



Land East of Lodge Road, Hurst

26519

For Mactaggart & Mickel

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Executive summary

Site information and setting

Objectives	To conduct a Phase 1 Desk Study and Phase 2 Ground Investigation to identify and evaluate geotechnical and geo-environmental site constraints.
Client	Mactaggart & Mickel
Site name and location	Land East of Lodge Road, Hurst
Proposed development	Development proposals have not been finalised at this stage and therefore a generic low rise residential development has been assumed.
Site description	The site is located between Lodge Road and Tape Lane. It is situated approximately 7km east of Reading train station. The National Grid Reference of the approximate centre of the site is SU 79447 73679. The site is approximately 10.7 Ha in area and is irregular in shape measuring approximately 450m x 400m. The site is bordered by Lodge Road to the north west, open fields to the north and south west, residential housing to the south and Tape Lane to the east.

Desk study summary

Topography	The site is mostly level. There is a drainage ditch that runs north to south along the western boundary of the site. The ditch was filled with water upon the time of inspection.
Hydrology	On site, along western site boundary. Ditch carries surface water from south to north, toward the inland river north west of the site. Rivers are located 180m west and 244m north of the site
Site History	The site was previously an open field across all of the available historical mapping dates.
Geology	Superficial: Kempton Park Gravel Member, consisting of sand and gravel, locally with lenses of silt, clay or peat. Solid: Lambeth group consisting of clay, silt and sand.
Anthropomorphic geotechnical hazards	A former quarry is located 100m east of the site (now occupied by residential development) and a former landfill is located 50 west of the site.
Hydrogeology	Secondary A Aquifers underly the site in the Kempton Park Gravel Member and the Lambeth Group.
UXO risk	A non-specialist UXO assessment indicates a low bomb risk.

Preliminary conceptual site model based on desk study

Potential contaminant sources	A former quarry is located 100m east of the site (now occupied by residential development) and a former landfill is located 50 west of the site.
Potential contaminant linkages (for	None identified

receptors for which there is or will be a pathway)	
<i>Ground model proven by investigation</i>	
Ground and groundwater conditions encountered by investigation	The ground conditions as proven by the investigation undertaken at the site comprise: • Topsoil was encountered across the site between 0m and 0.6m bgl, with an average thickness of 0.4m. The topsoil comprised dark brown silty slightly gravelly SAND. Gravel is fine subrounded flint The Kempton Park Gravel Member (KPGM) was encountered underlying the topsoil across the entire site. KPGM is between 1.9m and 3.2m thick, with an average thickness of 2.47m. The KPGM was described as orange to brown sandy GRAVEL. Sand is medium to fine, subangular to subrounded. Gravel is medium to fine, angular to subangular • The Lambeth Group was encountered underlying the KPGM across all of the site and is of an unproven thickness due to the base of the strata not being reached. The Lambeth group deposits were described as brown to grey slightly gravelly, slightly sandy CLAY. Groundwater was encountered at depths between 5.3 bgl and 0.8 m bgl during the investigation. Water levels recorded post-fieldwork ranged from 0.1 m bgl to 1.3m bgl. Groundwater was encountered within the Lambeth Group deposits during the ground investigation and then within the KPGM deposits during three occasions of monitoring, with water levels in the monitoring wells rising noticeably from the original water strikes noted during drilling.
<i>Summary of geotechnical conclusions</i>	
Groundwork	Excavation to proposed founding depth generally should be readily achievable with standard excavation plant. Excavations during investigation were generally unstable below 1m within the Kempton Park Gravel Member Water seepages into excavations are likely to be adequately controlled by sump pumping and alternative methods of dewatering are likely to be required for larger excavations.
Foundations	A GDR is recommended once full development masterplans have been created.
Roads and pavements	For road / pavement design, a design CBR of 2.5 % is recommended.
Sustainable drainage	Soakaway drainage is considered unsuitable for this site.
Buried concrete	Design Sulfate Class - DS-2 and ACEC Class AC-2. Equivalent to Design Chemical Class DC-2 for a 50 year design life.
<i>Summary of geo-environmental assessment</i>	
Human Health	No exceedances present in chemical testing
Phytotoxicity	No exceedances present in chemical testing
Natural contamination	No exceedances present in chemical testing

Radon:	The guidance indicates that the site is not in a Radon Affected Area and no radon protection measures are required.
Potable water supply pipes	Standard pipework is envisaged. However, confirmation should be sought from the water supply company at the earliest opportunity.
Ground gases or vapours:	Low risk from ground gases and CS1 conditions apply.
Enabling works	
Proposed mitigation measures	No remedial measures are considered necessary at the site.
Waste management	Excavated soils to be disposed of as waste, are likely to be classed as inert and non-hazardous
Future considerations	
Further work	Following the ground investigation works undertaken to date, the following further works will be required: - supplementary ground investigation to further indicate CBR values on site for pavement design. - discussion and agreement with utility providers regarding the materials suitable for pipework; - further testing of groundwater to confirm no presence of contaminants or leachates - discussions with regulatory bodies and the warranty provider regarding the conclusions of this report; - assessment of tree influence on foundations and design of foundations; - discussions with Vibro-stone Column Contractors regarding the viability of, and potential improvement by, VSCs; - discussions with piling Contractors regarding conclusions of this report and design of the piles; - provision of geotechnical design for the Category 1 structures (earthworks, retaining, floor slabs, foundations etc.); - production of a Remediation Strategy and Verification Plan (and agreement with the regulatory bodies and the warranty provider) if supplementary ground investigation finds evidence of leachate contamination; - production of a Materials Management Plan relating to reuse of soils at the site and import of soils to the site; - writing of a Materials Management Strategy relating to reuse of soils at the site; - remediation and mitigation works; and - verification of the earthworks, remediation and mitigation works.

This Executive Summary forms part of Hydrock Consultants Limited report number 26519-HYD-XX-XX-RP-GE-1001 and should not be used as a separate document.

1. Introduction

1.1 Terms of reference

In December 2022, Hydrock Consultants Limited (Hydrock) was commissioned by Mactaggart & Mickel (the Client) to undertake site investigation, comprising a Phase 1 desk study and Phase 2 preliminary ground investigation at the Land East of Lodge Road. The site is located in Hurst, Reading.

The site is currently an open field used for grazing horses.

Hydrock understands that Mactaggart and Mickel is looking to promote the site through the planning process, with the end land use proposed to be low rise residential housing and associated infrastructure.

The investigation works have been undertaken in accordance with Hydrock's proposal referenced (26519-FP-GE-0001, 11 October 2022) and the Client's instructions to proceed via email instruction on 3rd November 2022..

1.2 Objectives

The works have been commissioned to provide preliminary commentary on site conditions and to assist with the design of the development.

The objectives of the Phase 1 Desk Study are to formulate a preliminary Ground Model and an Initial Conceptual Site Model of the site to identify and make a preliminary assessment of any potential geo-environmental and geotechnical risks to the proposed development.

The objectives of the Phase 2 Ground Investigation are:

- » to resolve any geotechnical and geo-environmental uncertainties identified in the Phase 1 Desk Study by refining and updating the preliminary Ground Model, based on the conditions met in accordance with the principles of Environment Agency (EA) 'Land Contamination: Risk Management' (LCRM) (2020);
- » Identify the approximate size of the sand and gravel deposit on site to address the mineral safeguarding planning condition on site.
- » to identify any geo-environmental mitigation requirements to enable development to progress; and
- » to provide preliminary geotechnical recommendations for design.

1.3 Scope

The site investigation includes a Phase 1 Desk Study and a Phase 2 Ground Investigation.

The scope of the Phase 1 Desk Study comprises:

- » a field reconnaissance (walkover) to determine the nature of the site and its surroundings including current and former land uses, topography and hydrology;
- » acquisition and review of:
 - » historical Ordnance Survey maps, to identify any; former potentially contaminative uses shown at the site and immediately surrounding it, and an assessment of the associated contamination risks;
 - » a third-party environmental report to identify any; flooding warning areas, local landfills, pollution incidents, abstractions, environmental permits etc. All of which may have had the potential to have environmental impact on the site;
 - » topographical, geological and hydrogeological maps;

- » British Geological Survey (BGS) archive records;
- » regional UXB risk maps;
- » development of a preliminary Ground Model representing ground conditions at the site;
- » development of an initial Conceptual Site Model (iCSM), including identification of potential contaminant linkages;
- » a qualitative assessment of any geo-environmental risks identified; and
- » identification of any plausible geotechnical hazards.

The scope of the Phase 2 Ground Investigation comprises:

- » a preliminary ground investigation including trial pitting, windowless sampling, TRL DCP, cable percussive boring to:
 - » obtain data on the ground and groundwater conditions of the site;
 - » allow collection of samples for geotechnical and chemical laboratory analysis;
 - » allow geotechnical field tests to be undertaken;
 - » install gas and groundwater wells;
 - » Identify the approximate size of the sand and gravel deposit on site to address the mineral safeguarding planning condition on site.
- » gas concentration and groundwater level monitoring;
- » gas and groundwater sampling;
- » geotechnical and chemical laboratory analysis;
- » updating of the preliminary Ground Model;
- » preparation of a geotechnical risk register;
- » presentation of an initial geotechnical design recommendations;
- » formulation of an updated Conceptual Site Model (CSM), including identification of any plausible contaminant linkages;
- » completion of a generic quantitative risk assessment of any identified chemical contaminants to establish 'suitability for use' under the current planning regime;
- » discussion of any potential environmental liabilities associated with land contamination (soil, water and gas); and
- » identification of outline mitigation requirements to ensure the site is 'suitable for use'.

1.4 Available information

The following documents have been reviewed by Hydrock from publicly available sources for use in the preparation of this report:

- » Joint Strategic Planning Unit, Replacement Minerals Local Plan for Berkshire, Incorporating Alterations adopted in December 1997 and May 2001

Hydrock acknowledges that these documents are not assigned to The Client, and have been used for information purposes only. No formal reliance has been placed upon their contents.

1.5 Regulatory context and guidance

The investigation work has been carried out in general compliance with recognised best practice, including (but not limited to) BS 5930:2015+A1:2020, BS 10175:2011+A2:2017 and the AGS (2006) 'Good Practice Guidelines for Site Investigations'.

The geo-environmental section of this report is written in broad accordance with BS 10175:2011+A2:2017, EA LCRM, (2021) and the AGS (2006) 'Good Practice Guidelines for Site Investigations'.

The methods used follow a risk-based approach, the first stage of which is a Phase 1 desk study and field reconnaissance, with any potential geo-environmental risks assessed qualitatively. This is done using the 'source-pathway-receptor contaminant linkage' concept to assess risk as introduced in the Environmental Protection Act 1990 (EPA, 1990). Any potential geotechnical risks are also assessed from the Phase 1 desk study and site reconnaissance stage.

Phase 2 comprises intrusive ground investigation work and testing. The factual information from the desk study and the ground investigation are used to develop the Conceptual Site Model (CSM). This CSM is based on a ground model of the site physical conditions and an exposure model of the possible contaminant linkages. The CSM forms the basis for Generic Quantitative Risk Assessment (GQRA) in accordance with current guidelines. This GQRA might lead to more Detailed Quantitative Risk Assessment (DQRA).

Professional judgement is then used to evaluate the findings of the risk assessments and to provide recommendations for the development.

The geotechnical section of this report is prepared in general accordance with BS EN 1997-1+A1:2013, BS EN 1997-2:2007 and BS 8004:2015. This report constitutes a Ground Investigation Report (GIR) as described in Part 2 of Eurocode 7 (BS EN 1997-2) (EC7). However, it is not intended to fulfil the requirements of a Geotechnical Design Report (GDR) as specified in EC7.

Where relevant the relevant requirements of the current edition of NHBC Standards have also been applied.

The geo-environmental and geotechnical aspects are discussed in separate sections. Throughout the report the term 'geotechnical' is used to describe aspects relating to the physical nature of the site (such as foundation requirements). The term 'geo-environmental' is used to describe aspects relating to ground-related environmental issues (such as potential contamination). However, it should be appreciated that this is an integrated investigation and these two main aspects are inter-related. Designers should take all aspects of the investigation into account.

Remaining uncertainties and recommendations for further work are listed in Section 9 and Section 10.

2. Desk study (and field reconnaissance)

2.1 Data

A number of desk study sources have been used to assemble the following information. These are presented in Appendix C and include:

- » Third-party environmental report (Groundsure report, reference GS-9197660);
- » Historical Ordnance Survey mapping;
- » BGS Archive Records;
- » Zetica UXB Risk Maps (<https://zeticauxo.com/downloads-and-resources/risk-maps/>);
- » UK Radon Maps (<https://www.ukradon.org/information/ukmaps>)

2.2 Site referencing

Table 2.1: Site referencing information

Item	Brief Description
Site name	Land East of Lodge Road. Hurst
Site address	Land East of Lodge Road. Hurst, Reading. The nearest postcode is RG10 ODP.
Site location and grid reference	The site is located between Lodge Road and Tape Lane. It is situated approximately 7km east of Reading train station. The National Grid Reference of the approximate centre of the site is SU 79447 73679. The site is approximately 10.7 Ha in area and is irregular in shape measuring approximately 450m x 400m.
Site boundaries	The site is bordered by Lodge Road to the north west, open fields to the north and south west, residential housing to the south and Tape Lane to the east.



Figure 2.1: Site location

(Reproduced with permission from Groundsure)

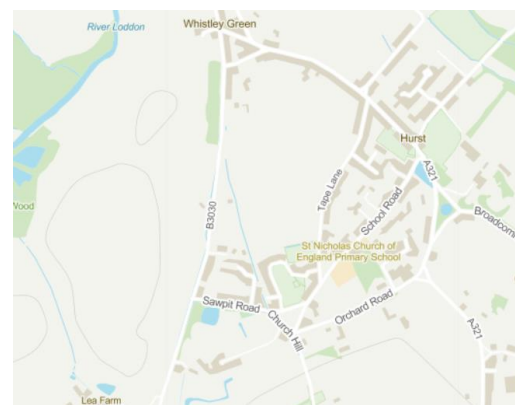


Figure 2.2: Extract from the Ordnance Survey Map.

(OS licence 100023353).

A site location plan (Hydrock Drawing 26519-HYD-XX-ZZ-SK-GE-1002) is presented in Appendix A

2.3 Site description and field reconnaissance survey

A field reconnaissance survey was undertaken on 5th December 2022 to visually identify assess potential geotechnical hazards, contaminant sources for future investigation and identification of possible source-pathway-receptor linkages. The weather during the field reconnaissance survey was clear and cold.

A description of the site is presented in Table 2.2 and selected photographs are presented in Figure 2.3 to Figure 2.5.

Table 2.2: Site description

Item	Brief Description
Site access	The site was accessed from a padlocked metal gate on Lodge Road. An additional locked gate is located on Tape Lane.
Site area	The site is irregular in shape measuring approximately 450m x 400m. and has an area of 10.7 Ha.
Elevation, topography and any geomorphic features	The site is mostly level. There is a drainage ditch that runs north to south along the western boundary of the site. The ditch was filled with water upon the time of inspection.
Site boundaries and surrounding land	The site is located between Lodge Road and Tape Lane. It is situated approximately 7km east of Reading train station. The site is bordered by Lodge Road to the north west, open fields to the north and south west, residential housing to the south and Tape Lane to the east The National Grid Reference of the approximate centre of the site is SU 79447 73679.
Present land use	The site is presently an open field in use as pasture / grazing land for horses.
Vegetation	There are sporadic trees and hedges along the site boundaries.
General site sensitivity	The site is presently an open field surrounded by open fields and existing residential housing. Therefore, the site sensitivity is moderate.



Figure 2.3: Archaeological excavations on site.



Figure 2.4: Archaeological excavations on site



Figure 2.5: Archaeological excavations and residences near site.

2.4 Site history

A study of historical Ordnance Survey maps (Appendix C) has been undertaken to identify any former land uses at the site and surrounding areas which may have geotechnical or geo-environmental implications for the proposed development. The key findings are summarised in Table 2.3.

Table 2.3: Site history review

Reference	Key features on site	Key features off-site
County Series: 1897 - 1900 1:10,560	The site is an open field.	Wells are present 100m, 250m and 450m north of the site. Wards Cross Smithy located 150m north east of the site. Elephant and Castle Public House is located 250m north of the site. A well is located 250m south east of the site.
County Series: 1910 - 1913 1:10,560	No change.	Old gravel pit now present 100m east of the site Nurseries present 100m south west and north of the site. All previously mentioned wells are no longer present on the historic map.
County Series: 1932 1:10,560	No change.	Allotment gardens present 50m south of the site. Smithy no longer present. Sewage tank present 400m south of the site, next to Hurst House.
County Series: 1956 - 1960 1:10,560	No change.	Housing now present at northern end of Tape Lane, 50m north east of site. Sewage tank no longer present next to Hurst House.
National Grid: 1975 - 1977 1:10,000	OS tile now displays drainage ditch running through the site running north to south, along the western boundary.	Housing development now extended all along Tape Lane, 25m east of the site. Tank no longer present. Old gravel pit assumed infilled.
National Grid: 1986 1:10,000	No change.	No change.
National Grid: 2001 1:10,000	No change.	First evidence of landfill 50m west of site in waste records, however no records present on historic maps..
National Grid: 2010 1:10,000	No change.	No change.
National Grid: 2022 1:10,000	No change.	No change.

2.5 Geology

The geology of the site area is shown on the 1:10,000 British Geological Survey (BGS) map extract reproduced as part of the Groundsure and is summarised below:

Table 2.4: Geology

Ref. for Figures	Location	Stratigraphic Name	Description
Superficial Deposits (Figure 2.6)			
1	On site	Kempton Park Gravel Member	Sand and gravel, locally with lenses of silt, clay or peat.
Solid Geology (Figure 2.7)			
1	On site.	Lambeth Group	Clay, Silt And Sand
2	156m SE	London Clay Formation	Clay, Silt And Sand



Figure 2.6: Superficial deposits.

(Reproduced with permission from Groundsure)

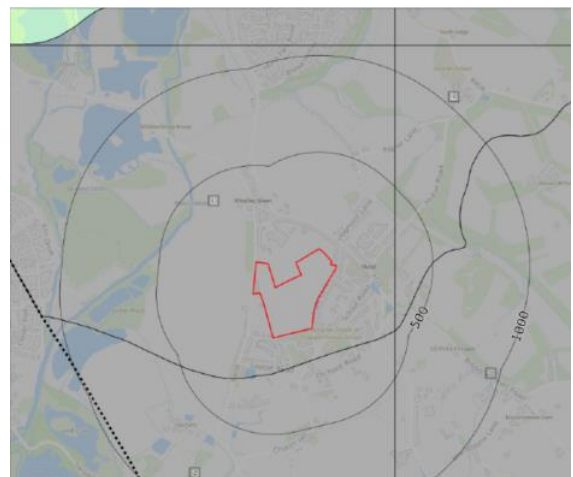


Figure 2.7: Solid geology.

(Reproduced with permission from Groundsure)

A borehole log from the BGS archive have been reviewed and selected records are summarised below:

- » 428007, located 50m to the west of the site (NGR 479150E,173610N), drilled to a depth of 4.4m and recorded:
 - » Topsoil from surface to 0.3m bgl.
 - » Sand and Gravel with well rounded quartz and flint between 0.3m and 3.6m bgl;
 - » Reading Beds of mottled red and grey CLAY 3.6m and 4.4m bgl

2.6 Hydrogeology

2.6.1 Aquifer designations

Based on the inferred geological sequence presented in Section 2.5 and the Environment Agency's interactive aquifer designation map, the aquifer system presented in Table 2.5 applies.

Table 2.5: Aquifer system

Stratum	Aquifer Designation	Comments
Superficial Deposits		
Kempton Park Gravel Member	Secondary A Aquifer	Sand and gravel, locally with lenses of silt, clay or peat.
Solid Geology		
Lambeth Group	Secondary A Aquifer	Vertically and laterally variable sequences mainly of clay, some silty or sandy, with some sands and gravels, minor limestones and lignites and occasional sandstone and conglomerate. The Lambeth Group was deposited in fluvial, estuarine, lagoonal or proximal marine environments. Late Paleocene to Early Eocene (late Thanetian to early Ypresian).

2.6.2 Groundwater abstraction

There are no active licensed groundwater abstractions within 1000m of the site.

2.6.3 Groundwater source protection zones and groundwater vulnerability

The site is within a Zone 3 (Total Catchment) groundwater Source Protection Zone (SPZ 3), see Figure 2.8.

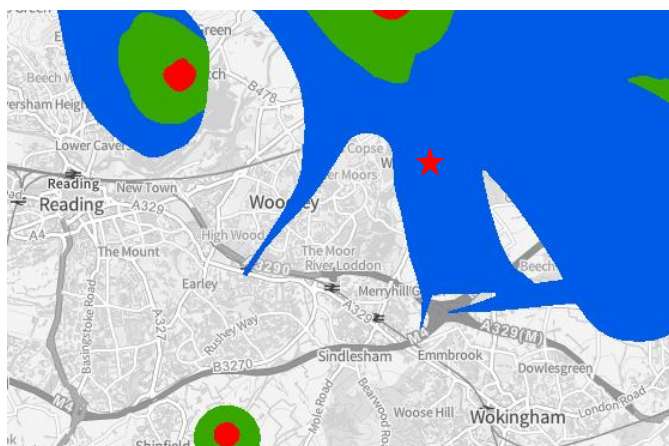


Figure 2.8: Groundwater Source Protection Zones (SPZ's) Site represented by red star.

(Reproduced with permission from Groundsure)

2.6.4 Groundwater levels, recharge, and flow

Information from the BGS Hydrogeological Maps and supporting data from BGS historical boreholes indicate groundwater is likely to be confined within the Lambeth Group.

Shallow groundwater is likely to be present within the Kempton Park Gravel Member, with a deeper groundwater body in the Lambeth Group. Groundwater flow is inferred to flow toward the drainage ditch along the western site boundary.

2.6.5 Groundwater quality

The groundwater body beneath the site (Twyford Tertiaries Water Body) is currently (2019 Cycle 3) classified under the Water Framework Directive as 'good'.

2.6.6 Groundwater flooding

The environmental data report indicates a moderate risk of groundwater flooding.

2.7 Hydrology

2.7.1 Surface water system and drainage

The surface water features in the vicinity of the site are listed in Table 2.6.

Table 2.6: Surface water features

Feature	Location Relative to Site
Drainage Ditch	On site, along western site boundary. Ditch carries surface water from south to north, toward the inland river north west of the site.
Inland River	180m west of site.
Inland River	244m north west of the site.

2.7.2 Surface water abstractions and discharges

There are no active water abstractions within 1km of the site.

There are 2 active licensed surface water discharges within 1km of the site. They are listed in Table 2.7.

Table 2.7: Surface water discharges

Location Relative to Site	Purpose of Discharge
Hogmoor Lane - 316m NE	Sewage discharge
Wokingham Road - 405m SE	Sewage discharge

2.7.3 Surface water quality

Reference to the Environment Agency web site shows the site is located within the catchment known as the Thames River Basin District. The specific river water body being the Twyford Brook Water Body. The current (2019 cycle 3) overall status under the Water Framework Directive is described as 'poor'.

The reason for the water body currently having a 'Bad' status is due to Perfluorooctane sulphonate (PFOS) and Polybrominated diphenyl ethers (PBDE). The objective is for phosphate levels to be 'good' by 2017.

2.7.4 Surface water flooding

The desk study information indicates the proposed development is in a very low flood risk, within the south western corner of the site area, with a 1 in 250 return period with a depth between 0.1m and 0.3m.

2.8 Mining and mineral extraction

The site is not within an area of recorded mining. However, the housing development immediately to the east has been built over a former gravel extraction pit.

The Kempton Park Gravel Member in the area has been quarried for sands and gravels but there is no evidence on the historical plans of any extraction being undertaken within the site boundary.

The Groundsure report indicates that gravel quarrying has been undertaken in the wider area, although not within the site boundaries. A Brick Pit existed 93m east of site, listed as the Tape Lane gravel pit.

2.9 Waste management

There is 1 waste management sites recorded within 250m of the site, as listed in Table 2.8.

Table 2.8: Waste management sites

Site Name and Location	Details
50m west of the site Whistley Court, Summerleaze Ltd.	Status: Closed. Operational dates: 16/08/1998 - 16/03/2001 Size: 25000 - 75000 tonnes Wastes accepted: Listed as co-disposal landfill site. Precise waste allowed unknown. Prohibited wastes: Unknown

2.10 Regulatory Information

Information in the Groundsure Report (Appendix C), relating to various regulatory controls has been reviewed, with a summary presented below in Table 2.9.

Table 2.9: Regulatory information within 500m of the site

Regulatory Data	Distance from Site	Details	Potential Risk	Comment
Treating Waste Exemption.	On Site	Treatment of waste wood, plant matter, spreading of plant matter, use of mulch, use of waste in construction.	Moderate	To be investigated with chemical and environmental testing.

Regulatory Data	Distance from Site	Details	Potential Risk	Comment
Using Waste Exemption. Hambridge Road Fram, East Hampstead Road.	145m SW	Use of waste in construction.	Low	
Land at Orchard Road, Hurst.	254m SE	Using and treating waste exemption. Treatment of waste wood and plant matter and use of mulch.	Low	
Orchard Nursery, Orchard Road.	342m S	Storing and disposing of waste by burning.	Low	

2.11 Natural soil chemistry

Information contained within the environmental report (Appendix C) gives indicative (estimated) concentration values for the natural soils at the site for a selection of Contaminants of Potential Concern (CoPC). These have been reproduced in Table 2.10.

Table 2.10: Natural soil chemistry

Element	Arsenic	Cadmium	Chromium	Lead	Nickel
Concentration (mg/kg)	15	<1.8	60 - 90	100	15 - 30

2.12 Radon

The radon risk is reported in the environmental report.

The guidance indicates that the site is not in a Radon Affected Area and no radon protection measures are required.

2.13 Unexploded ordnance (UXO)

In general accordance with CIRIA Report C681 (Stone et al 2009) a non-specialist UXO screening exercise has been undertaken for the purposes of ground investigation.

The non-specialist UXO screening exercise has indicated no further assessment is required with regard to UXO in relation to ground investigation. Further assessment may be considered prudent for construction activities.

3. Initial conceptual site model

3.1 Introduction

The initial Conceptual Site Model (iCSM) incorporates evidence from the site walkover and the Desk Study. The formulation of an initial Conceptual Site Model is a key component of the LCRM methodology. The iCSM incorporates a ground model of the site physical conditions and an exposure model of the possible contaminant linkages; it forms the basis for Generic Quantitative Risk Assessment (GQRA) in accordance with current guidelines.

3.2 Ground model

The preliminary ground model presented in Section 2 provides an understanding of the ground conditions and is the basis for preparing the preliminary geotechnical hazard assessment (Section 3.3) and the preliminary geo-environmental exposure model (Section 3.4)

3.3 Geotechnical hazard identification

3.3.1 Context

The preliminary geotechnical hazard identification has been undertaken in accordance with the general requirements of ICE/DETR Document 'Managing Geotechnical Risk' and the HE documents HD 41/15 and CD 622.

The following section sets out the identified geotechnical hazards and the development elements potentially affected (see Table J.1 in **Appendix H** for further information).

3.3.2 Plausible geotechnical hazards

Plausible geotechnical hazards identified at the site are:

- » Soft / loose compressible ground (low strength and high settlement potential).
- » Variable lateral and vertical changes in ground conditions.
- » Shallow groundwater.
- » Changing groundwater conditions.
- » Slope stability issues – retaining walls and general slopes.
- » Earthworks – unsuitability of site won material to be reused as fill.
- » Mining.

3.3.3 Potential development elements affected

Development elements potentially affected by geotechnical hazards are:

- » Buildings – foundations.
- » Buildings – floor Slabs
- » Roads and pavements.
- » General slopes.
- » Retaining walls.
- » Construction staff, vehicles and plant operators.

Health and safety risks to site Contractors and maintenance workers have not been assessed during these works and will need to be considered separately during design.

The above plausible geotechnical hazards and development elements affected have been carried forward for investigation and assessment. The investigation is presented in Section 5.4 and the assessment is presented in Section 6.

3.4 Geo-environmental exposure model

3.4.1 Context

The preliminary exposure model is used to identify geo-environmental hazards and to establish potential contaminant linkages, based on the source-pathway-receptor (SPR) approach.

A viable contaminant linkage requires all the components of an SPR to be present. If only one or two are present, there is no linkage and no further assessment is required.

3.4.2 Potential contaminants

For the purpose of this assessment the potential contaminants have been separated according to whether they are likely to have originated from an on-site or off-site source.

3.4.2.1 Potential on-site sources of contamination

- » Made Ground or waste, associated with historical farming activities, possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials, PAH and petroleum hydrocarbons (S01).
- » Naturally occurring elevated concentrations of metal (arsenic and vanadium) within soils (S02).

3.4.2.2 Potential off-site sources of contamination

- » Leachate from quarry backfill, associated with the former gravel pit located 100m from the eastern boundary of the site, possibly including metals, metalloids, asbestos, PAH and petroleum hydrocarbons (S03).
- » Ground gases (carbon dioxide and methane) from organic materials in the backfill to the former quarry, now filled, located 100m east of the site (S04).
- » Leachate and ground gas from the former landfill 50m west of the site (S05).

3.4.3 Potential receptors

The following potential receptors in relation to the proposed land use have been identified.

- » People (neighbours, site end users) (R01).
- » Development end use (buildings, utilities and landscaping) (R02).
- » Groundwater: Secondary A aquifer status of the Kempton Park Gravel Member (R03).
- » Surface water: on-site drainage ditch on southern site boundary (R04).

3.4.4 Potential pathways

The following potential pathways have been identified.

- » Ingestion, skin contact, inhalation of dust and outdoor air by people (P01).
- » Methane ingress via permeable soils and/or construction gaps (P02).
- » VOC and petroleum hydrocarbon vapour ingress via permeable soils and/or construction gaps (P03).
- » Root uptake by plant (P04).
- » Migration of contaminant via leachate migration through the unsaturated zone in the Kempton Park Gravel Member (P05).

- » Migration of contaminant from the groundwater within the Kempton Park Gravel Member to the groundwater within the Lambeth Group secondary A aquifer (P06).
- » Surface water via overland flow (P07).
- » Migration of leachate and gas from former landfill 50m west and infilled quarry 100m east of site, via groundwater (P08).

Health and safety risks to site development contractors and maintenance workers have not been assessed as part of this study and will need to be considered separately.

The above sources, pathways and receptors have been considered as part of the Preliminary Risk Assessment in accordance with LCRM (2021), are considered to be plausible in the context of this site and have been carried forward for investigation and assessment. The investigation is presented in Section **5** and the assessment is presented in Section **7**. An assessment of the Source – Pathway – Receptor linkages is undertaken following the assessment (Section **7**) and is presented in **Appendix I** (Table K.1).

4. Ground investigations

4.1 Site works

The ground investigation works, including the rationale which was based on the findings of the preliminary risk assessment is summarised in **Error! Reference source not found.** For the investigation rationale of the historical investigations, please refer to the historical reports in Appendix C

The fieldwork took place between 5th December 2022 and 16th of December 2022. The ground investigation locations were surveyed in using a topographic survey quality GPS and are shown on the Exploratory Hole Location Plan (Hydrock Drawing 26519-HYD-XX-ZZ-SK-GE-1001) in Appendix A.

The logs, including details of ground conditions, soil sampling, in situ testing and any installations, are also presented in Appendix D.

The weather conditions during the Hydrock fieldwork and for the previous week were dry and cold, with minor snowfall and frost in the second week of the GI.

Table 4.1: Summary of site works

Activity	Method	No	Name	Depth Maximum (m bgl)	In situ tests	Rationale
Drilling, Pitting and Probing						
Boreholes	Cable percussive	9	CP01-CP10	8.5	SPT	To investigate strength profile of the Kempton Park Gravel Member and underlying Lambeth Group
	Window sampler	8	WS01 – WS08	4		Additional testing of Kempton Park Gravel Member
Trial pits	Machine (JCB 3X)	55	SA01 and Archaeological Pits	3	Hand shear vane (HSV)	For general site coverage and collection of samples
	Hand-excavated	17				Confirmation of no services in exploratory positions.
Probes	TRL dynamic cone penetrometer	30		1	California Bearing Ratio (CBR)	
Other in situ testing or monitoring						Comment/s
Infiltration	BRE 365 / Indicative	1		1		In SA01, soakaway test over 6 hours.

Wells for monitoring groundwater levels and ground gas concentrations, and to facilitate the sampling of groundwater, were installed in all of the windowless sampler and cable percussion boreholes. A summary of the monitoring well installations is presented in Table 4.2.

Table 4.2: Summary of monitoring installations

Location	Standpipe / piezometer diameter	Screen top and base depth (m bgl)	Strata targeted
CP01	200	1 – 8.5	Kempton Park Gravel Member and Lambeth Group
CP02	200	0.5 – 2.4	Kempton Park Gravel Member.
CP03	200	0.5 – 3	Kempton Park Gravel Member
CP04	200	0.5 – 8.5	Kempton Park Gravel Member and Lambeth Group
CP05	200	1 – 3	Kempton Park Gravel Member
CP06	200	0.5 – 3	Kempton Park Gravel Member
CP08	200	1 – 3	Kempton Park Gravel Member
CP09	200	0.5 – 3.6	Kempton Park Gravel Member
CP10	200	1 – 6.3	Kempton Park Gravel Member and Lambeth Group

4.2 Geo-environmental testing

4.2.1 Sampling strategy and protocols

Exploratory hole positions were determined by reference to the site conditions and uncertainties identified in the Initial Conceptual Model.

No specific features were identified during the desk study as requiring targeted investigation and a reasonably even spacing was used. No specific sampling statistics or grid were utilised in this instance.

Samples were taken, stored and transported in general accordance with BS 10175:2011+A2:2017.

4.2.2 Geo-environmental monitoring

Gas monitoring boreholes have been monitored on 6 occasions. The results are presented in Appendix F Monitoring is ongoing and this report will be updated on completion of the monitoring.

4.2.3 Geo-environmental laboratory analyses

The chemical test certificates for testing undertaken as part of Hydrock's investigation are provided in Appendix G and summarised in the table below. Wherever possible, UKAS and MCERTS accredited procedures have been used.

The geo-environmental analyses undertaken on soils are summarised in

Table 4.3.

Table 4.3: Geo-environmental analyses of soils

Determinand Suite	Topsoil	Kempton Park Gravel	Lambeth Group
Hydrock minimum suite of determinands for solids*	7	9	0
Speciated aliphatic and aromatic banding Total petroleum hydrocarbons by HS-GC/MS and GC/FID (Hydrock Tier 2 TPH Suite)	9	5	0
Asbestos quantification	4	1	0
BS 3882 Topsoil Suite	3	0	0
Pesticide screen	10	0	0
Hydrock default groundwater suite	0	7	0
*Hydrock minimum soil suite comprises: As, B (water soluble), Be, Cd, Cr (total), Cr (VI), Cu, Hg, Ni, Pb, S (elemental), Se, V, Zn, cyanide (total), sulfide, pH, asbestos fibres, speciated polynuclear aromatic hydrocarbons (PAH, by GC-FID), total phenols and fraction of organic carbon			

The soils chemical test data are interpreted and assessed in Sections 7.3 and 7.4.

4.3 Geotechnical testing

4.3.1 Geotechnical laboratory testing

The geotechnical tests undertaken by Hydrock are summarised in

Table 4.4 and the test certificates are provided in Appendix E. Wherever possible, UKAS accredited procedures have been used.

The geotechnical tests undertaken as part of historical investigations are provided in the relevant reports in **Appendix C**.

Table 4.4: Summary of sample numbers for geotechnical tests

Test	Kempton Park Gravel Member	Lambeth Group	Topsoil
Natural moisture content	7	7	0
Atterberg limits	6	8	0
Particle size distribution	32	10	0
Sulfate and aggressive chemical environment classification for buried concrete classification (full BRE SD1 suite)	7	3	0
Oedometer Compressibility 'Standard' (up to 5 load/unload stages)	0	1	0
Optimum Moisture Content / Maximum Dry Density Relationship (4.5kg rammer), with hand shear vane at each compaction point	10	0	0
Remoulded California Bearing Ratio at natural moisture content (soaked)	5	0	0
Shear Strength Single stage test (70 - 100mm specimen)	0	1	0
Particle density	12	0	0
Organic Matter	6	4	0
Shear Box test (60mm x 60mm)	5	5	0

The geotechnical test data are summarised in Section 5.4 and interpreted in Section 6.

5. Ground investigation records and data

5.1 Physical ground conditions

5.1.1 Summary of strata encountered

The following presents a summary of the properties of the ground and groundwater conditions encountered, based on field observations, interpretation of the field data and laboratory test results, taking into account drilling, excavation and sampling methods, transport, handling and specimen preparation.

All relevant data from the Hydrock investigation discussed in Section 4 are used from this point forward.

Details of the Hydrock ground investigation works are provided in the logs in Appendix D, previous data are provided in Appendix C, a summary of the ground model is presented in Table 5.1 and the individual strata are described in the sections below.

Table 5.1: Strata encountered

Stratum	Depth to top (m bgl)	Depth to base (m bgl)	Thickness (m) (range)	Thickness (m) (average)
Topsoil	0	0.3 - 0.6	0.3 – 0.5	0.4
Kempton Park Gravel Member	0.3 – 0.6	2.3 - 3.5	1.9 – 3.2	2.47
Lambeth Group	2.3 – 3.5	>8.5 (base not proven)	1.5 – 5.6 (unproven)	(base not proven)

5.1.2 Surface covering

5.1.3 Topsoil

Topsoil was encountered across the site between 0.0m and 0.6m bgl, with an average thickness of 0.4m. The topsoil comprised dark brown silty slightly gravelly SAND. Gravel is fine subrounded flint.

For the purposes of this report, topsoil is defined as the upper layer of an in situ soil profile, usually darker in colour and more fertile than the layer below (subsoil) which is a product of natural chemical, physical, biological and environmental processes.

5.1.4 Kempton Park Gravel Member

The Kempton Park Gravel Member (KPGM) was encountered underlying the topsoil across the entire site. KPGM is between 1.9m and 3.2m thick, with an average thickness of 2.47m.

The KPGM was described as orange to brown sandy GRAVEL. Sand is medium to fine, subangular to subrounded. Gravel is medium to fine, angular to subangular.

5.1.5 Lambeth Group

The Lambeth Group was encountered underlying the KPGM across all of the site and is of an unproven thickness due to the base of the strata not being reached.

The Lambeth group deposits were described as brown to grey slightly gravelly, slightly sandy CLAY.

5.2 Groundwater

5.2.1 Groundwater observations and levels

Groundwater encountered during the investigation is listed in Table 5.2. A groundwater observation represents the depth at which groundwater was first observed and is likely to be deeper than the actual water table level at that location.

Table 5.2: Groundwater occurrence

Stratum	Date	Location	Fieldwork		Comment
			Groundwater observation (m bgl)	Rose to after 20 mins (m bgl)	
Lambeth Group	01/01/15	CP01	5.3	1.9	Medium inflow
		CP05	3.3	1.8	
		CP09	2.7	0.8	

Groundwater levels recorded during post-fieldwork monitoring are summarised in Table 5.3.

Table 5.3: Groundwater level data summary

Stratum	Date range	Location	Post-fieldwork monitoring
			Depth to groundwater (range) (m bgl)
Kempton Park Gravel Member	20/12/22– 20/01/22	CP01	0.1 – 1.0
		CP02	0.1 – 0.66
		CP03	0.59 – 1.3
		CP04	Not Recorded
		CP05	0.0 – 0.67
		CP06	0.0 – 0.41
		CP08	0.27 – 0.3
		CP09	0.0 – 0.2

5.2.2 Infiltration tests

The results of the infiltration testing undertaken are summarised in Table 5.4. The results sheets are presented in Appendix D.

Testing was carried out in accordance with Hydrock's 1-day assessment methodology. This is in general accordance with BRE Digest 365 (BRE DG 2016) where infiltration rates allow three test runs during a working day (or where there is no infiltration), but where low infiltration rates were

encountered the available time may not have been sufficient to fully comply with the BRE test method (i.e. three runs of the test).

Table 5.4: Infiltration test results

Stratum	Location	Depth to base of pit (m bgl)	Infiltration rate (m/s)
			Run 1
Kempton Park Gravel Member	SA01	1.1m	Infiltration rate not calculated due to slow rate of infiltration.

*Where less than three tests were possible in a particular location the results provided should be considered indicative only and should not be used for design purposes. If infiltration is critical to the development of the site, multi-day infiltration testing should be undertaken.

5.2.3 Groundwater summary

In general, groundwater was encountered within the Lambeth Group deposits towards the top of the stratum and the monitoring indicates there is perched water within the Kempton Park Gravel Member. Following drilling groundwater encountered in the Lambeth Group rose to steady levels within the KPGM strata. The groundwater flows appears to not be topographically controlled.

Groundwater was encountered within the Lambeth Group Deposits during the GI and then within the KPGM deposits during three stages of monitoring.

Within the KPGM, an infiltration test was attempted, however no infiltration occurred during the test. No infiltration testing was undertaken in the Lambeth Group, however, as an over-consolidated clay, this stratum is not expected to provide any infiltration potential for the site.

5.3 Ground gases (carbon dioxide and methane)

Records from the gas monitoring boreholes are presented in Appendix F and summarised in Table 5.5.

6 monitoring visits have been undertaken and the monitoring programme is complete. The data are assessed in Section 7.7.

Table 5.5: Range of ground gas data

Stratum	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Steady flow rate (L/hr)	Comment
Kempton Park Gravel Member	0 - 0	0 - 3.3	6.7 - 20.3	-3.40 - 111.1	
Lambeth Group	0 - 0	0 - 1.5	9.8 - 20.3	0 - 43.6	

5.4 Geotechnical data

5.4.1 Introduction

Laboratory test results are contained in Appendix E with *in situ* test results shown on the relevant exploratory hole log or datasheet in Appendix D. The following sections summarise the main findings and provide interpretation where appropriate.

5.4.2 Plasticity

The volume change potentials in terms of NHBC Standard (Chapter 4.2) with respect to building near trees have been determined from the results of plasticity index tests on samples of soil. These are summarised in Table 5.6.

Table 5.6: Volume change potential

Stratum	No. of tests	Plasticity Index			Modified Plasticity Index			Plasticity designation	Volume Change Potential
		Min.	Max	Av.	Min.	Max	Av.		
Kempton Park Gravel Member	2	5	41	23	2.4	41	18.47	High to low	High
Lambeth Group	4	13	44	25.2	10.7	44	23.9	Very high to low	High

5.4.3 Particle size distribution

Particle Size Distribution test (PSDs) results are summarised in Table 5.7 and summary descriptions and PSD plots of the material analysed are presented in **Appendix E**.

Table 5.7: PSD results summary

Stratum	No. of tests	Silt/Clay %	Sand %	Gravel %	General description
Kempton Park Gravel Member	31	11	42	47	Slightly clayey very sandy GRAVEL.
Lambeth Group	10	87.8	6.8	5.3	Grey firm CLAY.

5.4.4 Soil strength

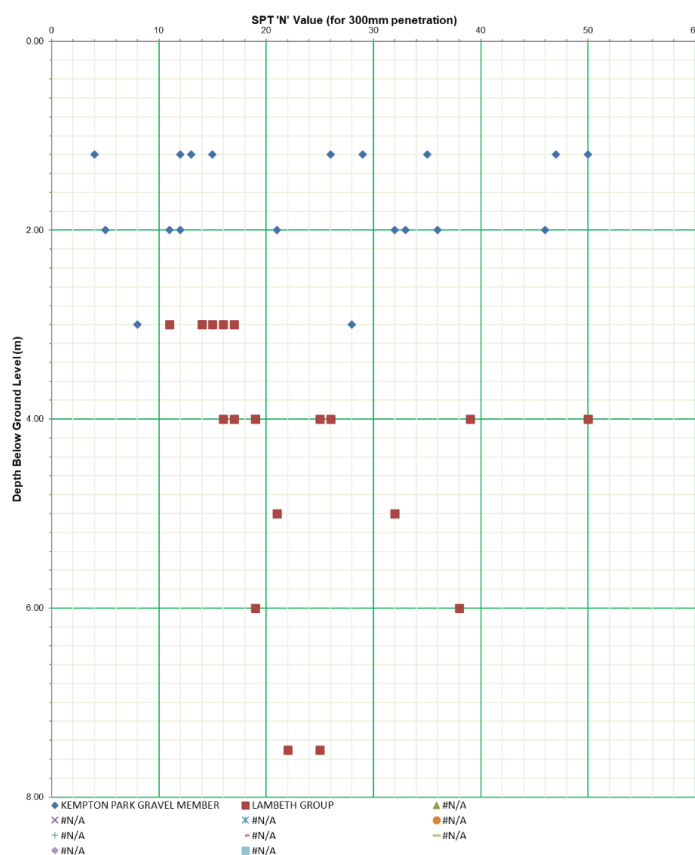
Table 5.8 summarises information pertaining to the shear strength of the soils according to geological stratum. Factual results are summarised for laboratory tests, field tests (e.g. hand shear vane) and uncorrected Standard Penetration Tests (SPT). Where the SPT is used to infer shear strength by published correlation, this is also tabulated.

Table 5.8: Soil strength results and derived values

Stratum	No. of tests	SPT (N-value) (range)	c_u (kPa)*	c' (kPa)**	ϕ_i' (°)**	Method
Kempton Park Gravel Member	21	4 - 50	26 - 200	5 - 20	21.4 - 34.2	SPT – cable percussion.
	3	-	55.4 – 122.6			Shear box
Lambeth Group	16	14 - 50	70 - 200	6 - 20	21 - 28	SPT – cable percussion
	5		74.5 – 149.5			Shear Box

*Calculated using an F1 value of 4.5. Correlation with Stroud (1989)
 ** Calculated using Sorensen and Okkels (2013)

Figure 5.1: SPT versus depth summary



As shown by Figure 5.1, the strength profile of the Lambeth Group indicates a general trend of increasing strength with depth, with N values of 11 @ 2.5mbgl and 38 @ 6mbgl indicating shear strength of 52kPa and 150kPa respectively. However there is an exception noted on site at CP01 as the deposits contain more sand and are thus weaker at depth (22 at 7.5mbgl).

The lowest N value of 4 indicates a minimum undrained shear strength of 26kPa for the Kempton Park Gravel Member at 1.2m below ground level however, the SPT values are highly variable throughout the deposit (4 – 50) at 1.2m and 2m bgl.

5.4.5 Compressibility

Table 5.9 presents a summary of the derived parameters for coefficient of consolidation and compressibility. The data indicates that the material is generally of medium to high compressibility over the pressure ranges tested.

Table 5.9: Summary of compressibility

Stratum	No. of tests / results	Method	Pressure range (kN/m ²)	Coefficient of volume compressibility (m _v) (m ² /MN)	Coefficient of consolidation (C _v) (m ² /yr)
Lambeth Group	1	One Dimensional Oedometer Testing	100	0.41	9.7 – 10
			200	0.17	11 – 8.8
			400	0.15	13 – 8.8
			800	0.083	6.6 – 4.9
			1600	0.04	0.63 – 1.4

5.4.6 Compaction and moisture content

Table 5.10 presents a summary of the moisture content tests and compaction studies undertaken at the site.

Table 5.10: Compaction study results

Stratum	No. tests	Method	Natural moisture content (%) (range)	Optimum moisture content (%) (range)	Particle density (Mg/m ³) (range)	Maximum dry density (Mg/m ³) (range)
Kempton Park Gravel Member	8	4.5kg Rammer	5.1 - 14	7.6 - 18	2.62 – 2.73	1.73 – 2.11
Lambeth Group	2		13 - 15	18 - 19	2.35 – 2.79	1.54 – 1.77

5.4.7 Subgrade stiffness

The subgrade stiffness (CBR and Modulus of Subgrade Reaction) results are summarised in Table 5.11.

Table 5.11: CBR results and derived values

Stratum	No. tests	Method	CBR (%) (Range)	Modulus of subgrade reaction (IAN73/06) MN/m ² /m
Kempton Park Gravel Member	7	Laboratory remoulded sample at Natural Moisture Content (NMC)	0.3 - 64	8.1 - 76

Where using the IAN method, 'k' has been back calculated from the Equivalent CBR.

5.4.8 Sulfate content

In accordance with BRE (Special Digest 1), the Design Sulfate (DS) classification and the Aggressive Chemical Environment for Concrete (ACEC) classification are presented in Table 5.12. The assessment summary sheet is [or] sheets are presented in Appendix E.

Table 5.12: Aggressive chemical environment concrete classification

Stratum	No. tests	DS	ACEC
Kempton Park Gravel Member	10	DS-2	AC-2

6. Geotechnical assessment

6.1 Geotechnical categorization of the proposed development

Eurocode 7, Section 2 advocates the use of geotechnical categorization of the proposed structures to establish the design requirements.

The site is understood to have a proposed development to comprise low rise (2 to 3 storey) residential dwellings, with associated gardens, Public Open Space and infrastructure. However Hydrock has not been provided a masterplan or proposed development plan.

Based on the above, for the purposes of this investigation, the proposed structures have been classed as Geotechnical Category 1.

Following ground investigation and as part of the assessment provided in the following section, the preliminary geotechnical hazard identification undertaken in Section 3.3 has been updated.

Assessment has been undertaken in accordance with the general requirements of ICE/DETR Document 'Managing Geotechnical Risk' and the HE documents HD 41/15 and CD 622. The preliminary Geotechnical Risk Register following investigation is provided in Appendix H (Table J.3) and will need to be updated during future design works.

6.2 Characteristic design values

For design of Category 1 structures in accordance with BS EN ISO 1997-1 (EC 7), the geotechnical parameters given in Table 6.1 can be used for design.

These values have been determined from laboratory testing, *in situ* testing and by professional judgement using published data together with knowledge and experience of the ground conditions. Care should be exercised in using these assumed soil strength parameters for any purpose beyond the scope of this report because it may be that additional sampling and testing is required for certain purposes. The reader should refer to the original test results summarised in Section 5 and provided in Appendix D and Appendix E.

Table 6.1: Geotechnical parameters recommended for design of Geotechnical Category 1 Structures (EC7)

Parameter Stratum	Bulk unit weight kN/m ³	Effective angle of internal friction °	Effective cohesion kN/m ²	Undrained shear strength kN/m ²	Coefficient of compressibility m ² /MN	Modulus of subgrade reaction (IAN73/O6) MN/m ² /m
	γ^a	$\phi'^{b,c}$	c'^d	c_u^e	m_v^f	k^g
Kempton Park Gravel Member	20.8	21.4 - 34.2	5 - 20	55.4 - 122.6	-	8.1 - 76
Lambeth Group	22.8	21 - 28	6 - 20	74.5 - 149.5	0.63 - 13	-

Internal friction (ϕ') values for the cohesive in-situ material derived from BS 8004-2015, where ϕ_{cv}' is derived from plasticity index. The use of ϕ_{cv}' in the analysis is considered to provide a conservative estimate of ϕ' .

BS 8002:1994 Code of practice for Earth retaining structures, British Standards institution.
Laboratory data.

Parameter	Bulk unit weight kN/m ³	Effective angle of internal friction °	Effective cohesion kN/m ²	Undrained shear strength kN/m ²	Coefficient of compressibility m ² /MN	Modulus of subgrade reaction (IAN73/06) MN/m ² /m
Stratum	γ^a	ϕ'^{bc}	c'^d	c_u^e	m_v^f	k^g

Based upon the equilibrium long term CBR from DMRB IAN 73/06 Rev 1 Table 5.1.

6.3 Groundwork

6.3.1 Site preparation

The site is previously undeveloped and no buried obstructions were encountered by this investigation. The possibility of buried obstructions being encountered is low.

Topsoil should be removed from beneath all building and hardstanding areas.

6.3.2 Groundworks

Following breaking out of hardstanding and obstructions, excavation of shallow soils should be readily undertaken by conventional plant and equipment. However, excavation through any buried intact rock quality strata may require heavy-duty excavation plant or the use of specialist breaking equipment.

Significant collapse of trial pit faces was noted during trial pit excavation. This was noted particularly in the Kempton Park Gravel Member and where groundwater ingress occurred. Collapses generally occurred in trial pits deeper than 1.5m depth.

Random and sudden falls should be expected from the faces of near vertically sided excavations put down at the site.

Temporary trench support, or battering of excavation sides, is recommended for all excavations that are to be left open for any length of time and will definitely be required where man entry is required. Particular attention should be paid to excavation at, or close to, site boundaries/adjoining existing roads/structures/buildings, where collapse of excavation faces could have a disproportionate effect.

A risk assessment of the stability of any open excavation should be undertaken by a competent person and appropriate measures adopted to ensure safe working practise in and around open excavations. Further guidance on responsibilities and requirements for working near, and in, excavations can be obtained from the Construction Design and Management Regulations (2015); Construction Information Sheet 47: Inspections and Reports (2005) and HSG47: Avoiding Danger from Underground Services.

To ensure no loads are imposed on the sides of the excavation, spoil should not be placed immediately adjacent to the excavation. Spoil should be placed a suitable distance from the side of the excavation (as assessed by a competent person).

Based on site observations, the rate of water ingress to the proposed excavations is likely to be slow to moderate. In these circumstances, groundwater control by sump pumping is likely to be sufficient.

However, it should be recognised that groundwater levels may vary from those at the time of the investigation, for example in response to seasonal fluctuations and the timing of construction may dictate the extent of groundwater control required.

Any water pumped from excavations may need to be passed via settlement tanks (to reduce suspended solids) before being discharged to the sewer. Discharge consents may also be required.

6.3.3 *Earthworks/reuse of site-won materials*

At this stage, Hydrock is not aware of proposals for earthworks at the site.

Should earthworks be required, supplementary earthworks testing and an earthworks Specification will be necessary to ensure the appropriate management and reuse of the existing soils.

If significant earthworks are required, the works may be Category 2 in accordance with BS EN ISO 1997-1 (EC 7) and further geotechnical design may be necessary. Once site proposals have been further defined more specific consideration will need to be given to the reuse of materials and reference should be made back to this office.

6.3.4 *Consolidation settlement from land raising*

It is understood that site levels are not currently proposed to be raised. A separate geotechnical design will be required to fully assess the impact of settlement and to design any ground improvement works. Site monitoring during the earthwork construction will be required to confirm the required settlements has been achieved.

6.4 Slope stability

There are no significant existing slopes on the site and, based on a review of proposed levels, no significant slopes are proposed, other than those to the attenuation basins, which are all less than 1:3 (vertical to horizontal). Therefore, Hydrock does not believe the existing or planned slopes will present a significant constraint to the development. However, the above preliminary conclusions should be reviewed as part of the separate geotechnical design.

6.5 Retaining walls

With regard to the proposed retaining walls, Hydrock understand there are currently no design masterplans for the site and therefore no indication of retaining walls.

6.6 Roads and pavements

Based on the test results and subject to *in situ* testing during construction, it is considered likely that there is insufficient data to estimate an equilibrium CBR of 2.5% will be achievable over the majority of the site. Further CBR testing is required across the site.

Proof rolling of the formation level will be required and any loose or soft spots should be removed and replaced with an engineered fill, in accordance with a suitable Specification. The formation level will also need to be protected during inclement weather from deterioration; all slopes should be trimmed to falls to shed rain water and the surface sealed to limit infiltration.

Prior to the placement of the founding materials and the construction of the road pavement, the sub-formation and formation will need to be inspected and checked in accordance with a suitable specification to ensure the ground conditions are as expected. All testing should be carried out in accordance with DMRB IAN 73/06 to confirm that the ground conditions at time of construction are consistent with the previous design parameters.

Where the CBR is found to be less than 2.5%, the sub-grade may be unsuitable for both the trafficking of site plant and as support for a permanent foundation, without improvement works being undertaken. Improvement works should be carried out in accordance with DMRB IAN 73/06 Rev 1 Chapter 5. In summary, consideration may be given to the following potential remedial techniques:

- » excavation and re-engineering or replacement of weaker soils;
- » the inclusion of geosynthetic reinforcement within the unbound layers of the capping and sub-grade;
- » where cohesive soils are present and they are deemed suitable for treatment with hydraulic binders, to employ modification and/or stabilisation techniques on the formation; and
- » where granular soils are present, de-watering and re-engineering the formation.

6.7 Drainage

Indicative infiltration rates for the ground investigation are presented in Appendix E and are summarised in Table 5.4.

Soakaways are considered unsuitable for the site based on the low infiltration rates obtained from testing. However, the infiltration rates recorded may assist with attenuation as part of a Sustainable Urban Drainage System (SUDS).

6.8 Buried concrete

Based on guidelines provided in BRE Special Digest 1 (BRE 2005) and the information presented in Section 5.4.8 (Table 5.12):

- » The shallow soils and Kempton Park Gravel Member can be classified as Design Sulfate Class DS-2 and ACEC Class AC-2.
- » This equates to a Design Chemical Class¹ of:
 - » DC-2 for the shallow soils (Lambeth Group and River Terrace Deposits);

The designer should check and confirm the classification of concrete using the information presented in Appendix D and Appendix E during the design.

¹ The calculated ACEC class can be used in accordance with BS 8500-1+A2 (2019), Table A.9 to select the Designated Concrete (DC) class for an intended working life of 50 years. However, the designer is referred to BS 8500-1+A2 (2019), for full details and notes to Table A.9, including any Additional Protective Measures (APMs).

7. Geo-environmental assessment

7.1 Updated conceptual model

7.1.1 Updated ground model

The initial conceptual site model developed from the desk study and field reconnaissance survey Section 3 has been updated using the findings of the ground investigation and is presented in Section 5. This CSM is the basis for the geo-environmental assessment presented in this section.

7.1.2 Updated exposure model

Following the ground investigation, the plausible contaminant sources, receptors and pathways identified in the preliminary geo-environmental exposure model Section 3 have been updated or confirmed as follows.

7.1.2.1 Sources

The following potential sources have been removed from the exposure model due to chemical testing indicating the concentrations of relevant elements and compounds to be below GAC.

- » Made Ground or waste, associated with historical farming activities, possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials, PAH and petroleum hydrocarbons (S01).
- » Naturally occurring elevated concentrations of metal (arsenic and vanadium) within soils (S02).
- » Leachate from quarry backfill, associated with the former gravel pit located 100m from the eastern boundary of the site, possibly including metals, metalloids, asbestos, PAH and petroleum hydrocarbons (S03).
- » Ground gases (carbon dioxide and methane) from organic materials in the backfill to the former quarry, now filled, located 100m east of the site (S04).
- » Leachate and ground gas from the former landfill 50m west of the site (S05).

7.1.2.2 Receptors

No potential receptors have been removed from, or added to, the exposure model.

7.1.2.3 Pathways

No pathways have been removed from, or added to, the exposure model.

Using the updated ground model and updated exposure model, generic risk assessment is undertaken as presented below.

7.2 Risk assessment approach

Using the updated CSM, a Tier 2 generic quantitative risk assessment (GQRA) for identified receptors based on all media sampled has been undertaken in accordance with the principles of LCRM.

Firstly, the risks associated with the identified potential contaminant linkages have been estimated using standardised methods (typically involving comparison of site data with published 'screening values'). Secondly, where screening values are exceeded, the result has been evaluated in an authoritative review of the findings with other pertinent information to determine whether or not the exceedance is or is not acceptable in the site-specific circumstances.

The data sets used in the assessment comprise the analytical results obtained by Hydrock as listed in Section 5.

7.3 Human health risk assessment

7.3.1 Soils Assessment

7.3.1.1 Generic Assessment Criteria

The soil screening values used are generic assessment criteria (GAC) (i.e. derived in accordance with EA CLEA guidance (2009) using the updated exposure model detailed in Defra SP1010 (2014), with the exception of published C4SLs. The term 'GAC' used in this report is inclusive of all generic soil screening values.

Based on the proposed development, generic assessment criteria (GAC) based on a default residential with homegrown produce CLEA land use scenarios have been adopted.

GAC are selected based on the following hierarchy:

- » Category 4 Screening Levels (C4SL), where available.
- » SoBRA Acute GAC for free cyanide, as acute dose toxicity is the primary risk driver.
- » Hydrock GAC, derived by Hydrock as detailed in **Appendix G**.

The results of the assessment are presented in **Appendix G**.

7.3.1.2 Data sets

The data set(s) used in this report is based on the conceptual site model and the proposed development, and is taken to be the entire area of the site with the data separated into, Topsoil and natural soils.

GAC based on a soil organic matter (SOM) of 1% have been adopted for all soils based on laboratory results. Assessment sheets are presented in Appendix G

7.3.1.3 Assessment Results

Results indicate that all chemicals of potential concern (CoPC) are below the relevant GAC, therefore the contaminant linkage is incomplete.

All samples submitted for analysis of petroleum hydrocarbons (PHCs), SVOCs, VOCs and PCBs reported concentrations below the GAC and/or laboratory limit of detection.

The phrase 'further assessment required' is used to denote soil concentrations that exceed a GAC. This does not necessarily mean that the soil is 'contaminated' or not otherwise suitable for use. The assessment and any mitigation required are to ensure the site does not pose an 'unacceptable risk' as defined under Planning and Part 2A of EPA 1990.

7.3.2 Asbestos

There is no visual evidence of Asbestos Containing Materials (ACM) in all exploratory hole locations, or laboratory testing of samples across the site.

7.3.3 Risk evaluation

The screening exercise has identified no substances in natural soils at concentrations above the GAC and therefore no further assessment is required at this time.

7.4 Phytotoxicity risk assessment

7.4.1 Risk estimation

Priority phytotoxic chemical concentrations have been screened against published values to determine the likely risk to plant growth (phytotoxic GAC). Phytotoxic GAC based on a pH of 7% have been adopted for all soils based on laboratory results.

As with human health, individual sample test results are compared directly with the phytotoxic GAC.

Results indicate that all CoPC are below the relevant phytotoxic GAC, therefore the contaminant linkage is incomplete.

7.4.2 Risk evaluation

The screening exercise has identified no substances in natural soils at concentrations above the GAC. Therefore no further assessment is required at this time.

7.5 Pollution of controlled waters risk assessment

7.5.1 Risk estimation

The risks to groundwater and surface water from contaminants on site have been assessed in accordance with the Environment Agency (2006) Remedial Targets Methodology (RTM).

Site contaminant loadings are compared with relevant screening values (Water Quality Targets (WQTs), which are linked to the CSM.

Acceptable WQT are defined for protection of human health (based on Drinking Water Standards (DWS)) and for protection of aquatic ecosystems (Environmental Quality Standards (EQS)).

As related specifically to this site, the data are compared with criteria selected in accordance with the methodology presented in Appendix G. This methodology involves selecting which of several alternative risk scenarios apply in this case. The assessment is presented in Section 7.5.2 below.

7.5.2 Risk evaluation

Groundwater testing was undertaken in all WS boreholes, with the exception of WS05. All results from the groundwater testing yielded results that were below laboratory equipment detection limits. Therefore, no further assessment is required.

7.6 Ground gases risk assessment

No viable source of ground gas has been detected on site, and therefore in accordance with CL:AIRE RB17 (Card et al 2012) no further action is required in relation to potential on-site sources of ground gas.

A former Landfill, located 50m west of the site, was active from 1998 to 2001. The management status of the landfill (in terms of closure and permit surrender and any associated active or passive gas management) is not currently known. The KPGM provides a permeable stratum through which ground gas could migrate, but there is no evidence of this from the site gas monitoring (notwithstanding the limitations of that monitoring as a result of the high water table). The low permeability of the LG does not provide a preferential pathway for off-site gas migration.

It is not currently known what gas protection measures (if any) were required for the housing development over the former gravel pit to the east of the site, and what that could infer in relation to the risk of off-site gas migration from that gravel pit infill.

7.6.1 Data

Hydrock has undertaken 6 rounds of monitoring, including during periods of falling atmospheric pressure.

On a small number of occasions, high gas flow rates have been measured immediately on opening the gas taps (up to 111.0 L/hr), with the high initial flow rates, dropping below 1.0 L/hr within 5 seconds. The incidence of initial high flow rates corresponds with a rise in the groundwater level between monitoring rounds and are likely to be caused by this change. The rise in the water level in the standpipe will compress the gas in the standpipe head-space, resulting in a short, high-pressure release on opening the monitoring tap. It was generally noted that the high initial flow rates only occurred when the water level rose above the response zone of the pipe, presumably because the gas would otherwise be able to disperse via the slotted pipe. As such, the temporary initial high gas flow rates are discounted as not being typical of actual gas emission rates.

7.6.2 Assessment

The risks associated with the ground gases methane (CH₄) and carbon dioxide (CO₂) have been assessed using BS 8485:2015 +A1:2019.

There is an alternative assessment method described by the NHBC (2007) which is referenced in BS8485 as good practice guidance and is directly relevant to residential houses built under the NHBC scheme with beam and block construction ground floors. As this building construction design is not applicable for the planned development being considered in this report the risk assessment has been carried out using the characteristic situation approach detailed in BS 8485.

The assessment guidelines set out in Table 2 of BS 8485 are based on interpretation of the gas concentrations and the gas flow rates. The quantitative assessment has been carried out by comparing the individual gas concentrations and gas screening values (GSV²) in Appendix D with the published CS thresholds (BS 8485 Table 2), in addition to a worst-case GSV assessment in accordance with section 6.3.7 of BS 8485. The assessment is summarised in Table 7.1 and the full assessment is presented in Appendix F. High initial flow rates observed during the monitoring are not deemed to be representative of actual

Table 7.1: Ground gas risk assessment

	Min	Max	Typical ⁽ⁱ⁾	Comment
Carbon Dioxide GSV (L/hr)	0	3.3	<0.07	CS1
Methane GSV (L/hr)	0	0	<0.07	CS1

⁽ⁱ⁾ Hydrock assume that values are considered to be atypical if 95% or more of the remaining data are less than the value under consideration

For the purposes of the calculation, where the recorded gas flow rate is below the manufacturer's limit of detection for the instrument used, the detection limit has been adopted for the gas flow rate.

As indicated in Table 7.1, the computed GSV for carbon dioxide and methane indicates CS1 conditions and methane and carbon dioxide at concentrations are 'typically' below 1% and 5% respectively. As such, the site is provisionally classified as Characteristic Situation 1.

Based on the data to date no mitigation measures are required.

² Note: GSV is synonymous with 'site characteristic hazardous gas flow rate' (Q_{hgs}) of BS 8485:2015 +A1:2019 Table.

7.6.3 Off-site risks from carbon dioxide and methane

The National Planning Policy Framework requires that a developed site should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990. This position includes a consideration of the potential for off-site migration of ground gases that may impact on adjacent properties.

Consequently, it may be necessary to consider the use of measures to protect adjacent, off-site receptors. In this case a former gravel extraction pit lies 100m east of the site. However, this area has since been occupied by low rise residences with no known history of increased risk carbon dioxide and methane. Furthermore the testing of groundwater has shown absence of dissolved methane (all reading below limit of detection) within groundwater and therefore the risk to the site from the neighbouring former quarry and former landfill appears to be negligible.

7.7 Construction materials risk assessment

7.7.1 Water pipelines

A formal water pipe investigation and risk assessment is beyond the scope of this report. However, the findings of this investigation have been compared to the threshold values in Water UK HBF (2014), Table 1 as far as is practicable.

The site is previously undeveloped and the preliminary risk assessment and investigation has indicated no plausible contaminant sources. It is envisaged that standard pipework will be suitable for the site. However, confirmation should be sought from the water supply company at the earliest opportunity.

7.7.2 Other construction materials

Plastic pipes for drains and sewers are manufactured from unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) or polyethylene (PE). These materials may be affected by the presence of organic compounds in the soil.

In accordance with the British Plastics Federation Guidance (August, 2018), as the concentrations of PAH, and BTEX are below 100mg/kg and the concentrations of petroleum hydrocarbons (TPH) are below 200 mg/kg, PVC-U, PP or PE pipework is considered suitable.

The implications for buried concrete are discussed in Section 6.8.

7.8 Findings of the generic contamination risk assessments

The potential sources, pathways and receptors identified in the desk study (Section 2) have been investigated (Sections 5 and 6) and assessed (Sections 7.2 to 7.7). A Source-Pathway-Receptor linkage assessment has been undertaken and is presented in Appendix I (Table K.2).

There are no Source-Pathway-Receptor contaminant linkages which require mitigation, however, further information on the nature of the wastes accepted at the landfill 50m to the west of the site, and the design and regulatory status of the landfill is advised.

8. Waste and materials management

8.1 Introduction

The Waste Framework Directive (WFD) (2009/98/EC) defines waste as *'any substance which the holder discards or intends to discard.'* In a geo-environmental context, the waste is most often 'soil' and the two main scenarios are offsite disposal of the material as a waste and/or reuse of the material on site. For cost and sustainability reasons, reuse is preferred to off-site disposal.

Section 8.2 below describes the key issues relating to off-site disposal to landfill and Section 8.3 considers requirements relating to reuse of soils and materials management.

8.2 Waste disposal

8.2.1 Principles

Based on the WFD, any material excavated on site may be classified as waste and it is the responsibility of the producer of a material to determine whether or not it is waste. Where off-site disposal is undertaken, the following guidance applies.

Classification is a staged process:

- » A hazardous waste is defined under the WFD as one which possesses one or more of fifteen defined hazardous properties. If a waste is not defined as hazardous, then it is non-hazardous.
- » Where the materials are soil, it is then be assigned using the 'List of Waste Codes', which classifies the material as either:
 - » hazardous (17-05-03), which is defined as *"soil and stones containing hazardous substances"*; or
 - » non-hazardous (17-05-04), which is defined as *"soil and stones other than those mentioned in 17-05-03"*.
 - » Hydrock utilise the proprietary assessment tool, HazWasteOnline™ to undertake this assessment.
- » Waste Acceptance Criteria (WAC) testing is then undertaken if required, and are only applicable following classification of the waste, and only where the waste is destined for disposal to landfill. The WAC are both qualitative and quantitative. The WAC and the associated laboratory analyses (leaching tests) are not suitable for use in the determination of whether a waste is hazardous or non-hazardous.

It should be noted that some non-hazardous wastes may be suitable for disposal at an inert landfill as non-hazardous waste, subject to meeting the appropriate waste acceptance criteria.

It should be noted that classification must be undertaken on the waste produced, by the waste producer. Necessary sampling frequency to adequately characterise a soil population is defined within WM3.

Further discussion with regards to the characterisation process for different scenarios and waste types is provided below.

Topsoil and Peat

Topsoil and peat are biodegradable, therefore if they are surplus to requirements and cannot be re-used in accordance with a Materials Management Plan, they cannot be classified as inert. As such, topsoil and peat need to be classified by a staged assessment and sampling process and would either be classified as hazardous or non-hazardous, depending upon the results of the assessment.

Greenfield sites

Waste from completely greenfield sites may be accepted at a landfill as inert waste if it meets the requirements of paragraph 10 (wastes acceptable without testing at landfills for inert waste) of the Landfill (England and Wales) (Amendment) Regulations (2005) ('the Regulations') can be met. Paragraph 10 of the Regulations states, "*soils may be able to be classified as inert waste without testing, if:*

- » *they are single stream waste of a single waste type;*
- » *there is no suspicion of contamination and they do not contain other material or substances such as metals, asbestos, plastics, chemicals, etc...."*

As such, where the site is greenfield and the waste producer is confident about the quality of a soil (i.e. naturally occurring and uncontaminated), further sampling and laboratory testing is not necessary for the Basic Characterisation and this can be undertaken on qualitative Waste Acceptance Criteria testing.

In this instance the waste producer can characterise the waste based on visual assessment and written description of the waste in addition to supporting evidence such as a desk study assessment of the greenfield status. However, it should be noted this characterisation is subject to agreement by the landfill operator who may require testing to be undertaken to confirm classification.

Contaminated or potentially contaminated sites

If the site is brownfield, contaminated or potentially contaminated, the waste must undergo an initial waste classification exercise using background information on the source and origin of the waste and assessment of chemical test data in accordance with Environment Agency Technical Guidance WM3.

If following the initial waste classification exercise, the soils are acceptable for disposal to a non-hazardous landfill, further qualitative Waste Acceptance Criteria (WAC) testing is not required.

However, if soils are potentially able to be disposed to an inert landfill as non-hazardous waste, or require testing to determine if they can be disposed of to a stable non-reactive hazardous or hazardous class of landfill, the next stage of assessment is to undertake qualitative WAC testing. This will determine the Basic Characterisation and the landfill category at which the soils can be accepted.

Hazardous material must be subjected to WAC testing to determine whether it requires treatment before it can be accepted at the hazardous landfill, while non-hazardous material can be tested to determine whether it may be suitable for placement in an inert landfill.

8.2.2 *HazWasteOnline™ assessment*

As the site is greenfield, HazWasteOnline™ assessment is not required and as such has not been undertaken at this stage. Whilst unlikely, if requested, assessment may be required during the Basic Characterisation process required by the Landfill operator for the excavated material prior to disposal.

8.2.3 *WAC testing*

As the site is greenfield, quantitative WAC testing is not required and as such has not been undertaken at this stage. Whilst unlikely, if requested, WAC testing may be required during the Basic Characterisation process required by the Landfill operator for the excavated material prior to disposal.

8.2.4 *Preliminary waste disposal options*

A preliminary assessment indicates that based on the greenfield status of the site (as proven by the desk study assessment and a visual assessment of the soils), as long as no unexpected contamination is encountered and materials with high organic matter are not due for disposal (e.g. topsoil or peat), the natural subsoils would likely be disposed of at an 'inert' landfill.

It should be noted that the waste producer will need to characterise the waste to be disposed (following excavation) based on visual assessment and written description of the waste.

8.2.5 *General waste comments*

It should be noted that:

- » It is the waste producer's responsibility to segregate the waste at source and waste producers must not mix waste materials/streams or dilute hazardous components, for example by mixing with less or non-hazardous waste on site to meet WAC limit values.
- » The above preliminary assessment has been made on the basis of the soils tested as part of the ground investigation. However, the formal classification of waste can only be undertaken on the material to be disposed of, and by the waste producer and the receiving landfill as license conditions vary from landfill to landfill.
- » Basic Characterisation should be undertaken in accordance with Environment Agency guidance by the waste producer. Hydrock can assist if required and this report will assist the characterisation. However, Basic Characterisation does not form part of the current commission and would require further assessment and testing on the wastes actually to be disposed.
- » Once the waste producer has undertaken an initial Basic Characterisation on each waste stream, they can manage the soils as part of the on-site processing programme (for example, stockpiling, treatment, screening and separation). The waste producer and landfill operator will then need to agree the suite of compliance testing for regularly generated waste to demonstrate compliance with the initial Basic Characterisation prior to disposal.
- » At the time of disposal, additional testing on the excavated soils to be disposed of, will likely be necessary.
- » Non-hazardous and hazardous soils require pre-treatment (separation, sorting and screening) prior to disposal.
- » The costs for disposal of non-hazardous and hazardous soils are significant compared to disposal of inert material.
- » In addition to disposal costs, landfill tax will be applicable. Non-hazardous and hazardous waste will generally be subject to the Standard Rate Landfill Tax. Inert or inactive waste will generally be subject to the Lower Rate Landfill Tax. The landfill tax value changes each April

and can be found at <https://www.gov.uk/government/publications/rates-and-allowances-landfill-tax/landfill-tax-rates-from-1-april-2013>.

- » Before a waste producer can move waste to a landfill site for disposal, they need to check the landfill site has the appropriate permit and must have completed the following³:
 - » Duty of care transfer note / Hazardous Waste consignment note, including comment as to if pre-treatment has been undertaken; and
 - » Basic Characterisation of the waste, to include: description of the waste; waste code (using list of wastes); composition of the waste (by testing, if necessary) and; WAC testing (if required).

8.3 Materials management

8.3.1 Introduction

Soils that are to remain on site, should be managed and reused in accordance with a Materials Management Plan (MMP), prepared in accordance with 'The Definition of Waste: Development Industry Code of Practice', Version 2 (CL:AIRE), known as the DoWCoP. Where all aspects of the DoWCoP are followed the soils are considered not to be waste, because they were never discarded in the first place.

Version 2 of the DoWCoP clearly sets out the principles and an outline of the requirements of a MMP. The following compliance criteria must be seen to apply to the MMP for the site:

- Factor 1: Protection of human health and protection of the environment.
- Factor 2: Suitability for use, without further treatment.
- Factor 3: Certainty of Use.
- Factor 4: Fixed Quantity of Material.

The reuse of soils at sites should be considered during the planning and development design process so that compliance with issues such as fixed quantity and certainty of use clearly relate to agreed site levels. Suitability of Use is normally evident from the remediation strategy or the design statement, which form an integral part of a MMP. However, some soils may need to be tested post-excavation to prove they are suitable for use.

Once the MMP is finalised, it must be declared by a Qualified Person (QP). The Declaration is an on-line submission as part of which the QP is required to confirm that the declaration is being made before the relevant works have commenced (i.e. it is not a retrospective application).

Once all material movements have been completed in accordance with the MMP a verification report must be produced, kept for 2 years and provided to the EA on request.

It should be noted that failure to comply with the requirements of the DoWCoP when re-using materials has potentially significant consequences for the waste holder. The risk is that the reused materials are still regarded as a waste that has been illegally deposited. From 1 April 2018, the scope of Landfill Tax has been extended to sites operating without the appropriate environmental disposal permit, and operators of illegal waste sites will now be liable for Landfill Tax. Further information is available at: <https://www.gov.uk/government/publications/landfill-tax-disposals-not-made-at-landfill-sites/landfill-tax-disposals-not-made-at-landfill-sites>.

³ ENVIRONMENT AGENCY. November 2010. Guidance on waste acceptance procedures and criteria. Waste acceptance at landfills. The Environment Agency.

If soils are excavated and reused on sites (or moved to another site) without a MMP, exemption, or appropriate Permit in place, anyone who knowingly facilitates the disposal may be *'jointly and severally liable'* to any assessment of tax, fines or prosecution.

8.3.2 *Materials management scenarios*

The materials management scenarios present on site are discussed below.

It should be noted that more than one scenario may apply, dependent upon where the soils are proposed for reuse.

8.3.2.1 *Clean, naturally occurring materials – reused on the site of origin*

Where soils are naturally occurring, uncontaminated and are reused on the site they are excavated (i.e. greenfield site with documented site history, with no Made Ground), they will fall outside the Waste Framework Directive (WFD) (i.e. they will not be a waste when reused on the site of origin).

However, there needs to be certainty of that reuse, and evidence is necessary to support this strategy, for example through information provided during the planning process. The onus is on the developer to demonstrate that the materials are not a waste and will never become a waste. As such, a Materials Re-use Strategy is recommended to show certainty. Alternatively, if the volume of material is under 1,000 tonnes, then a U1 waste exemption may be applied for from the Environment Agency.

It may be noted that some 'clean naturally occurring materials' may still fail the 'suitable for use' test, for example, soils with a naturally high organic content may not be suitable for use because of their propensity to produce ground gases such as methane. Rules regarding other more unusual circumstances such as where natural soils contain an unacceptably high mineral content are described in the DoWCoP.

8.3.2.2 *Clean, naturally occurring materials – transferred to other sites*

Where soils are naturally occurring, uncontaminated and are transferred to other sites (i.e. direct transfer), they will not become waste as long as the transfer is undertaken in accordance with the DoWCoP. A MMP must be prepared for the receiving site and the materials movement must be noted in the MMP of the Donor site. This movement must have been declared to CL:AIRE prior to the works commencing.

8.3.2.3 *Geotechnical improvement requirements*

Construction activities carried out on uncontaminated soils solely for the purpose of improving geotechnical properties e.g. lime / cement modification, are not generally regarded as waste treatment operations and do not require a permit.

However, should processing be needed (such as screening, treatment or improvement), that would constitute a waste activity and require a mobile treatment permit. This may be as simple as removing oversize material with an excavator bucket, to using a riddle bucket to remove hardcore to full mechanical screening.

9. Uncertainties and limitations

9.1 General comments

Hydrock Consultants Limited (Hydrock) has prepared this report in accordance with the instructions of Mactaggart & Mickel (the Client), by e-mail dated 11th of November 2022 under the terms of appointment for Hydrock, for the sole and specific use of the Client and parties commissioned by them to undertake work where reliance is placed on this report. Any third parties who use the information contained herein do so at their own risk. Hydrock shall not be responsible for any use of the report or its contents for any purpose other than that for which it was prepared or for use of the report by any parties not defined in Hydrock's appointment.

This report details the findings of work carried out in December 2022. The report has been prepared by Hydrock on the basis of available information obtained during the study period. Although every reasonable effort has been made to gather all relevant information, not all potential environmental constraints or liabilities associated with the site may have been revealed.

Hydrock has used reasonable skill, care and diligence in the design of the investigation of the site and in its interpretation of the information obtained. The inherent variation of ground conditions allows only definition of the actual conditions at the locations and depths of trial pits and boreholes at the time of the investigation. At intermediate locations, conditions can only be inferred.

Groundwater data are only representative of the dates on which they were obtained and both levels and quality may vary.

Unless otherwise stated, the recommendations in this report assume that ground levels will remain as existing. If there is to be any re-profiling (e.g. to create development platforms or for flood alleviation) then the recommendations may not apply.

Information provided by third parties has been used in good faith and is taken at face value; however, Hydrock cannot guarantee its accuracy or completeness.

Where any existing reports prepared by others have been provided by the Client, it is assumed that these have been either commissioned by the Client, or can be assigned to the Client, and can be relied upon by Hydrock. Should this not be the case Hydrock should be informed immediately as additional work may be required. Hydrock is not responsible for any factual errors or omissions in the supplied data, or for the opinions and recommendations of others. It is possible that the conditions described may have since changed through natural processes or later activities.

The work has been carried out in general accordance with recognised best practice. Unless otherwise stated, no assessment has been made for the presence of radioactive substances or unexploded ordnance. Where the phrase 'suitable for use' is used in this report, it is in keeping with the terminology used in planning control and does not imply any specific warranty or guarantee offered by Hydrock.

The chemical analyses reported were scheduled for the purposes of risk assessment with respect to human health, plant life and controlled waters as discussed in the report. Whilst the results may be useful in applying the Hazardous Waste Assessment Methodology given in Environment Agency Technical Guidance WM3, they are not primarily intended for that purpose and additional analysis will be required at the time of disposal to fully classify waste. Discussion and comment with regards to waste classification are preliminary and do not form the requirements of 'Basic Characterisation' as required.

Assessment and testing for the presence of coal tar has only been completed at the locations of exploratory holes undertaken for risk assessment purposes. This investigation is not designed to provide a definitive assessment of the risk from coal tar, nor the waste classification for bituminous bound pavement arising at the site.

Unless otherwise stated, at the time of this investigation the future routes of water supply pipes had not been established. This investigation and sampling strategy may not be fully compliant with UKWIR recommendations. Consequently, a targeted investigation and specific sampling and chemical testing may be required at a later date once the routes of the supply pipes are known. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

Whilst the preliminary risk assessment process has identified potential risks to construction workers, consideration of occupational health and safety issues is beyond the scope of this report.

The non-specialist UXO screening has been undertaken for the purposes of ground investigation only (i.e. low risk activity in accordance with CIRIA Report C681). Further assessment should be undertaken with regards to other higher risk activities e.g. construction.

Please note that notwithstanding any site observations concerning the presence or otherwise of archaeological sites, asbestos-containing materials or invasive weeds, this report does not constitute a formal survey of these potential constraints and specialist advice should be sought.

Any site boundary line depicted on plans does not imply legal ownership of land.

10. Recommendations for further work

Following the ground investigation works undertaken to date, the following further works will be required:

- » supplementary ground investigation to further indicate CBR values on site for pavement design.
- » discussion and agreement with utility providers regarding the materials suitable for pipework;
- » further testing of groundwater to confirm no presence of contaminants or leachates
- » discussions with regulatory bodies and the warranty provider regarding the conclusions of this report;
- » assessment of tree influence on foundations and design of foundations;
- » discussions with Vibro-stone Column Contractors regarding the viability of, and potential improvement by, VSCs;
- » discussions with piling Contractors regarding conclusions of this report and design of the piles;
- » provision of geotechnical design for the Category 1 structures (earthworks, retaining, floor slabs, foundations etc.);
- » production of a Remediation Strategy and Verification Plan (and agreement with the regulatory bodies and the warranty provider) if supplementary ground investigation finds evidence of leachate contamination;
- » production of a Materials Management Plan relating to reuse of soils at the site and import of soils to the site;
- » writing of a Materials Management Strategy relating to reuse of soils at the site;
- » remediation and mitigation works; and
- » verification of the earthworks, remediation and mitigation works.

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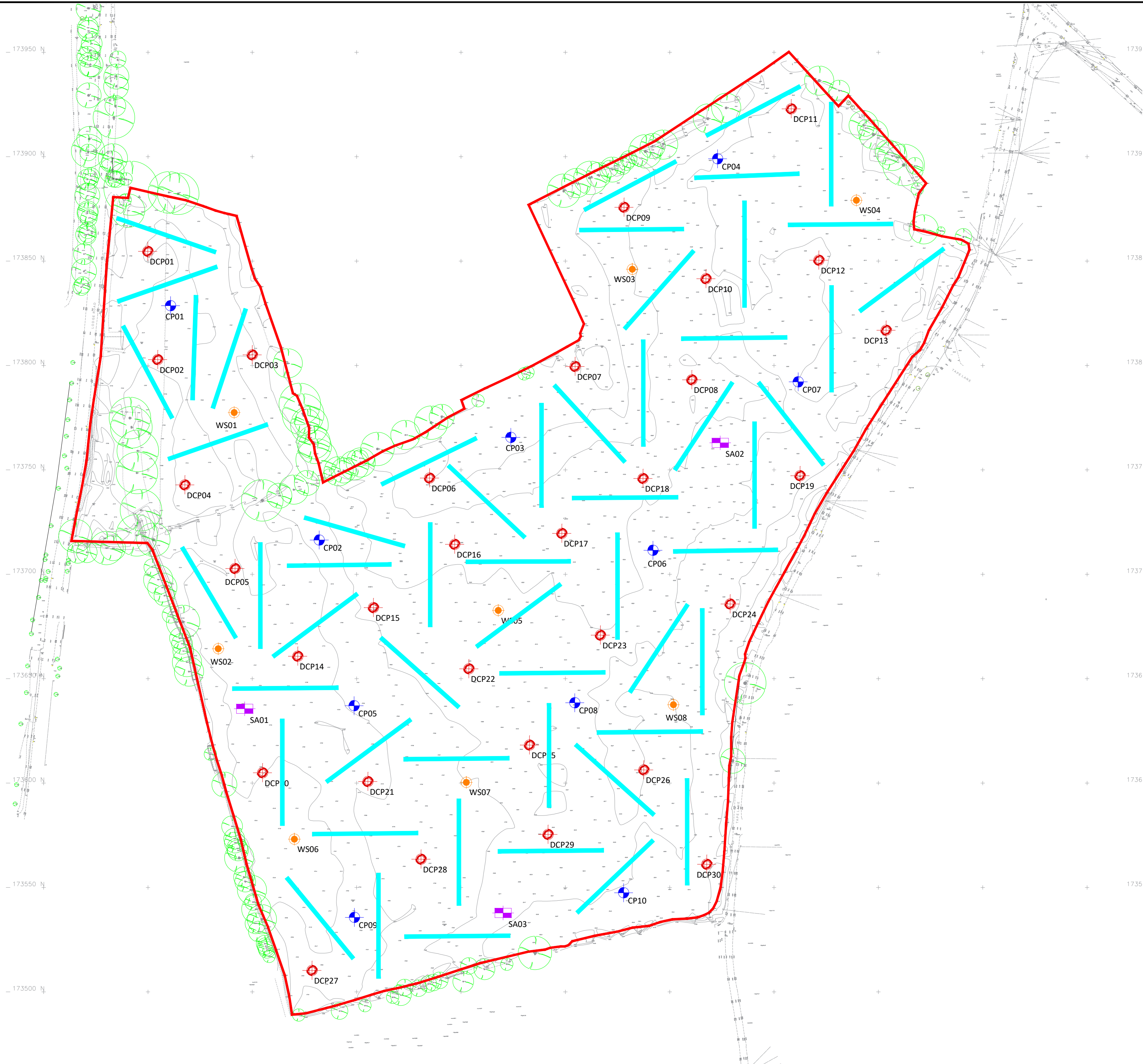
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Appendix A Drawings

 Cable Percussion Borehole

 DCP Test Location

 Soakaway Test Location

 WS## Dynamic Sampler Borehole

— Evaluation Trench

1. All dimensions are to be checked on site before the commencement of works. Any discrepancies are to be reported to the Architect & Engineer for verification. Figured dimensions only are to be taken from this drawing.

2. This drawing is to be read in conjunction with all relevant Engineers' and Service Engineers' drawings and specifications.

3. This drawing has been based on the following drawings and information:
Unreferenced drawing supplied by the Client.

P01	FIRST ISSUE					
	SD	18/10/22	KG	18/10/22	NM	18/10/22

REV.	REVISION NOTES/COMMENTS					
	DRAWN BY	DATE	CHECKED BY	DATE	APPROVED BY	DATE



CLIENT

Mactaggart & Mickel Homes England Ltd

PROJECT

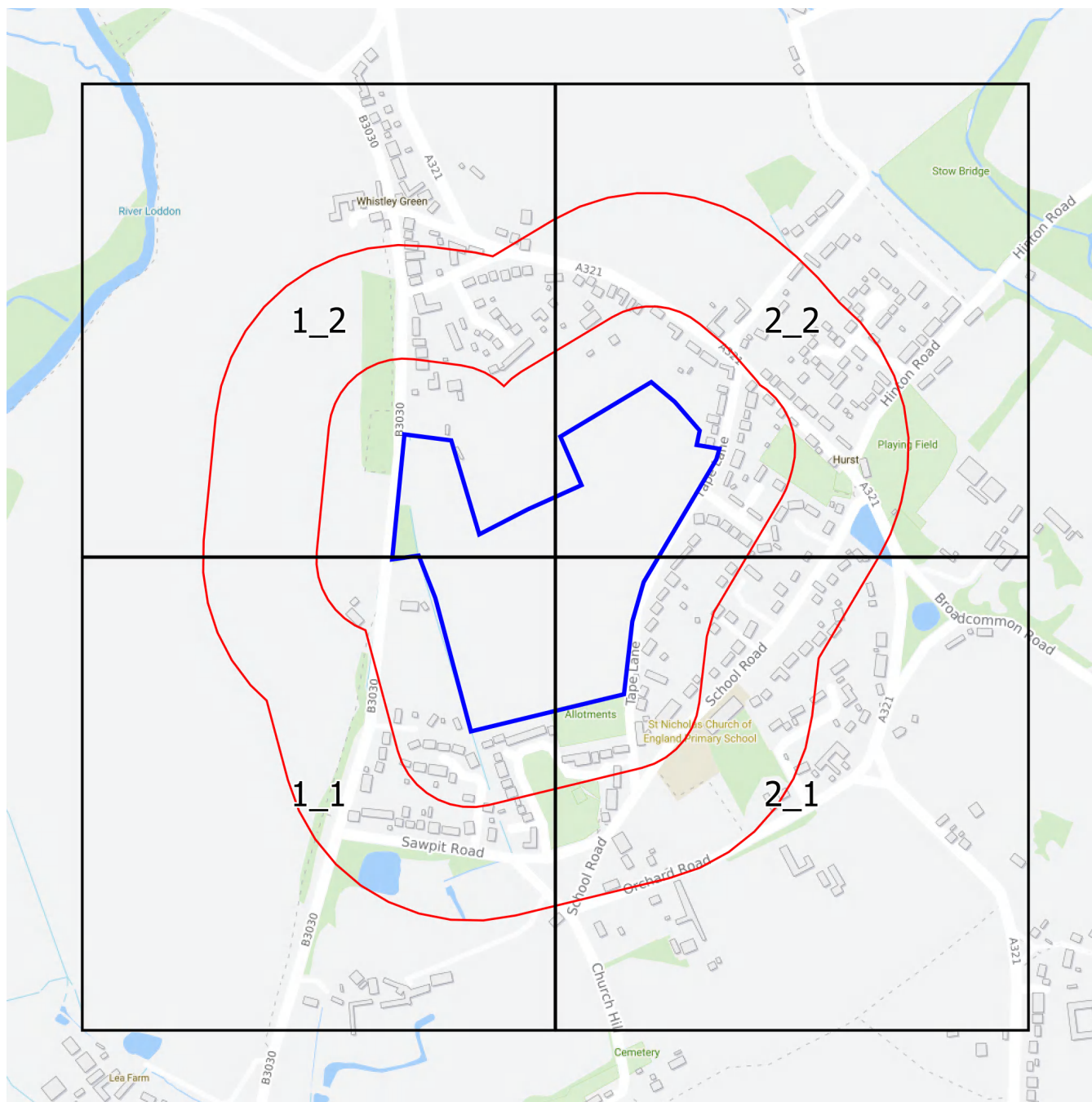
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Exploratory Hole Location Sketch Plan

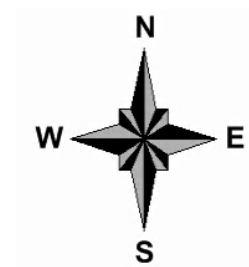
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Appendix B Historical ordnance survey maps



Groundsure
INSIGHTS

1:2,500 Scale Grid Index



Site Details:

479274, 173515

Client Ref: 26519-GELO
Report Ref: GS-9197659_LS_1_1
Grid Ref: 479167, 173405

Map Name: County Series

Map date: 1872

Scale: 1:2,500

Printed at: 1:2,500



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 Revised 1872
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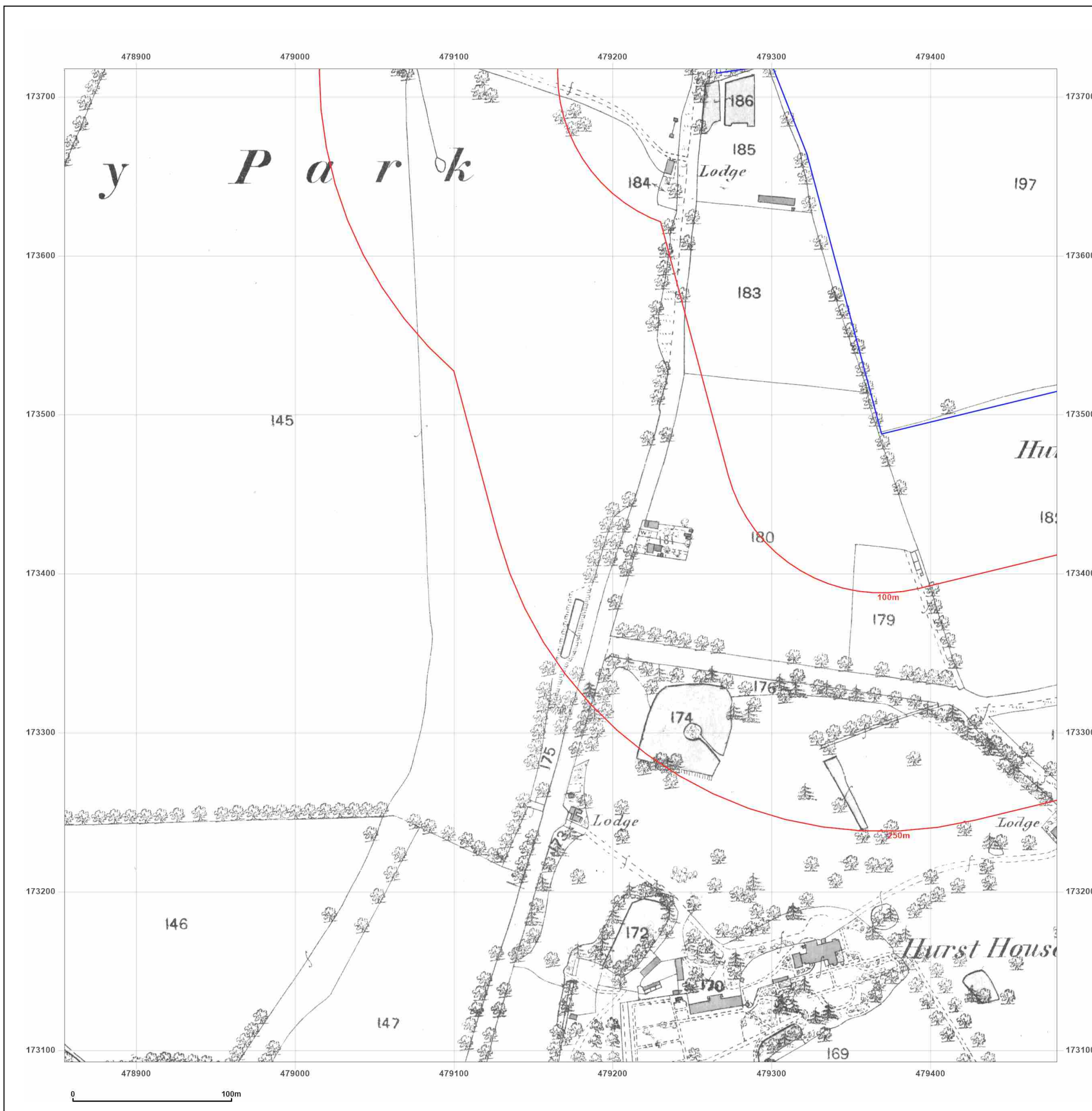


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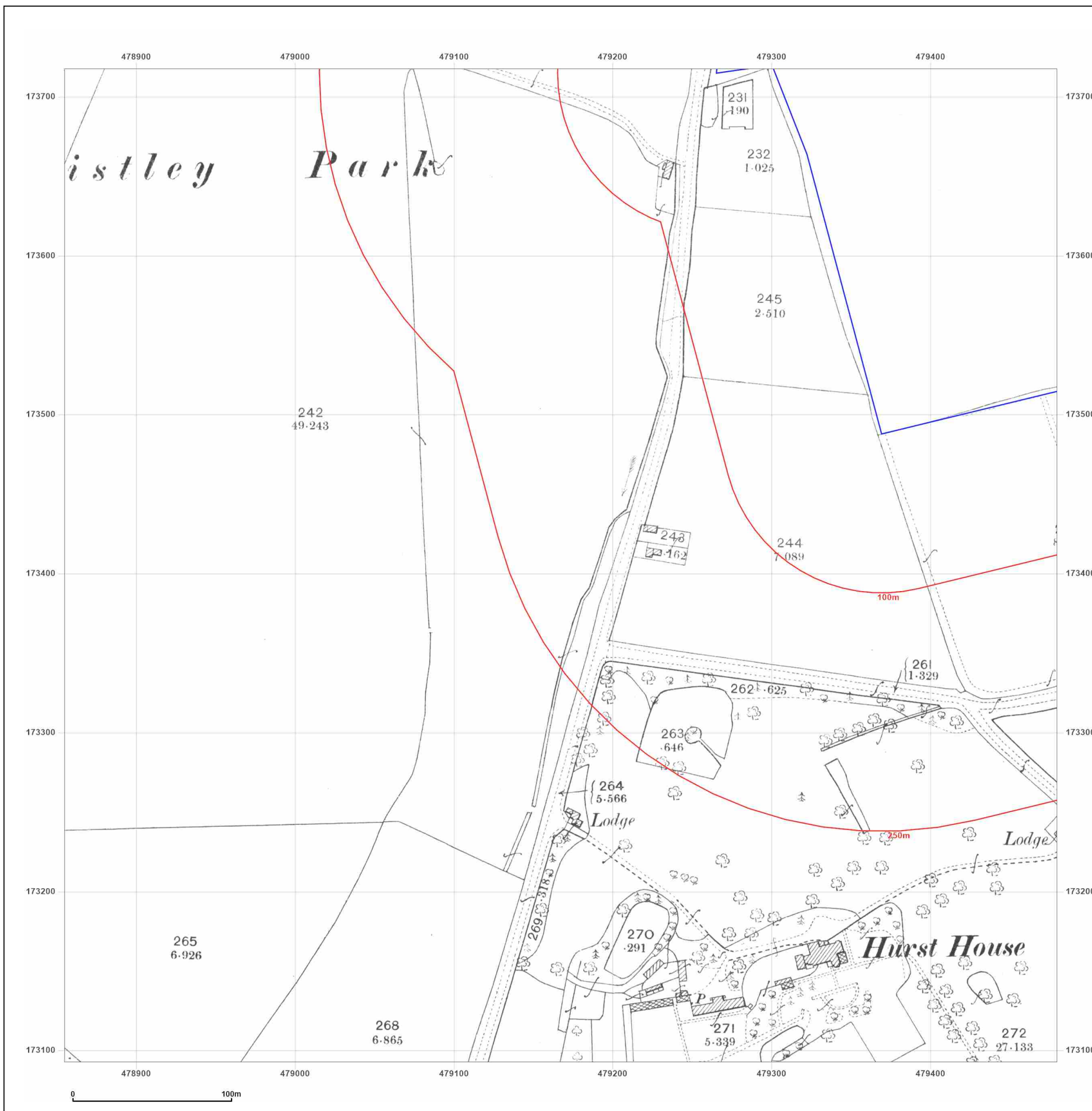


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Map Name: County Series

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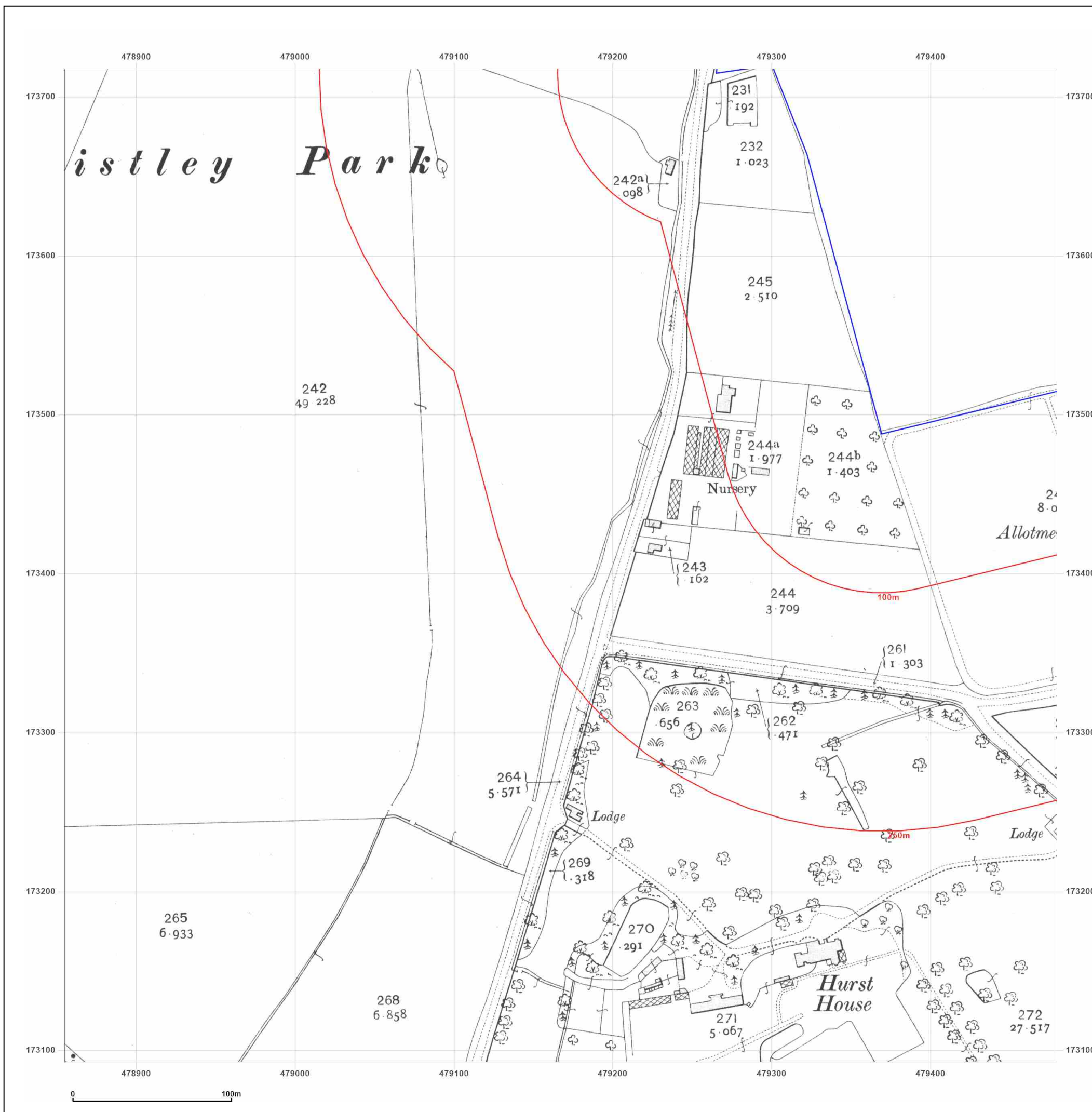


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Map Name: County Series

Map date: 1933

Scale: 1:2,500

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Map Name: National Grid

Map date: 1967

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Map Name: National Grid

Map date: 1967

Scale: 1:2,500

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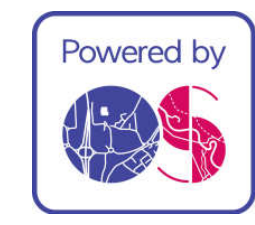
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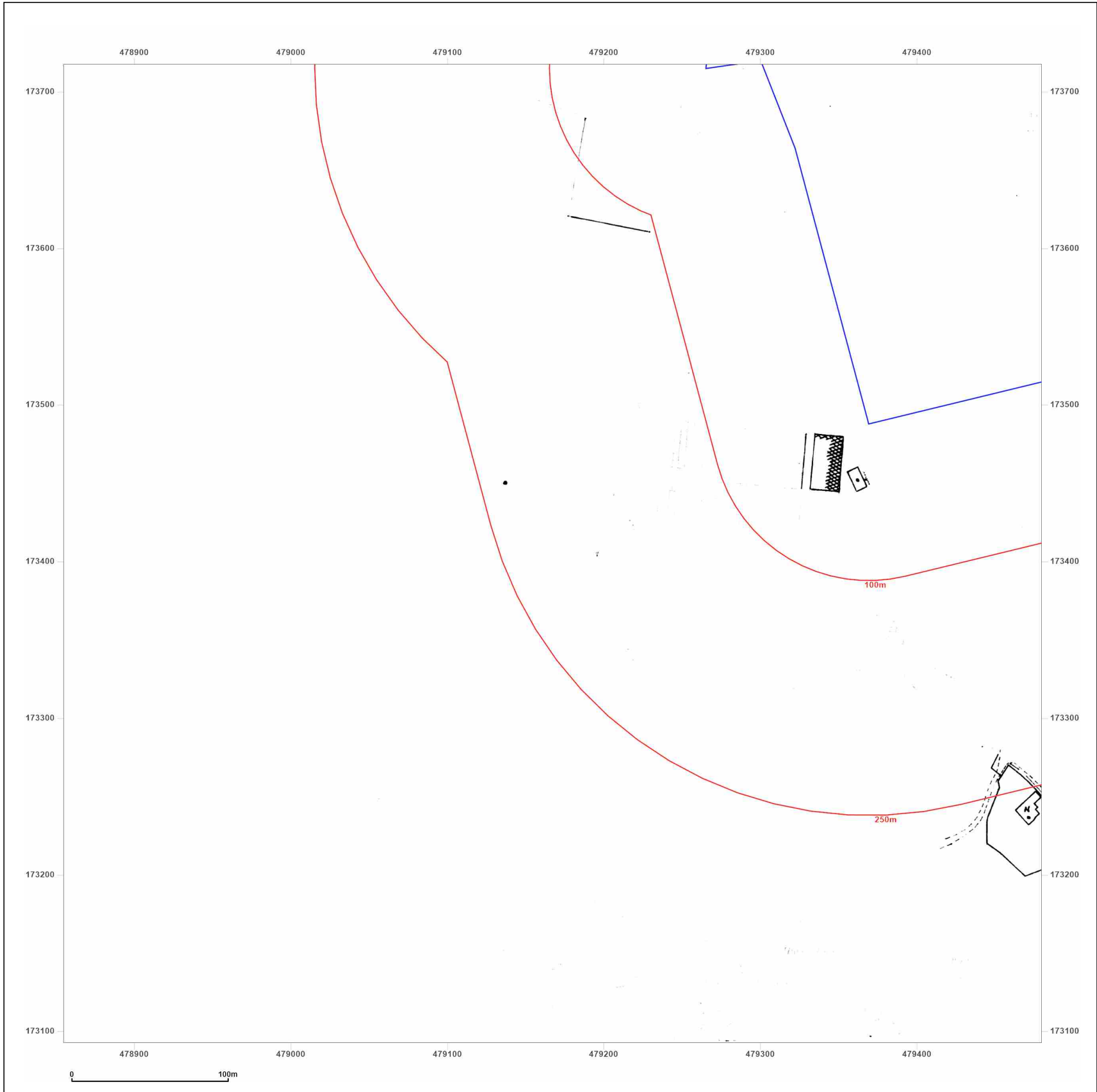
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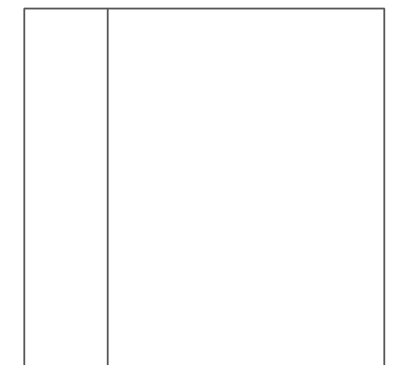
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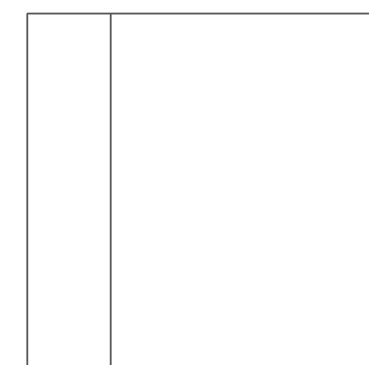
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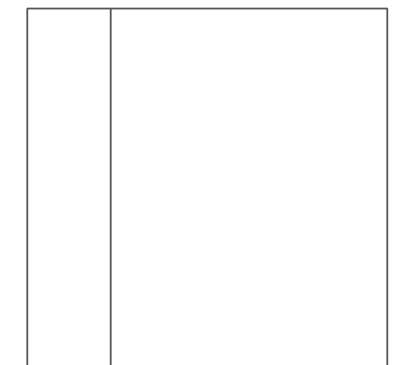
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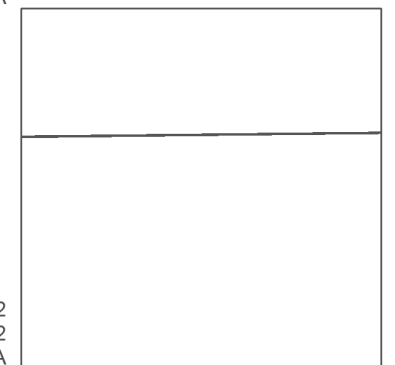
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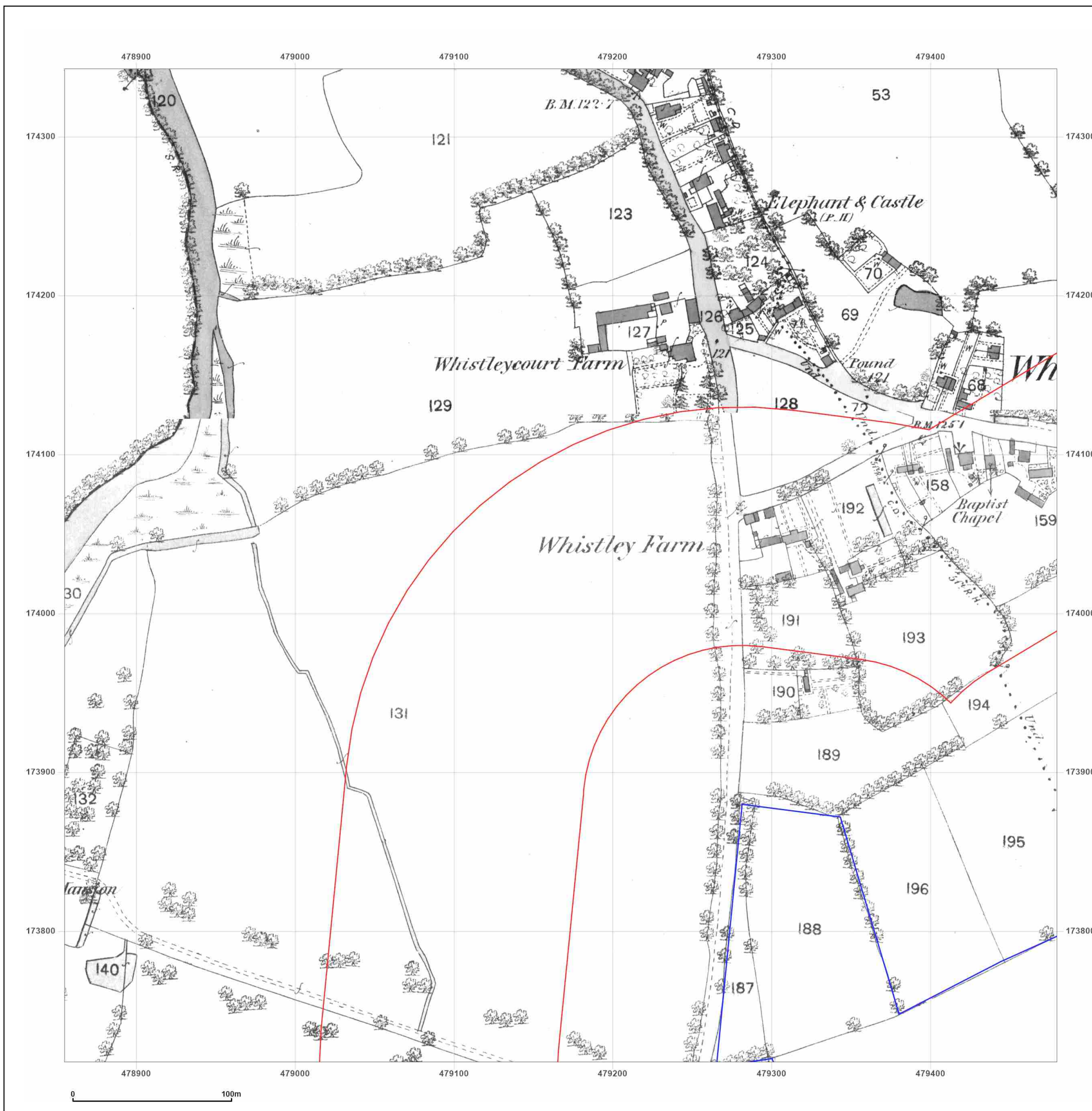


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Grid Ref: 479167, 174030

Map Name: County Series

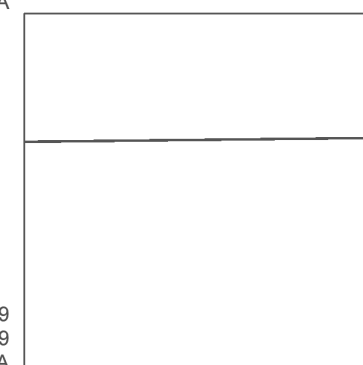
Map date: 1899

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1899
 Revised 1899
 Edition N/A
 Copyright N/A
 Levelled N/A



Surveyed 1899
 Revised 1899
 Edition N/A
 Copyright N/A
 Levelled N/A

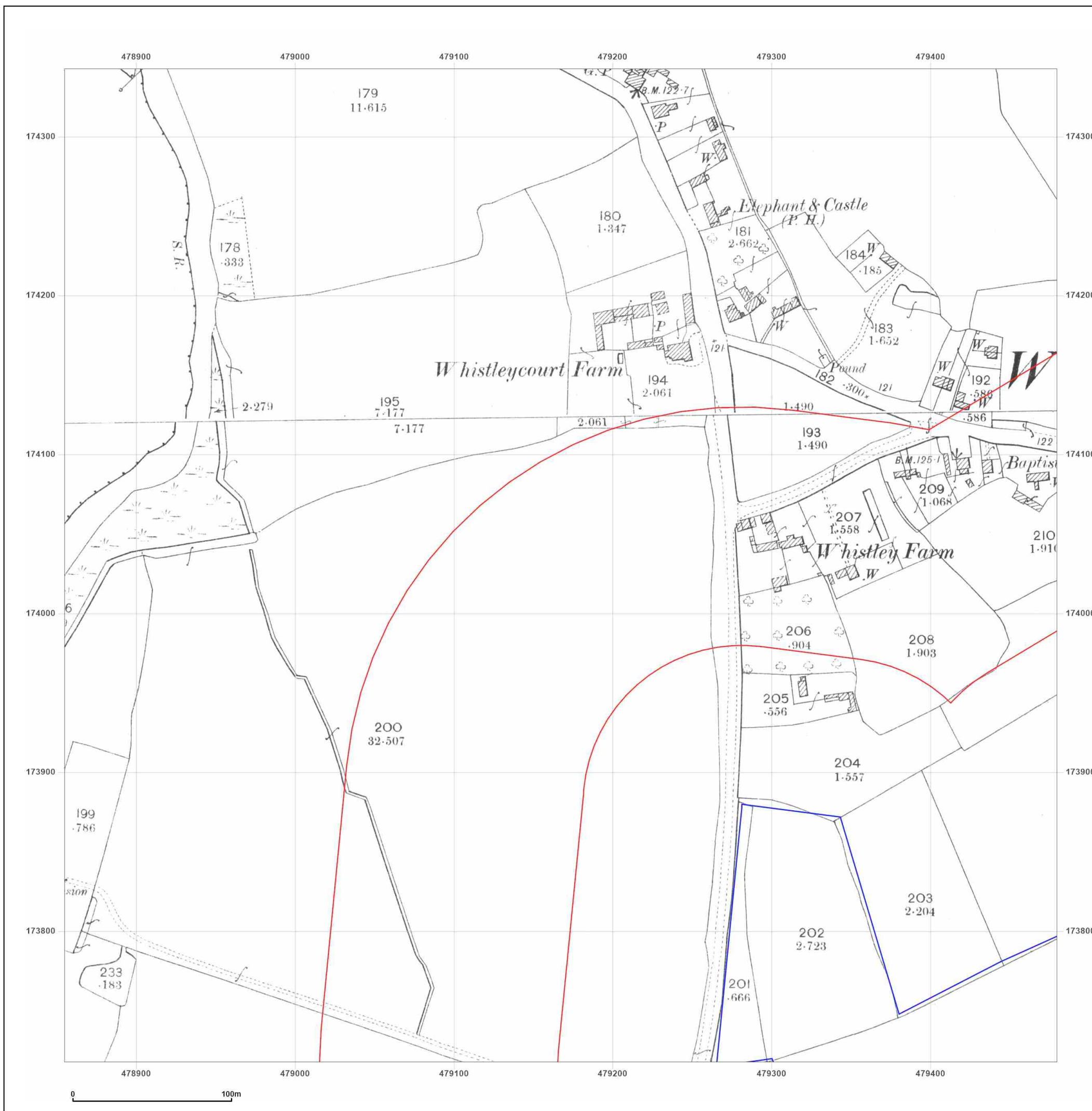


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Site Details:

479274, 173515

Client Ref: 26519-GELO
Report Ref: GS-9197659_LS_1_2
Grid Ref: 479167, 174030

Map Name: County Series

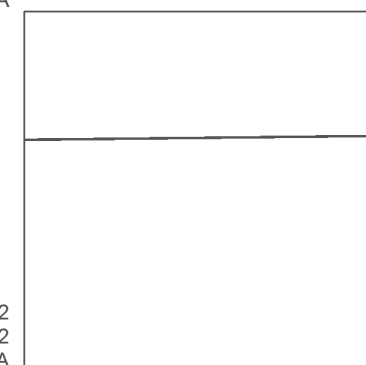
Map date: 1912

Scale: 1:2,500

Printed at: 1:2,500



Surveyed 1912
 Revised 1912
 Edition N/A
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Surveyed 1912
 Revised 1912
 Edition N/A
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 Levelled N/A

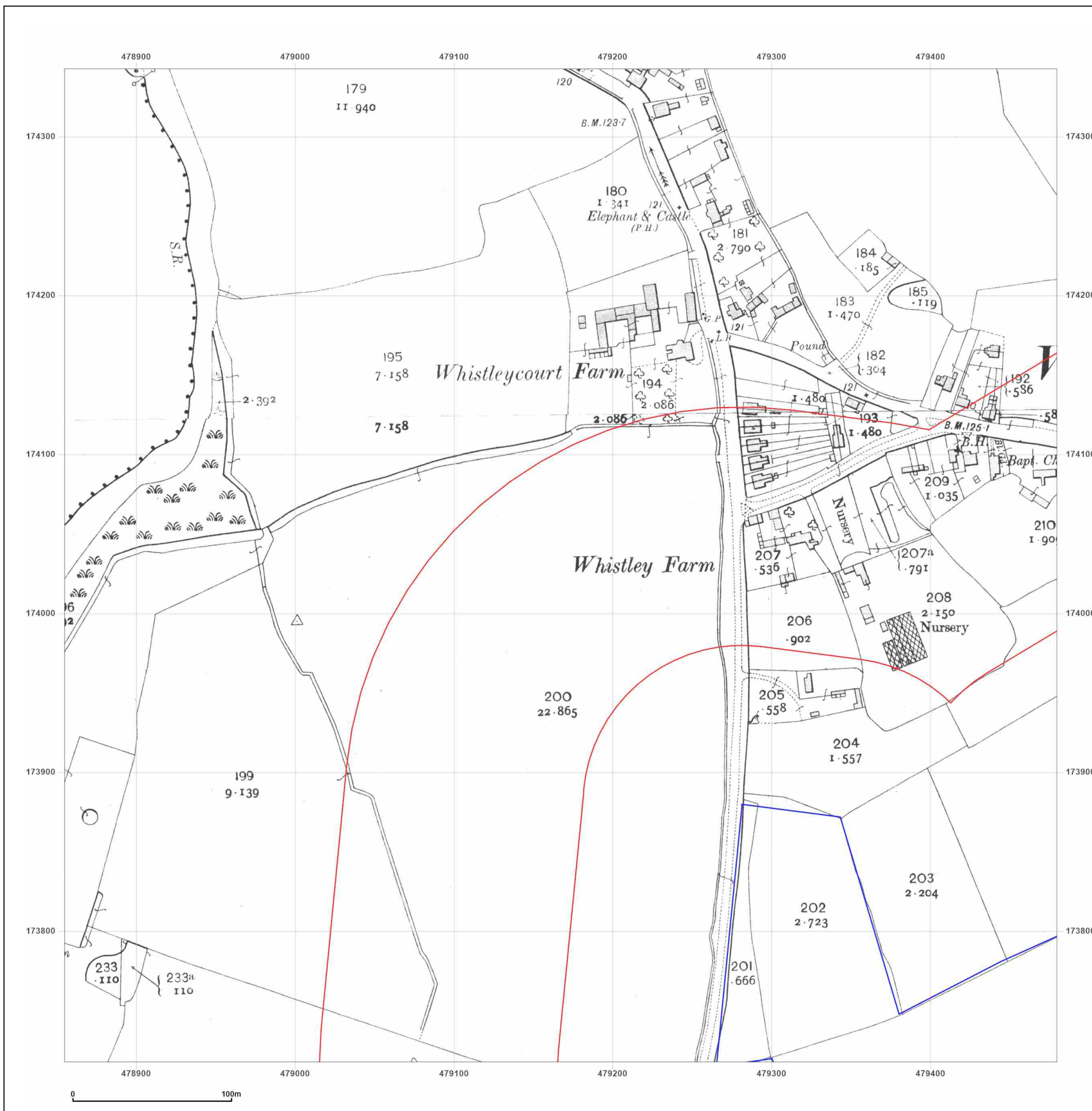


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Site Details:

479274, 173515

Client Ref: 26519-GELO
Report Ref: GS-9197659_LS_1_2
Grid Ref: 479167, 174030

Map Name: County Series

Map date: 1932-1933

Scale: 1:2,500

Printed at: 1:2,500



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Surveyed 1933
 Revised 1933
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