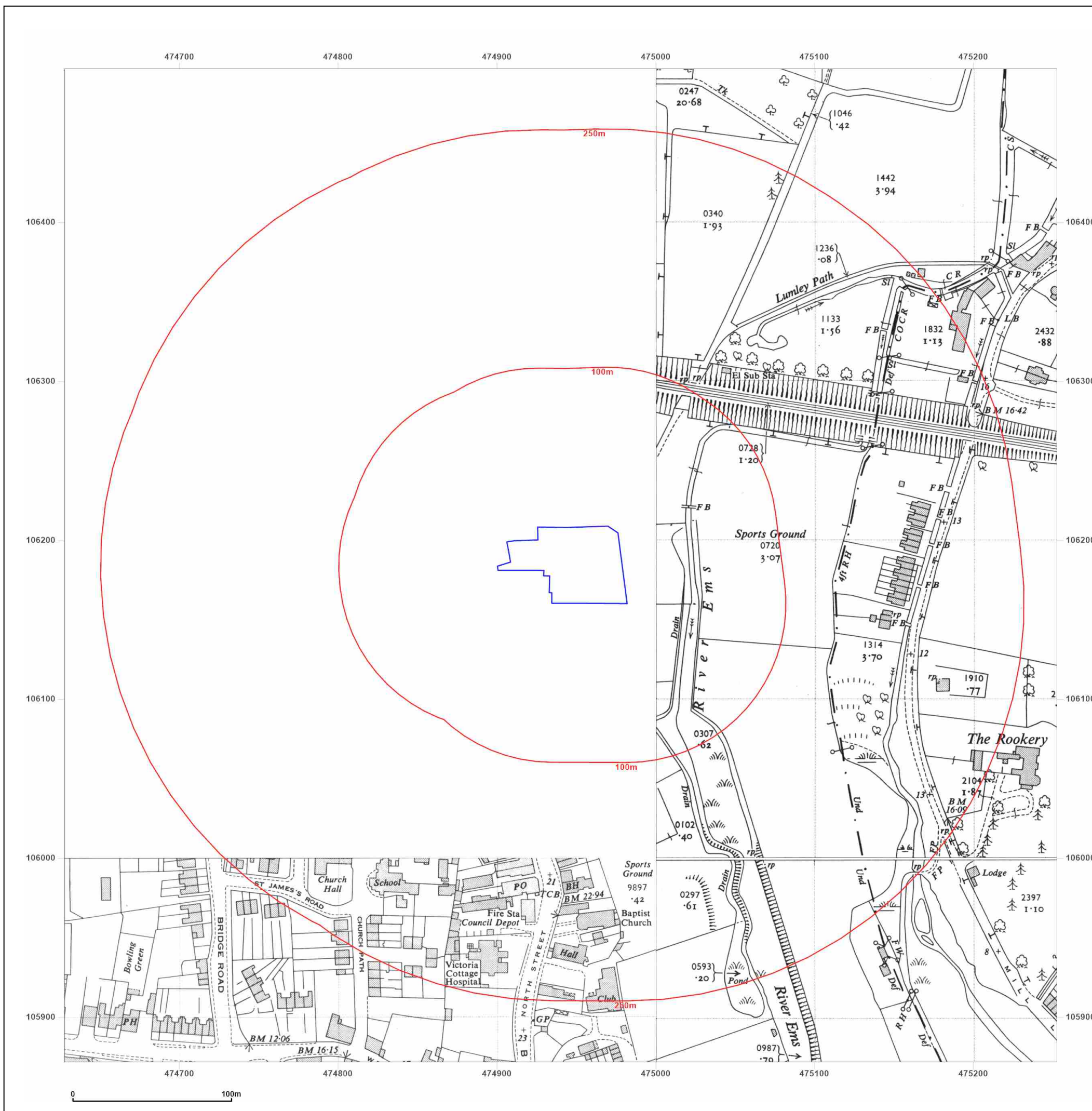


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Site Details:

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PO10 7QH

Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: National Grid

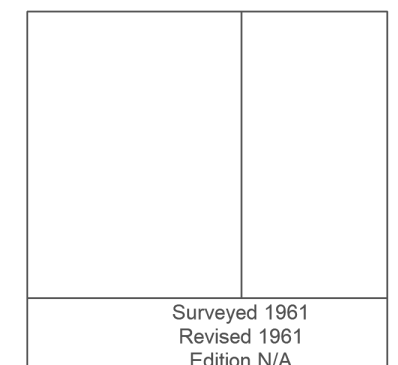
Map date: 1965-1969

Scale: 1:2,500

Printed at: 1:2,500



Surveyed N/A
Revised N/A
Edition N/A
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Site Details:

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PO10 7QH

Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: National Grid

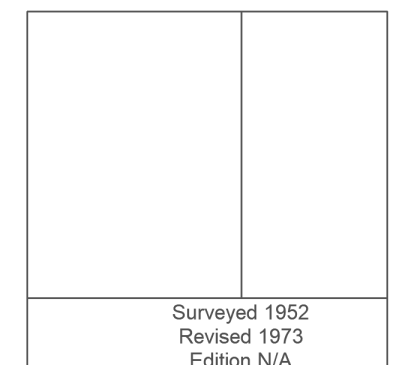
Map date: 1974-1978

Scale: 1:2,500

Printed at: 1:2,500



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Surveyed 1952
Revised 1973
Edition N/A
Copyright 1974
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Site Details:

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Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: National Grid

Map date: 1979-1980

Scale: 1:1,250

Printed at: 1:2,000



Surveyed 1978
Revised 1978
Edition N/A
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Surveyed 1978
Revised 1978
Edition N/A
Copyright 1979
Levelled 1958

Surveyed 1978
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Site Details:

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PO10 7QH

Client Ref: GWPR5385_2-6_Seagull_lane_Emsworth
Report Ref: GS-TXX-XOX-4UK-H41
Grid Ref: 474940, 106184

Map Name: National Grid

Map date: 1986-1989

Scale: 1:1,250

Printed at: 1:2,000



Surveyed 1958
Revised 1989
Edition N/A
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Revised 1986
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