Appendix 14

GEO-ENVIRONMENTAL AND GEOTECHNICAL PRELIMINARY RISK ASSESSMENT

Archer's Spring, Land North of Welwyn Road, Hertford

London & Regional Properties Ltd.

June 2014

70002900-EF1

Quality Management

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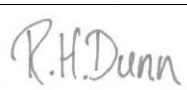
Signature	
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Archer's Spring, Land North of Welwyn Road, Hertford

June 2014

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Table of Contents

Executive Summary

WSP UK Ltd (WSP) was instructed by London & Regional Properties Ltd. (the Client) to undertake a Geo-environmental and Geotechnical Preliminary Risk Assessment (PRA) in relation to Archer's Spring, Land north of Welwyn Road (B1000), Hertford (the Site). This report is designed to support the outline planning application for the development of the site.

Overview

The site occupies an approximately rectangular shaped area of approximately 12.5 hectares and is located north of Welwyn Road (B1000) at a distance of 2.5 km north west of Hertford Town Centre.

The site can be separated into three distinct areas; the eastern and western plateaus (divided by a wooded spur) and the local wildlife site. An earth berm has been constructed along the southern boundary of the site to prevent trespassers accessing the site. The eastern plateau is characterised by variable topography and areas of weeds, grasses and immature trees. Some areas of burning were noted to be present.

The western plateau is located in the south west of the site and is 2m lower in elevation than the eastern plateau. It is characterised by open grassed land with many weeds and bushes. The western boundary of the site is comprised of immature trees situated on an earth berm approximately 1m to 2m in height.

A local wildlife site is present in the north west of the site and is situated at the base of a slope approximately 10m in height. This area is characterised by open grassed land with flint gravel pathways. Several immature trees and shrubs are present, and are most dense in the north west corner of the site and along the northern boundary adjacent to the wooded spur.

The Geological Solid and Drift Map for Hertford (Sheet 239, Scale 1:50,000, 1979) in conjunction with the BGS website indicate that the site is underlain by Kesgrave Sand and Gravel, which is classified as a Secondary (A) Aquifer by the Environment Agency (EA) and subsequently by the Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated), which is classified as a Principal Aquifer. The site was previously used as a site for unauthorised mineral extraction and landfill.

The site is located within an EA Groundwater Source Protection Zone 2 (SPZ 2). There is one surface water abstraction point within 1 km of the site, located 945m to the south. The abstraction is operated by Redland Aggregates Ltd., sourced from a river and is abstracted for use as spray irrigation.

The building control officer at East Hertfordshire District Council stated that the proposed development is in proximity to a building that has previously suffered structural damage caused by subterranean cavities forming under foundations. The officer advised that these were as a result of solution features or "swallow holes" in the underlying chalk strata. The officer stated that ground investigation comprising close-centred dynamic probing on the lines of foundations together with boreholes would be required prior to development.

Groundwater was not encountered during any of the previous ground investigations. Groundwater seepage was noted in several trial pits at depths of 2.2m to 2.5m bgl. This may indicate the presence of perched groundwater.

Contamination Considerations	Potential sources of contamination were identified. On site these comprised Made Ground/landfill, mineral extraction, trail bikes, areas noted as potentially containing potential asbestos containing materials and tipped liquids of unknown origin (on-site) and farmland. Off site these comprised farmland (adjacent to the north and east), and quarrying (adjacent north, 80m north east, and 480m north east). Potential receptors of the identified contaminants have been identified. Current site users including walkers and trail bike users, future site residents and neighbours, and construction workers have been identified as potential human health receptors. Groundwater in the underlying Principal Aquifer and the underlying Secondary (A) Aquifer has been identified as a potential controlled water receptor. Other potential receptors have been identified as future building foundations/buried concrete, and the local wildlife site in the north western portion of the site.
Risk Classification	Based on the information contained in this report and with due regard to the proposed development, it is the opinion of WSP that the site represents a **Moderate** risk with respect to contaminated land liability issues and a **Moderate - High** risk with respect to geotechnical issues, mainly due to the potential presence of solution features within the chalk.
Recommendations	The recommendations below are detailed in full in **Section 9.2** of this report. • It is recommended that a factual report and risk assessment using the national cavity database, as held by Peter Brett Associates, regarding natural and man-made cavities in the vicinity of the site is obtained, due to the potential presence of chalk solution features. • CIRIA document C574, Engineering in Chalk, recommends that due to the potential for the creation of dissolution features, drainage infiltration solutions such as soakaways are advised to be avoided if at all possible, but, if unavoidable, will need to be sited at least 20m from any building footprint construction. The position of such infiltration and soakaway features should also be located away from areas of thick Made Ground at the site. • It is recommended that due to the presence of the chalk and the need to identify any potential solution features, a Ground Investigation is undertaken. This would assist in the characterisation of the site, further delineate the lateral extent of the Made Ground, supplement existing contamination data and inform foundation design. • WSP recommends the installation of ground gas and groundwater monitoring wells within the deep cable percussive boreholes and the window sample boreholes. Subsequent ground gas and groundwater monitoring visits are recommended to assess the risk to groundwater and the risk of ground gas emissions on site. • As a part of the ground investigation, the collection of soil and groundwater samples for geochemical and geotechnical analysis is advised to assess concentrations of contaminants in relation to current screening guidance. • The completion of an ecology survey to assess for the potential presence of invasive plant species (e.g. Giant Hogweed/Japanese Knotweed) and sensitive habitat/species. • If any significant changes to the proposed development are made it may be necessary for the PRA undertaken as part of this report to be updated.

Please Note: This summary forms part of WSP UK Ltd. Preliminary Risk Assessment (ref: 70002900-EF1). Under no circumstances is it to be used as an independent document

1 Introduction

1.1 Authorisation

WSP UK Ltd (WSP) was instructed by London & Regional Properties Ltd. (L&R) (the Client) to undertake a Geo-environmental and Geotechnical Preliminary Risk Assessment (PRA) in relation to Archer's Spring, Land north of Welwyn Road, Hertford (the Site). This report is designed to support an outline planning application for the site and inform the client's understanding of potential contamination and geotechnical related risks. A Site Location Plan is provided as Figure 1 in **Appendix A**. An annotated site plan is provided as Figure 2 in **Appendix A.**

1.2 Proposed Development

London & Regional are seeking to establish a residential development on the site, comprising of approximately 300 residential dwellings with associated private gardens, car parking, landscaping and the provision of public open space. The existing protected wildlife site will be maintained. Proposed development plans are provided as Figure 3 in **Appendix A**.

1.3 Objectives

The principal purpose of undertaking this Geo-environmental and Geotechnical PRA is to assess the presence, likely extent and nature of any ground contamination or geotechnical related risks at the site. These risks relate predominantly to ground, ground gas and groundwater conditions.

This study has been supplemented by a site visit; the observations from which have been described in this report and are accompanied by photographs taken during the visit which are provided in **Appendix B**.

This report has been prepared in general accordance with the requirements of the National Planning Policy Framework (NPPF) (Communities and Local Government, 2012).

1.4 Scope of Works

The scope of this Geo-environmental and Geotechnical PRA comprised:

- Purchase of a Landmark Envirocheck Report (Ref: 56213984_1) and a review of historical maps and assessment of former land uses on site and in the surrounding area;
- A review of geological, hydrogeological and environmental information for the site and surrounding area in order to determine the nature of the ground conditions and the environmental sensitivity of the site;
- The completion of a site walkover to provide information on topography and surface features to gain an understanding of the site and its context to the surrounding area;
- The assessment of the potential location, nature and extent of any soil, ground gas and groundwater contamination associated with the future use of the site;
- The significance of potential environmental risks to humans and the natural and built environment associated with any ground contamination both in the site's existing condition and for the proposed future use. This will be undertaken via the source-pathway-receptor contaminant linkage approach;
- Preliminary enquiries with the East Hertfordshire District Council Environmental Protection Officer, Building Control Officer and the Environment Agency to be undertaken;
- The production of a preliminary Conceptual Site Model and PRA, in accordance with the Environment Agency (EA) / DEFRA Model Procedures for the management of land contamination, 2004 (CLR11);
- The status of the site with respect to Part 2A of the Environmental Protection Act 1990 and the nature and extent of any associated environmental liabilities to be determined;
- Evaluation of the significance of geotechnical risk;
- Evaluation of the potential need for and scope of any site investigation and / or remedial action or design.

1.5 Basis of Environmental Risk Assessment

In order to assess the contamination status of the site, with respect to a proposed residential use development, it is necessary to assess whether the site could potentially be classified as "Contaminated Land", as defined in Part 2A of the Environmental Protection Act 1990 and Contaminated Land Statutory Guidance 2012 (Ref.

Section 4, DEFRA).This is assessed by the identification and assessment of potential contaminant linkages. The linkage between the potential sources and potential receptors identified needs to be established and evaluated. To fall within this definition, it is necessary that, as a result of the condition of the land, substances may be present in, on or under the land such that:

a) Significant harm is being caused or there is a significant possibility of such harm being caused; or
b) Significant pollution of controlled waters is being caused, or there is significant possibility of such pollution being caused.
c) It should be noted that DEFRA has advised (Ref. Section 4, DEFRA Contaminated Land Statutory Guidance 2012) Local Authorities that land should not be designated as "Contaminated Land" where:

- The relevant substance(s) are already present in controlled waters;
- Entry into controlled waters of the substance(s) from land has ceased; and
- It is not likely that further entry will take place.

These exclusions do not necessarily preclude regulatory action under the Water Resources Act 1991, which makes it a criminal offence to cause, or knowingly permit, any poisonous, noxious or polluting matter to enter controlled waters. In England and Wales, under the Anti-Pollution Works Regulations 1999, an anti-pollution notice may be served by the regulator requiring appropriate investigation and clean-up.

In addition, consideration has been given to a wide range of related topics including (where appropriate): environmental processes; current and foreseeable environmental legislation; the practices and duties of environmental regulators; the health and safety of occupiers and neighbours as affected by contamination; effects on the structure of buildings; and financial implications. References to risk classifications are made according to the following definitions:

- LOW Risk – it is unlikely that the issue will arise as a liability / cost for the owner of the site;
- MEDIUM Risk – it is possible that the issue could arise as a liability / cost for the owner of the site. Further work is usually required to clarify the risk; and
- HIGH Risk – it is likely that the issue will arise as a liability / cost for the site owner.

1.6 Limitations

The general limitations to the assessment are outlined in **Appendix F**.

2 Previous Reports

Six previous reports related to a previous planning application for the development of a sports and leisure centre were made available to WSP for consideration within this PRA.

2.1 Contaminated Land Investigation Report, April 1998

Contaminated Land Investigation Report, Site at Welwyn Road, Hertford. STATS Geotechnical Ltd., Ref: 31361/01.

In April 1998, STATS Geotechnical Ltd. (SGL) was instructed by East Hertfordshire District Council to undertake a contaminated land investigation in order to provide information on the ground conditions in relation to the proposed development. This comprised the advancement of 6 trial pits to a maximum depth of 3.8m below ground level (bgl) and subsequent laboratory testing on soils for a limited suite of determinands. The locations of these trial pits were specified by East Hertfordshire District Council and targeted potential areas of backfilling.

At the time of investigation, the site comprised a partially excavated, partially backfilled mineral excavation site with a site cabin and diesel tank situated at the entrance. The boundaries were formed by the B1000 to the south, a residential development to the east and open fields and woodland to the west and north.

Geological mapping identified that the site was likely to be underlain by Glacial Gravel overlying Upper Chalk of the Cretaceous Period. It was noted that the presence of chalk at shallow depths indicated the potential presence of solution features such as “swallow holes”. The exploratory holes encountered a clay-based backfill (depths of between 2.2 and 3.6m bgl) overlying Glacial Gravels (thicknesses of at least 0.5m). The Upper Chalk was not encountered during this investigation.

The backfill material comprised a firm to stiff brown and black silty, sandy clay fill with varying aounts of brick, hardcore, cable, plastic, glass, wood, metal and wire. The Glacial Gravel typically comprised orange coarse sand and fine to cobble sub-angular and sub-rounded gravel.

Groundwater was not encountered in any of the six trial pits.

Chemical analyses were performed on a total of twelve samples of the fill material. The results were assessed against ICRCL Threshold Trigger Concentrations, the limits of which were exceeded at the locations below.

Substances present at or above ICRCL Threshold Trigger Concentration (TTC) (concentration in brackets as mg/kg)			
Category of Substance	**Domestic Gardens**	**Landscaped Areas**	**Hard Cover**
“Heavy” metals	TP3 1.1m (Pb 557)	None	TTCs not published
Phytotoxins	TP6 1.9m (Cu 136)	None	TTCs not published
Non-metals	TP6 1.0m (PAH 87.6)	None	None

As this testing was undertaken in 1998, the laboratory results have been reassessed in comparison to the updated CLEA Soil Guideline Values (SGV's) and Generic Assessment Criteria (GAC) derived by WSP using CLEA V.1.06. Based on the proposed end use of the site all of the samples were compared to a residential with plant uptake end use scenario based on 1% Soil Organic Matter.

One exceedence of the GAC for lead (410 mg/kg) was identified at the location TP3 at 1.1m bgl (557mg/kg). There is no GAC for total PAH, however it is noted that at TP6, 1.0m bgl, concentrations of PAH are recorded as 87.6mg/kg. WSP recommends that future site investigations target this area and reassess this determinand in line with current guidelines with speciation of PAH compounds.

2.2 Trial Pit Investigation, June 1999

Trial Pit Investigation, Site at Welwyn Road, Hertford. Ashdown Site Investigation Ltd., Ref: 10179.

In June 1999, Ashdown Site Investigation Ltd. was instructed by David Lloyd Leisure Ltd.to undertake a Trial Pit Investigation in order to support a planning application for a sports and leisure centre. This comprised the

advancement of 16 trial pits to a depth of 2.7m to 3.5m below ground level (bgl) and the collection and analysis of soil samples for a limited suite of determinands.

These investigations suggested that a variable depth of Made Ground (0m to 3.5m in thickness) was present overlying glacial Sands and Gravels (Secondary (A) Aquifer) and interbedded glacial till. The Made Ground comprised silty clay and clay containing a variable quantity of flint, brick, concrete, wire, plastic, clinker, chalk, rubber, metal and timber and was considered to be unsuitable for use as fill material. The Sands and Gravels were characterised by medium-dense orange-brown fine to medium sand and fine to coarse flint gravel. The clay was stiff, orange-brown and sandy with a trace of fine flint gravel.

Groundwater was not encountered during the ground investigation. Organic odours suggestive of decomposition were noted in four of the trial pits.

WSP notes that due to the absence of an exploratory hole plan, the spatial extent of the Made Ground and natural deposits cannot be determined. Therefore, the above summary of the site's ground conditions is a generalised ground profile. WSP also notes that there appear to be several inconsistencies within the trial pit logs, including the visual key for sand with gravel, and the assessment of topsoil and Made Ground.

A laboratory analysis suite was undertaken on samples from each of the 16 trial pits. As this testing was undertaken in 1999, the laboratory results have been reassessed in comparison to the updated CLEA Soil Guideline Values (SGV's) and Generic Assessment Criteria (GAC) derived by WSP using CLEA V.1.06. Based on the proposed end use of the site all of the samples were compared to a residential with plant uptake end use scenario based on 1% Soil Organic Matter.

Two exceedances of the GAC for arsenic (32 mg/kg) were identified in TP3 and TP9. TP3 recorded a concentration of 83.5 mg/kg at 1.5 m bgl within the sandy clay. TP9 recorded a concentration of 111.6 mg/kg at 0.5 m to 1.0 m bgl within the sand with gravel.

The ground investigation reported that no special precautions were necessary regarding buried concrete. It was also considered that CBR values of 1% should be adopted for the design of road pavements.

2.3 Desk Top Study, November 1999

Desk top study for a site at Welwyn Road, Hertford. Mitchell, McFarlane & Partners Ltd., Ref: L3291.

In November 1999, Mitchell, McFarlane & Partners Ltd. (MMP) was instructed by Next Generation to undertake a desk top study for a proposed sports and leisure club to comment upon statutory authorities, ground conditions and potential contamination.

At the time of the study the site was undeveloped and bounded by trees and hedges. The eastern half of the site was noted as having been filled and levelled. The south western portion of the site was flat bare earth and the north western area was characterised by grass and scrub. The southern boundary was formed by a steep bank approximately 2-3m in height, leading to the adjacent A1000 Welwyn Road. A residential area was noted to be adjacent to the east of the site and an area of coniferous woodland (Archers Spring) was noted to be adjacent to the north west of the site.

The planning officer at East Herts District Council indicated that during levelling of the site following the previous ground investigation, the imported fill material consisted of primarily subsoil and topsoil with approximately 5% builder's rubble. The local building control officer advised that the ground on site is generally granular fill with glacial clay. He also indicated that he had previously experienced problems due to cavities in this area.

During the site visit, anecdotal evidence was offered by local residents regarding an area in the north east corner of the site suspected of containing asbestos containing materials (ACMs) and an additional area to the east of the site entrance where unknown liquids have been released into the ground. These were identified as potential contamination hotspot areas, and it was recommended that these were targeted in future ground investigations.

The Environment Agency was consulted with regard to potential drainage solutions at the site, considering the commercial development of a sports and leisure centre. It was indicated that due to the potential contamination in the subsoil, conventional soakaway drainage would be unlikely to be suitable for the site. The use of deep bore soakaways would also be unlikely to be acceptable due to the presence of local aquifers.

Thames Water was also consulted concerning the public sewers in the area. At the time of consultation there were no public sewers located adjacent to the site, however sewer requisition could be considered if the end

site use was residential. Current local sewers are in the order of 300m distance from the site and it was advised that these were quite small and attenuation of surface water would be required.

2.4 Trial Pit Investigation Report, January 2000

Report on a Trial Pit Investigation at Welwyn Road, Hertford. Mitchell, McFarlane & Partners Ltd., Ref: L3291.

In January 2000, Risk Management Ltd. were instructed by MMP on behalf of Next Generation Clubs Ltd. to undertake a Trial Pit Investigation Report following the conclusions of the November 1999 Desk Study by MMP. This comprised a total of thirty mechanically excavated trial pits to depths of between 2.5m and 3.5m bgl. This work was commissioned in order to provide information on the leachability of the Made Ground and the permeability of the natural ground.

The site comprised two plateaus – a western plateau and an eastern plateau, where the eastern plateau was elevated approximately 3m above the western plateau. The two were identified to be linked in the south of the site via an embankment. A third sloping area was present in the north west of the site, approximately 10m below the western plateau. Several earth mounds were present across the site.

At the time of writing, WSP has not been provided with the full report, as part of the trial pit logs and laboratory test data were omitted. The following summary is therefore incomplete.

The Trial Pit investigation encountered Fill Material (Made Ground present in thicknesses of between 0.1m and >3.5m) or Topsoil (present in thicknesses of between 0.2m and 0.35m) overlying glacial Sands and Gravels (encountered at depths of 0.1m to 3.0m). The greatest thicknesses of Made Ground were present in the north eastern portion of the site, the central southern portion of the site and the western portion of the site (as summarised in Figure 3 within **Appendix A**).

A laboratory analysis suite for leachate testing was undertaken on 64 small disturbed samples taken from across the 30 Trial Pits. As this testing was undertaken in 2000, the laboratory results have been reassessed by WSP in comparison to Water Target Values (WTVs). Based on the presence of the underlying Principal Aquifer all of the samples were compared to Drinking Water Standards (DWS) for a groundwater/drinking water receptor. The results of this analysis are detailed in the table below.

Trial Pit	Depth (m bgl)	Contaminant	Leachate Concentration (µg/l)	WTV (µg/l)	Strata
TP1	0.2	Cyanide (Free)	200	50	Made Ground
		pH	10	6.5-10	Made Ground
		PAH (total)	0.37	0.1	Made Ground
TP4	0.5	Iron (soluble)	220	200	Made Ground
TP6	3	pH	10.3	6.5-10	Sand
TP12	0.5	Iron (soluble)	250	200	Made Ground
		Lead (soluble)	32	25	Made Ground
TP13	1	Iron (soluble)	240	200	Made Ground
		Benzo(a)pyrene	0.032	0.01	Made Ground
		PAH (total)	0.4	0.1	Made Ground
TP13	2	PAH (total)	0.24	0.1	Made Ground
TP17	0.5	Iron (soluble)	250	200	Made Ground
TP17	1	Iron (soluble)	320	200	Made Ground
		PAH (total)	0.24	0.1	Made Ground
TP17	1.5	pH	10	6.5-10	Made Ground
TP18	2	Iron (soluble)	>200	200	Made Ground
TP21	1	Arsenic (soluble)	12	10	Made Ground
		PAH (total)	0.41	0.1	Made Ground
TP22	0.5	Arsenic (soluble)	10	10	Made Ground

Trial Pit	Depth (m bgl)	Contaminant	Leachate Concentration (µg/l)	WTV (µg/l)	Strata
TP25	1	Selenium (soluble)	11	10	Made Ground
TP25	2	PAH (total)	0.27	0.1	Made Ground
TP26	0.5	pH	10.3	6.5-10	Made Ground
TP28	1	Sulphate as SO4	960000	250000	Made Ground
TP30	0.5	Iron (soluble)	270	200	Made Ground

The majority of the exceedances are recorded within the Made Ground. As such, the above trial pits are generally located in the areas where the greatest thickness of Made Ground is recorded.

Soakaway testing was undertaken in 6 of the 30 trial pits to determine the soakage characteristics of the Sand and Gravels. Trial pits were filled up to 3 times from a 2000 gallon lorry mounted water bowser and the time taken for the water to soak away was noted. The following table summarises the findings.

Trial Pit	Soil Infiltration Rate (m/s)	Drainage Characteristics
TP1	3.86×10^{-5}	Good
TP12	3.09×10^{-4}	Good
TP14	3.71×10^{-4}	Good
TP15	3.02×10^{-5}	Good
TP19	4.71×10^{-6}	Poor/Good
TP23	6.69×10^{-6}	Poor/Good

WSP notes that although drainage is generally good within the natural ground on site, discussion would be required with the Environment Agency regarding soakaway permits due to the exceedances recorded within the Made Ground with regard to contaminated land.

2.5 Site Investigation Report, April 2002

Site Investigation at Welwyn Road, Hertford. Risk Management Ltd., Ref: RML 182.

In April 2002, Risk Management Ltd. were instructed by MMP on behalf of Next Generation Clubs Ltd. and Bank of Scotland to undertake a Trial Pit Investigation Report following the conclusions of both the November 1999 Desk Study by MMP and the January 2000 Trial Pit Investigation by Risk Management Ltd. This investigation comprised the excavation of 17 trial pits to depths of between 2.2m and 3.8m bgl, and the advancement of 6 boreholes to a depth of 10m bgl. Upon completion of each borehole, the lower 3m was infilled with a cement/bentonite mix, and a monitoring standpipe installed. Three gas monitoring visits were subsequently undertaken over a period of 10 days.

This study was commissioned to provide information on the contamination and leachability of the Made Ground, geotechnical information on the underlying natural ground and gas monitoring information.

At the time of the site investigation, the site was mainly characterised by grass scrubland and topsoil. One section midway long the western boundary appeared to have been excavated to a depth of 1m to 1.5m bgl. The site fell 6m from south to north, however due to the size of the site, the ground appeared generally flat. The area in the north west of the site was approximately 10m lower that the rest of the site, and was demarked by an embankment. In several locations across the site, grass covered spoil heaps were present, some being 3m to 4m in height.

The report noted that the encountered ground conditions confirmed the expected geology on site, with reference to the BGS Geological Mapping. This generally comprised Glacial Gravel underlying Upper Chalk at depth. The ground conditions encountered are summarised in the following tables, although it should be noted that the original logs should be consulted for completeness.

South western portion (BH4 & TP1)		
Depth to top of Stratum (m bgl)	**Thickness (m)**	**Description**
0.00	4.90	Fill (Made Ground)
4.90	1.50	Superficial silty Clay
6.40	0.40	Sand and Gravel
6.80	2.00	Silty Clay and Rock Chalk
8.80	1.20+	Sand and Gravel

Central southern portion (BH1 & BH3)		
Depth to top of Stratum (m bgl)	**Thickness (m)**	**Description**
0.00	2.60 – 3.50	Fill (Made Ground)
2.60 – 3.50	3.60 – 3.10	Sand and Gravel
5.80	1.40	Silty Clay (BH3 only)
6.60	3.40+	Chalk Wakeling Grades IV-III (BH1 only)
7.20	2.80+	Sand and Gravel (BH3 only)

North eastern portion (TP3-TP6, TP14-TP16 & BH6)		
Depth to top of Stratum (m bgl)	**Thickness (m)**	**Description**
0.00	1.80 – 3.80+	Fill (Made Ground)
1.80 – 3.70	0.30+ - 6.30+	Sand / Sand and Gravel (Where encountered)

South eastern portion (TP2, TP7 – TP13, TP17, BH2 & BH5)		
Depth to top of Stratum (m bgl)	**Thickness (m)**	**Description**
0.00	0.10 – 0.60	Topsoil/Fill (Made Ground)
0.10 – 0.60	2.50 – 6.00	Sand/Sand and Gravel
2.60 – 6.20	3.30 – 1.70	Silty Clay
5.90 – 7.90	4.10+ – 2.10+	Sand and Gravel

Small seepages of groundwater were encountered within trial pits TP7, TP8, TP9, TP10, TP13, TP14, TP15 and TP17 at depths of between 2.20m and 2.50m bgl. Groundwater was not encountered within any of the boreholes.

2.5.1 Laboratory Results

Twelve representative samples were taken from across the site and tested for a basic suite of contaminants. As this testing was undertaken in 2002, the laboratory results have been reassessed in comparison to the updated

CLEA Soil Guideline Values (SGV's) and Generic Assessment Criteria (GAC) derived by WSP using CLEA V.1.06. Based on the proposed end use of the site all of the samples were compared to a residential with plant uptake end use scenario based on 1% Soil Organic Matter. A laboratory analysis suite for leachate testing was also undertaken. The laboratory results have been reassessed in comparison to the Drinking Water Standards and/or Generic Assessment Criteria (GAC) derived by WSP using CLEA V.1.06. Based on the presence of the underlying Principal Aquifer all of the samples were compared to the standards for a groundwater/drinking water receptor. The results of these analyses are detailed in the table below.

Leachate/Soil testing	Exploratory Hole	Depth (m bgl)	Contaminant	Concentration	GAC	Strata
Soil	BH2	0.5	Benzo(a)anthracene	4.7 mg/kg	3.1 mg/kg	Made Ground
			Benzo(a)pyrene	2.4 mg/kg	0.83 mg/kg	Made Ground
Soil	BH4	3	Benzo(a)pyrene	1 mg/kg	0.83 mg/kg	Made Ground
Soil	BH6	1	Benzo(a)pyrene	1.1 mg/kg	0.83 mg/kg	Made Ground
Leachate	TP7	0.15	PAH (total)	0.63 µg/l	0.1 µg/l	Topsoil
Leachate	TP8	0.15	PAH (total)	0.38 µg/l	0.1 µg/l	Topsoil
Leachate	TP9	0.15	PAH (total)	1.5 µg/l	0.1 µg/l	Topsoil
Leachate	TP13	0.15	PAH (total)	3.1 µg/l	0.1 µg/l	Topsoil
Leachate	TP14	1.5	PAH (total)	2.8 µg/l	0.1 µg/l	Made Ground
Leachate	TP17	0.15	PAH (total)	1.6 µg/l	0.1 µg/l	Topsoil

In addition to the above, WSP notes that although there is no GAC for PAH (total) in soils, one sample was significantly elevated. TP5 (1.0m bgl) recorded a value of 300mg/kg PAH. WSP recommends that subsequent ground investigation includes re-testing for speciated PAHs to allow comparison to existing GACs.

2.5.2 Gas Monitoring

Monitoring standpipes were installed in the six boreholes, to depths of 7.0m. Three gas monitoring visits were undertaken on 16th April 2001, 22nd April 2002 and 26th April 2002. During these visits, concentrations of carbon dioxide and methane were measured. Carbon dioxide was found in a number of boreholes, up to concentrations of 4% v/v in BH6. Methane was only detected in BH4 at a maximum concentration of 0.5% v/v. This was located in the central southern portion of the site.

WSP notes that flow rates were not recorded as part of these monitoring visits, and that the monitoring visits only took place over a very short period of time. WSP recommends that supplementary gas monitoring is undertaken as a part of any future ground investigations.

2.5.3 Geotechnical Summary

The Atterberg limit and natural moisture content were determined for one sample within the Made Ground and two samples within the more cohesive natural ground.

Stratum	Liquid Limit (LL) (%)	Plastic Limit (PL) (%)	Plasticity Index (PI)	Natural Moisture Content (%)
Made Ground	49	19	30	19
Clay	41	14	27	16
Clay	48	16	32	21

The results indicated that within the cohesive deposits, strata would be classified as being of “Intermediate” plasticity (CI) in accordance with the Casagrande Geotechnical Classification System. The cohesive elements

of both the Made Ground and the Clay were classified as having “Medium” shrinkage potential (NHBC classification system). It should be noted that numerous large trees and shrubs are present along the boundaries of the site, and WSP recommends that due to the potential for shrinkage within clays present at the site, the presence of trees should be taken into consideration when formulating detailed foundation plans.

The California Bearing Ratio (CBR) had been determined. CBR values for the Made Ground were 4% and 5%. CBR values for the Sand and Gravel ranged between 17% and 32%. The CBR value for the Made Ground reflects the poor engineering properties and variability of this deposit. Risk Management Ltd. recommended that in areas of particularly loose or soft ground, proof rolling is undertaken and provision is made for an additional 150mm of sub-base.

Risk Management Ltd. recommended that due to the potential for shrink-swell on the site, footings are founded on the Sand and Gravel, below the Made Ground. However, ground investigations had shown that the lateral and vertical extent of the Made Ground is extremely variable across the site. It was recommended that shallow foundations may be suitable where natural ground is within 1m to 2m bgl, however deeper foundations may be required.

WSP recommend that further ground investigation is undertaken in order to better assess the extent of the Made Ground and to better inform foundation design. It is anticipated that due to the nature of the proposed development, foundation design may vary on a plot by plot basis.

2.6 Remediation Strategy, May 2002

Remediation Strategy for a site at Welwyn Road, Hertford. Mitchell, McFarlane and Partners, Ref: L3291.

In May 2002, Mitchell, McFarlane and Partners (MMP) were instructed by Next Generation Clubs Ltd. to prepare a remediation strategy report to prepare the study site for commercial redevelopment. The site area for this report comprised a portion of the current site area comprising the eastern plateau with an area of approximately 4.8ha. The report comments on ground conditions, potential contamination, previous site investigations (reviewed above) and provides a conceptual site model and remediation strategy.

MMP were informed by East Hertfordshire District Council Environmental Health Officer that the site was partly filled with inert waste as part of a levelling exercise.

Potential historical contamination sources were identified as follows:

- Contamination originating from the fill material deposited on site. It should be noted that it was confirmed that only inert sub-soil and topsoil with approximately 5% builders waste was used as the fill material.
- Oil/fuel contamination originating from potential storage tanks that may have been used during the above groundworks.
- Anecdotal evidence from local residents was presented in the November 1999 desk study. This suggested that fly tipping of potential asbestos containing materials may have occurred, and unknown liquids had been dumped in the north east corner of the site. These areas were investigated as part of the January 2000 site investigation.

MMP noted that the soils on the site were identified as soils of intermediate to high leaching potential within the Sitescope report supplied as a part of the November 1999 desk study. These define the soils as having little to moderate ability to attenuate diffuse source pollutants.

A conceptual site model was produced detailing potential source-pathway-receptor contaminant linkages. WSP notes that this was based on previous GACs for a commercial/industrial end use scenario. The report identified the following potential sources of contamination;

- Contaminants adsorbed onto to soil particles in the Made Ground, identified as elevated pH, PAHs, Arsenic, TPH and Zinc.

The following potential pathways were identified;

- Volatilisation and subsequent inhalation of vapours and inhalation of fugitive dust;
- Ingestion of soil and/or groundwater;
- Dermal contact with contaminated soil and/or groundwater;
- De-sorbed and mobile contaminants released from the soil particles by infiltration forming leachate; and

- The migration of this leachate downward to the water table and then via lateral migration through the underlying Chalk stratum (Principal Aquifer).

The following potential receptors were identified;

- Site-end users – adult and children users of the new development;
- Construction workers and repair/maintenance workers;
- The general public and off-site residents;
- The Chalk Principal Aquifer; and
- On-site buildings.

It was concluded that although the above sources, pathways and receptors could be identified, the potential sources were deemed to not be significant due to the proposed levels of hard-standing within the proposed development. Areas of soft landscaping were proposed to be underlain by a layer of clean and inert topsoil material. It was therefore considered that there are no reasonable pathways by which the identified receptors may be exposed to these soil-based contaminants.

It was noted that although soil-based contaminants were not deemed to pose a significant risk to potential receptors, groundwater within the underlying Principal Aquifer could still be at risk. As such, a Controlled Waters Risk Assessment was undertaken. This concluded that, considering concentrations of contaminants, dilution factors as a result of precipitation, the footprint of the development and the concentration at the proposed receptor given the above, the contamination as measured on the study site would not significantly affect the water quality within the Principal Aquifer or within the nearest river receptors. WSP notes that this assessment was based on a number of assumptions, including levels of precipitation, the cessation of polluting activities and the final end use of the development.

The report concluded that due to the nature of the proposed development, the proposed areas of hardstanding would be sufficient to break the source-pathway-receptor model. It was also considered that contaminated soil could also remain on site as the groundwater risk assessment showed that the soil did not pose any risk to controlled waters. It was then advised that removal of PAH contamination hotspots should be undertaken.

WSP notes that the above conclusions are based on a commercial end land use scenario, and that the GACs used are now considered to be outdated. WSP also notes that this remediation strategy only concerns a small portion of the proposed site area. WSP therefore recommends that the data is rescreened and re-evaluated, based on the proposed residential land use scenario.

3 Site Information

3.1 Site Details and Reconnaissance

A site visit was carried out by WSP on Thursday 22nd May 2014. The site details and key observations made during the site reconnaissance are outlined below. A photographic record is provided in **Appendix B**, and an Annotated Site Plan is presented as Figure 2 in **Appendix A**.

Site Address	Land North of Welwyn Road, A1000, Hertford
Grid Reference	530180, 213320
Site Location	The site occupies an approximately rectangular shaped area of approximately 12.5 hectares and is located north of Welwyn Road (B1000) at a distance of 2.5 km north east of Hertford town centre.
Site Description	The site itself is located to the north of Welwyn Road, and the southern boundary is marked by an earth berm constructed to prevent trespassers accessing the site. This berm was vegetated with small weeds, bushes and nettles, and contained timber, wire, concrete, brick and tarmac (Photo 1). At the easternmost extent of this berm, a dry ditch is present (Photo 2). The eastern plateau (the land to the east of the wooded spur) is characterised by open grassed spaces with extensive areas of raised ground with weeds and broad leaved plants (Photo 3). Occasional bushes and immature trees are present. Occasional areas of burning likely to be associated with trespassers were present. A pedestrian entrance is present on the eastern boundary of the site, and access to the woodland is present on the northern boundary. A large earth mound is present to the east of the wooded spur and is between 3m and 4m in height (Photo 4). Several immature trees and bushes were present. The wooded spur in the centre of the site divides the site in two. The spur is elevated approximately 2m to 3m above the eastern plateau and comprises several mature and immature trees (Photo 5). The western plateau is located in the south west of the site and is 2m lower in elevation than the eastern plateau. It is characterised by open grassed land with many weeds and bushes (Photos 6 and 7). The western boundary of the site is comprised of immature trees situated on a raised embankment approximately 1m to 2m in height. A local wildlife site is present in the north west of the site and is situated at the base of a slope approximately 10m in height (Photo 8). This area is characterised by open grassed land with flint gravel pathways. Several immature trees and shrubs are present, and are most dense in the north west corner of the site and along the northern boundary adjacent to the wooded spur. A small rusted car was present in this area, adjacent to an area of land previously used for burning (Photo 9). It is understood that the gravel paths are used for unauthorised trail biking. In the wooded area adjacent to the north of the site at the base of the slope, several circular depressions were present which may potentially indicate the presence of solution features (Photo 10).
Trees	Several immature trees and occasional mature trees were noted to be present within the site boundary during the visit. The species of trees were unable to be confirmed during the site visit.
Invasive Species	Anecdotal evidence from a local online newspaper suggested that Giant Hogweed may be present on site.
Topography	The site has a varied topography, which is detailed on Figure 2. As a summary, the eastern plateau gently slopes towards the north before dropping away steeply at the northern boundary, with areas of raised ground (0.5m to 1m) and occasional mounds. In the south east of the site, a dry ditch (2m depth) is present between two raised

	berms (1m tall). The spur of woodland in the central north of the sits extends to separate the site into two sections, and is situated on raised earth approximately two metres in height. The western plateau is situated in the south western portion of the site, is largely flat, and is approximately 2m lower than the eastern plateau. The local wildlife site in the north west of the site is approximately 10m lower than the western plateau. Along the southern and western boundaries, an earth berm is present (between 1m in height and 4m in height).
Bulk Materials Storage	No storage tanks or other bulk storage units were identified on site.
Polychlorinated Biphenyls (PCBs)	No potential sources of PCBs were identified on site.
Ozone Depleting Substances	No potential sources of Ozone Depleting Substances were identified on site.
Waste Management	No areas of Waste Management were present on site.
Drainage	No standing water was noted to be present.
Asbestos Containing Materials (ACMs)	No evidence of ACMs was noted during the site visit.
Geotechnical Risks	The topography is extremely variable. Potential solution features were identified in the woodland adjacent to the north of the site.

3.2 Surrounding Land Use

North	Coniferous woodland, Archer's Spring, is present immediately to the north west of the site. Non-coniferous woodland is present to the north east of the site. A steep slope up to 10m in height is present immediately adjacent to the northern boundary of the site, mostly through woodland. Beyond this, farmland and further woodland are present.
East	To the east of the site, a residential development is present, comprised of a mixture of semi-detached, detached and terraced housing with rear gardens.
South	Welwyn Road (B1000) runs adjacent to the southern site boundary. Beyond this, open fields and woodland are present.
West	The land to the west of the site is characterised by open fields and woodland. The boundary of the site is marked by a right of way. A mast is present approximately 10m west of the site.

4 Historical Land Use

4.1 Review of Historical Plans

The history of the site and environs has been determined with reference to Ordnance Survey maps (from 1880 to 2014) contained within the Envirocheck Report (obtained from the Landmark Information Group, Ref: 56213984_1). A study has been undertaken to identify any potentially contaminative former land uses. The following section provides a summary of this information and a selection of historical maps are provided in **Appendix C**.

4.1.1 The Site

The first published map for the site is dated 1880. At this time the site is open fields divided into sections by fences and rows of trees. The site is bounded by woodland and trees to the north and Welwyn Road to the south. By 1898, a small rectangular structure is present in the central east portion of the site. By 1923, this structure is no longer present and a well is present adjacent to the northern boundary. By 1978, the field boundaries within the site has changed. By 2006, a small area in the north of the site is occupied by deciduous woodland. The rest of the site except the north western corner is now occupied by shingle workings. By 2014, these workings are marked as disused and the shingle is no longer present.

4.1.2 The Surrounding Area

A review of the surrounding land uses has been undertaken and is summarised below.

- The first published map dated 1880 (1:2,500) shows the surrounding area to be mainly undeveloped fields and woodland. Welwyn Road is present to the south of the site and a small cutting/pit is present immediately adjacent to the north east of the site. The 1884 mapping (1:10,560) shows Broadoak End, located 430m north east of the site and Archer's Spring woodland located adjacent to the north west of the site. Panshanger woodland is located 200m to the south and south west.
- By 1899, a gravel pit and an old gravel pit are located 480m to the north east, adjacent to Broadoak End. A small quarry is present 80m to the north east of the site.
- By 1951, a small quarry is present adjacent to the north of the site, accessed by a track to the north. By 1960, these gravel pits have increased in size.
- By 1962, a residential development has occurred immediately to the east of the site. By 1967, Sele Farm Community centre is present as a part of this development.
- By 1970, the gravel pits to the north of the site are no longer present and are now non-coniferous woodland. The access track continues to remain.
- By 1978, a school with adjacent playground and playing field is present 500m east of the site.
- By 2006, shingle workings are present at Panshanger, 220m south of the site. A shooting club is present 380m to the north.

5 Regulatory Information and Consultations

5.1 Regulatory Information

Information relating to various regulatory controls has been taken from the Envirocheck Report obtained from the Landmark Information Group, dated March 2014 (a summary of which is presented in **Appendix D**). The potential for any hazardous materials associated with these activities to impact upon the ground conditions, surface or groundwater on site are summarised below.

Environmental Data	Distance from site (within 500 m)	Details	Potential Risk?
Discharge Consents	186m east and 387m north east	One consent for sewage discharge into the river Beane is held by Thames Water Utilities Ltd. A further consent is held by Mr L. Adams at Horn Broadoak Manor Nursing Home for the discharge of treated sewage effluent to land.	NO
Pollution Prevention and Control	N/A	There are no pollution prevention controls within 500m of the site.	NO
Pollution Incidents to Controlled Waters	N/A	There are no pollution incidents to controlled waters within 500 m of the site.	NO
Substantial Pollution Incident Register	N/A	There are no records registered on the substantial pollution incident register within 500m of the site.	NO
Historical or Local Authority Recorded Landfill Sites	1 No. between 349 and 477m north/north east.	The Waterford Quarry Landfill is present to the north of the site and extends over a large area. Four separate Historic Landfill Licenses have been held for this site. Deposited waste includes Inert, Commercial, Industrial, Household and Special waste. This site is also a local authority recorded landfill site.	NO
Registered Waste Transfer Sites	N/A	There are no registered waste transfer sites within 500 m.	NO
Licensed Waste Management Facilities	N/A	There are no licensed waste management facilities within 500 m of the site.	NO
Contemporary Trade Directory Entries	4 No. between 12m and 203m east.	All contemporary trade directory entries are currently inactive. These comprise ironing and home laundry, pest and vermin control and concrete reinforcements.	NO

5.2 Regulatory Consultation

5.2.1 Environment Agency

The Environment Agency was contacted on 16th May 2014 with regard to obtaining environmentally pertinent information for the site. At the time of writing this report, no information had been received. The final copy of this report will include the results of this consultation.

5.2.2 Environmental Protection Officer

The Environmental Protection Officer (EPO) at East Hertfordshire District Council, was contacted on 16th May 2014 with regard to obtaining environmentally pertinent information for the site. The Officer reported the following: “The site has not been designated contaminated land under Part 2A of the Environmental Protection Act. The site is on the council’s list of prioritised sites, however due to its current use, the council does not have any plans to investigate the site in the near future in connection with contaminated land whether formally or informally, based upon information known at this time. The council’s position may change if fresh information becomes available. There are no concerns with the site at this time.”

The EPO stated that she was unaware of any gas or leachate generation, and advised that the authority is not monitoring any of the closed landfill sites in the vicinity of the site for gas or leachates.

A report was attached identifying the site as a former landfill “Archer’s Spring”, however no further details were made available to WSP.

5.2.3 District Surveyor

The Principal Surveyor at East Hertfordshire District Council (Building Control) was contacted on 16th May 2014 with regard to obtaining geotechnically pertinent information for the site. The officer stated that the proposed development is in proximity to a building that has previously suffered structural damage caused by subterranean cavities forming under foundations. The officer advised that these were as a result of solution features or “swallow holes” in the underlying chalk strata.

The officer recommended that a site investigation from a suitably qualified person is undertaken to show that reasonable steps have been taken in the design process in order to guard against this risk. The officer advised that the foundation design and method of surface water disposal will be influenced by the results of such an investigation which would normally include close-centred dynamic probing on the lines of foundations together with boreholes as necessary to establish the geological profile.

The officer was also contacted on 27th May 2014 with regard to seeking further advice about the site. The officer stated that the aforementioned solution feature was located at the corner of The Ridgeway and Bentley Road. No further details were held on this feature. It was confirmed that further solution features were present on the Sele Farm Estate, including the Cherry Tree Green sinkholes which were identified on the 18th February 2014.

The officer stated that the Sele Farm estate was constructed using traditional foundations founded within the Glacial Gravels. No groundwater has been encountered in the vicinity of the site.

The officer stated that although the infiltration rates within the Glacial Gravels are good, infiltration drainage at the site (i.e. soakaways) would generally not be recommended due to the high potential risk associated with solution features within the chalk. Further comment could be made on the suitability of using infiltration drainage following a comprehensive site investigation which included close-centred dynamic probing.

5.2.4 Minerals Planning Officer

The Minerals planning officer at Hertfordshire County Council, Martin Wells, was contacted on the 21st May 2014 with regard to obtaining information held by the Mineral Planning Authority relevant to the site. It was found that five previous applications had been submitted with regard to planning in terms of minerals and waste developments. None of the applications were approved, and as far as Hertfordshire Council were aware, the site still has the potential to contain underlying sand and gravel.

The officer stated that as Archer’s Field has not been subjected to mineral extraction, no infilling has occurred to the knowledge of Hertfordshire County Council. However, the officer suggested that East Hertfordshire District Council were also consulted, with reference to any available records that relate to the site.

The officer also stated that Archer's Field is not designated as a 'preferred area' in the current Hertfordshire Minerals Local Plan (adopted March 2007), and that the nearest mineral working is Panshanger Quarry, which is adjacent to the south of the site. This has planning permission until October 2020.

The officer was not aware of any recent site investigations that have been carried out to establish the extent of any underlying mineral at this site. The only data the council hold on the site regarding possible mineral reserves is contained within the Mineral Assessment Report No. 69 produced in 1981 by the Institute of Geological Sciences (now the British Geological Survey). This suggests that the site is situated within an area where there is underlying sand and gravel with an approximate thickness of 9-11 metres. During the officer’s investigations, the site was identified in East Herts Council's Draft District Local Plan consultation as a site suitable for potential housing development for approximately 300 dwellings (ref: HERT3-West of Hertford, North of Welwyn Road).

It was stated that as Minerals Planning Authority, Hertfordshire County Council requests that further site investigations are carried out to establish the extent of any mineral reserves. The results of the study would establish whether any of it would be economically viable to extract, prior to any development taking place. The officer stated that this is in accordance with the county's Minerals Policy 5: Mineral Sterilisation. It was also stated that if practical, any underlying mineral could also be used during the construction phase itself.

During further consultations with the minerals officer, it was revealed that previous unauthorised mineral extraction had been undertaken on the site, and as no planning permission was acquired, no records were held on this activity. Following this conversation, WSP identified the STATS April 1998 report as a result of an online search, undertaken on behalf of East Hertfordshire District Council, which is reviewed in Section 2.1 of this report.

6 Environmental Setting

6.1 Geology

The Geological Map for Hertford (Solid and Drift Edition, Sheet 239, Scale 1:50,000, 1979) indicates the site is underlain by superficial Glacial Gravel (with Bunter Pebbles), overlying the Upper Chalk at depth. The BGS website confirms this general profile, but uses the updated classifications listed below.

Geological Unit	Location on site	Description	Aquifer Status*
Kesgrave Catchment Subgroup – Sand and Gravel. (superficial)	Beneath the majority of the site except a small central northern section and the far north east corner.	Quartz and quartzite fluvial gravels with sands.	Secondary (A) Aquifer
Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated)	Beneath the entire site.	Chalk with flints. With discrete marl seams, nodular chalk, sponge-rich and flint seams throughout.	Principal Aquifer

*Environment Agency Website

The previous ground investigations confirm the above ground profile. Made Ground was found to be present across the site at a maximum thickness of 4.9m. Interbedded Clay was also noted as being present within the Kesgrave Catchment Subgroup.

The ground profile ascertained by the previous investigations are summarised in the table below.

Stratum	Description	Depth to top (m bgl)	Depth to Base (m bgl)
Topsoil	Loose grey topsoil with a little flint gravel	0.0	0.2 to 0.45
Made Ground	Brown - grey clay (occasionally orange brown fine to coarse sand) with fine to coarse flint gravel and ironstone. Inclusions of wire, concrete, clinker, plastic, brick, rebar, ash, timber, chalk, rubber, china, metal and rubble.	0.0 to 0.4	0.1 to 4.9
Kesgrave Catchment Subgroup – Sand and Gravel	Dark orange brown slightly to very clayey sand and rounded to subangular gravel	0.0 to 3.5	6.6 to >10.0 (where known)
Kesgrave Catchment Subgroup – Clay (interbedded within Sand and Gravel)	Light brown sandy clay with frequent grey mottling and occasional flint gravel.	1.0 to 5.8	1.4 to 8.8
Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated)	White and off white, rubbly to blocky chalk with large flints and occasional rust-red staining on fissure surfaces. (Wakeling grades IV – III)	6.6	>10.0

It should be noted that the East Hertfordshire District Building Control Officer stated that the proposed development is in proximity to a building that has previously suffered structural damage caused by subterranean cavities forming under foundations. The officer advised that these were as a result of solution features or “swallow holes” in the underlying chalk strata.

6.2 Hydrogeology

The site is underlain by the Kesgrave Catchment Subgroup – Sand and Gravel, which is classified as a Secondary (A) Aquifer by the Environment Agency (EA) and subsequently by the Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated), which is classified as a Principal Aquifer by the EA.

The site is located within an EA Groundwater Source Protection Zone 2. There is one water abstraction point within 1 km of the site, located 945m to the south. The abstraction is operated by Redland Aggregates Ltd., sourced from a river and is abstracted for use as spray irrigation.

Groundwater was not encountered during any of the previous ground investigations. Groundwater seepage was noted in several trial pits at depths of 2.2m to 2.5m bgl. This may indicate the presence of localised areas of perched groundwater associated with lenses or horizons of lower permeability deposits. It is anticipated however, that there is generally direct vertical hydraulic continuity between shallow groundwater within the Made Ground and glacial deposits, and the underlying Principal Chalk Aquifer.

6.3 Hydrology

There are no recorded surface water features within 500m of the site. The site is not within a Flood Risk Zone. It is noted that the name of the site area and adjacent woodland, “Archer’s Spring”, indicates that a spring may be present or may historically have been present in the vicinity of the site area. It is considered that the spring lines, if present, could represent the base of the glacial sand and gravels where they overlie the Chalk, or horizons of lower permeability clays within the deposit which outcrop at surface.

6.4 Infiltration

Soakaway tests were undertaken by Risk Management Limited in January 2000. Soakaway testing was undertaken in 6 of the 30 trial pits to determine the soakage characteristics of the Sand and Gravels. Trial pits were filled up to 3 times from an attendant 2000 gallon lorry mounted water bowser and the time taken for the water to soak away was noted. Soil infiltration rates were noted to be between 3.09×10^{-4} m/s and 6.69×10^{-6} m/s. Drainage is therefore good within the superficial granular deposits.

7 Preliminary Conceptual Site Model and Preliminary Risk Assessment

7.1 Introduction

The objectives of the contaminant linkage assessment process are to:

- determine the sources of contamination (if present);
- identify specific chemicals of potential concern (if present);
- identify possible contaminant migration pathways;
- identify possible receptors (e.g. soil, groundwater, humans, property and third parties) which could be affected, including their relative potential sensitivity to contaminants given their nature of exposure; and
- construct a Conceptual Site Model (CSM) which clarifies the mechanisms by which the site may present a risk highlighting those sources of risk which will require further assessment and those which can be eliminated.

The CSM provides a description of three elements:

- the actual and probable nature, extent and location of contaminants, i.e. the SOURCE term;
- the likely migration PATHWAYS by which contaminants may reach such receptors; and
- the potential existing and reasonably foreseeable future on-site and off-site RECEPTORS to contamination.

Such information enables the development of plausible contaminant linkages between sources of contamination and receptors and thus an estimation of the risks that may be present. The typical chemicals associated with the identified land uses have been referenced within DEFRA R&D Publication CLR8: Potential Contaminants for the Assessment of Land and this information has been used to inform our CSM.

7.2 Outline Conceptual Model

Potential Contaminants	On-Site Sources and Contaminants	• Contaminants related to the presence of Made Ground on site, used for infilling the unauthorised mineral workings, including the use of heavy machinery. These include lubricants, oils, petroleum hydrocarbons and heavy metals. It was noted during the April 1998 report that a diesel tank was present adjacent to the site entrance. • The site was identified as a landfill by East Hertfordshire District Council. Accepted wastes were unknown, although it is proposed that the area was identified as a landfill due to the above described processes however this is not confirmed. Ground gases, including methane and carbon dioxide may be generated on site. • The site is currently used recreationally by trail bike riders. Potential contaminants include oils, heavy metals and petroleum hydrocarbons. • Previous reports have revealed anecdotal evidence relating to areas of potential asbestos containing materials (ACMs) and tipped liquids of unknown origin. • The area is previously identified as farmland. Potential contaminants include pesticides, herbicides, heavy metals, oils, lubricants and petroleum hydrocarbons.
	Off-Site Sources and Contaminants	• Farmland is present adjacent to the north and west of the site. Potential contaminants include pesticides, herbicides, heavy metals, oils, lubricants and petroleum hydrocarbons. • Quarrying activities have occurred to adjacent to the north of the site. Potential contaminants include lubricants, oils,

		petroleum hydrocarbons and heavy metals.

Potential Receptors	Controlled Waters	• Groundwater in the underlying Secondary (A) Aquifer and Principal Aquifer.
	Human Health Risks	• Current site users – walkers, trail bike users. • Future site residents and neighbours • Construction workers
	Other	• Future building foundations/buried concrete • Local wildlife site in north western corner

Potential Contaminant Pathways & Pollutant Linkages	On-Site Contaminants	• Direct and dermal contact; • Soil and dust ingestion; • Ground gas, dust and vapour inhalation; • Vertical and lateral migration of contaminants into controlled waters; • Degradation of foundations and services from aggressive ground conditions. • Given the presence of the permeable geology directly underlying the site, there is the potential for any mobile contaminants within soils to impact groundwater. • The site has been identified as having soils of medium to high leaching potential. As a result, contaminants are considered more likely to be mobile. • In the event of below ground works, site workers may be exposed to any subsurface contamination. It should be ensured that future construction workers adopt appropriate procedures to manage health and safety risks associated with any contamination.
	Off-Site Contaminants	• Given the presence of the underlying permeable geology, there is the potential for contaminated groundwater from the off-site contaminant sources identified to migrate onto the subject site.

Potential contaminant linkages have been identified as a result of the site's contaminative history. The site is also on the council's list of prioritised sites. Despite the environmental protection officer stating that the council currently has no plans to investigate the site, it is likely that investigation will be undertaken in the event of development occurring on the site, however the council currently have no concerns regarding the site.

There is considered to be potential for contamination on the subject site to migrate and impact third party land due to the presence of the Secondary (A) and Principal Aquifer beneath the site and therefore result in third party liability. Previous site investigations have identified concentrations of contaminants at the site which will need to be assessed for a residential land use with plant uptake scenario.

7.3 Preliminary Risk Assessment

7.3.1 On Site

Source	Receptor	Risk	Comment on Hazard Realisation
Made Ground processes	Human Health Controlled Waters Other	MEDIUM	• The area has been identified as containing Made Ground up to 4.9m in thickness, with variable content. • Leachate analysis has previously been undertaken on site and has identified concentration exceeding GACs. • Possibility of flow or leaching into subsurface aquifers through the unsaturated zone. • Possibility of direct dermal contact and soil and dust ingestion or inhalation. • Possibility of aggressive ground conditions, which may affect building foundations.
Reported Landfill	Human Health Controlled Waters Other	MEDIUM	• The area was reported as being subject to landfill by East Hertfordshire District Council. • Accepted wastes, dates of operation and operator are unknown. The site is, however, considered as landfill due to the infilling of the unauthorised mineral extraction site with Made Ground. • Previous reports have identified ground gases, including methane, as present on site. • Possibility of the build up and emission of ground gases.
Mineral Extraction	Human Health Controlled Waters	LOW	• The area was identified as being subject to unauthorised mineral extraction. • During this time, a diesel tank was located adjacent to the entrance of the site. • Heavy plant vehicles were reported to be present on site. • Possibility of flow or leaching into subsurface aquifers through the unsaturated zone. • Possibility of direct dermal contact and soil and dust ingestion or inhalation.
Trail Bikes	Human Health Controlled Waters	LOW	• The site is currently used recreationally by trail bikers. • Possibility of flow or leaching into subsurface aquifers through the unsaturated zone. • Possibility of direct dermal contact and soil and dust ingestion or inhalation.
Areas noted as containing potential ACMs and tipped liquids of unknown origin.	Human Health Controlled Waters Other	MEDIUM	• Anecdotal evidence was provided in a previous report regarding these contaminants. • Possibility of flow or leaching into subsurface aquifers through the unsaturated zone. • Possibility of direct dermal contact and soil and dust ingestion or inhalation. • Possibility of aggressive ground conditions, which may affect building foundations.

Farmland	Human Health Controlled Waters	LOW	• Local land may be used for agricultural purposes. • Possibility of flow or leaching into subsurface aquifers through the unsaturated zone. • Possibility of direct dermal contact and soil and dust ingestion or inhalation. • No evidence of contamination from farmland sources is known at the site.

7.3.2 Off Site

Source	Distance (Direction)	Receptor	Risk	Comment on Hazard Realisation
Farmland	Adjacent (north and west)	Human Health Controlled Waters	LOW	• Local land may be used for agricultural purposes. • Possibility of flow or leaching into subsurface aquifers through the unsaturated zone. • Possibility of direct dermal contact and soil and dust ingestion or inhalation.
Quarrying	Adjacent (north) and 80m, 480m (north east)	Human Health Controlled Waters	LOW	• The area is subject to gravel, sand and chalk quarrying. • Possibility of flow or leaching into subsurface aquifers through the unsaturated zone. • Possibility of direct dermal contact and soil and dust ingestion or inhalation.

8 Geotechnical Considerations

8.1 Proposed Works

London & Regional are seeking to establish a residential development on the site, comprising of approximately 300 residential dwellings with associated car parking and landscaping and the provision of public open space. The existing protected wildlife site will be maintained. Proposed development plans are provided as Figure 3 in **Appendix A**.

8.2 Geotechnical Hazards

A review of geotechnical information provided as part of the Envirocheck Report has been undertaken. The information obtained indicates that the hazards applicable to this site are classified as low or very low. The potential hazards at the site as classified by the BGS are summarised below.

Ground Stability Feature	Hazard
Potential for collapsible ground	Very Low
Potential for landslide ground instability	Very Low
Potential for running sand ground instability	No Hazard
Potential for shrinking or swelling clay	No Hazard
Potential for compressible ground	No Hazard
Potential for ground dissolution	Moderate

There are no man-made mining cavities within 500m of the site. A sinkhole and solution pipe is located 373m east of the site within the chalk group. Three sinkholes are located 407m east of the site within the chalk group. There is one active BGS Recorded Mineral Site 394m west of the site. The Building Control officer at East Hertfordshire District Council reported that properties in the vicinity of the site had previously suffered structural damage caused by subterranean cavities forming under foundations. These were as a result of "swallow holes". This incident was further investigated by WSP, and a report produced by the Hertfordshire County Council Highways and Waste Panel, titled "Sink Holes And Other Features: Winter Damage And Potential Impact On Future Programme", dated 18th March 2014 was identified on the internet.

This reported that the sinkhole was originally reported anonymously and then again by East Herts District Council. The report states the following: "The hole reported is on private property managed by Riversmead Housing Association. Following probe investigations, the hole has been filled. There is, however, further evidence of ground subsidence to a parking bay in the vicinity of the initial hole, possibly indicating the presence of a sink hole. The maintenance of this parking bay is the responsibility of East Herts District Council. Whilst the carriageway appears not to be affected, there are signs of cracks in the footway. It has been recommended that ground radar investigations are carried out in the footway, carriageway, parking bay and verge. Joint working with East Herts District Council will be pursued." Anecdotally, the reported cause of the solution feature was a broken water mains pipe, which has since been repaired.

Panshanger Quarry is an opencast quarry operated by Lafarge-Tarmac, quarrying sand and gravel from ancestral Thames River Terrace Deposits. There are several inactive BGS Recorded Mineral Sites where quarrying has ceased. These are recorded in the table below.

Site Name	Distance from Site (m)	Direction	Type	Operator	Commodity	Geology
Chain Walk Pit	Onsite	N/A	Opencast	Unknown	Sand and Gravel	Kesgrave Catchment Subgroup
Panshanger Quarry	164	South	Opencast	Lafarge Aggregates Ltd.	Sand and Gravel	Kesgrave Catchment Subgroup

Panshanger Quarry	382	South	Opencast	Lafarge Aggregates Ltd.	Sand and Gravel	Kesgrave Catchment Subgroup
Panshanger Quarry	425	South west	Opencast	Lafarge Aggregates Ltd.	Sand and Gravel	Kesgrave Catchment Subgroup
Broadoak End Gravel Pit	436	North east	Opencast	Unknown	Sand and Gravel	Kesgrave Catchment Subgroup
Panshanger Quarry	486	South	Opencast	Lafarge Aggregates Ltd.	Sand and Gravel	Kesgrave Catchment Subgroup
Broadoak End Gravel Pit	500	East	Opencast	Unknown	Sand and Gravel	Kesgrave Catchment Subgroup

The Envirocheck Report indicates that the ground conditions present on site are not considered by the Health Protection Agency to present a Radon risk. The site is located in a low probability radon area, as less than 1% of homes are above the Action Level and no Radon protection measures are required.

8.3 Geotechnical Constraints

Geotechnical Constraints	Comments
Solution Features	Solution features are recorded as being present in the vicinity of the site, and the building control officer reported the occurrence of previous issues with foundations of local properties. 4 sinkholes and 1 solution pipe are shown to be present within 407m to the east of the site. WSP advises that further consultation of available records is advised, prior to a site investigation in order to quantify the risk associated with this hazard.
Excavation Instability	Stability of the cohesive strata beneath the site should not be relied upon in unsupported excavations.
Mature Trees	Trees are present within the hedgerows of the boundaries, some of which are mature. Consideration should be given to potential changes in the strength of the soils if these were to be removed.
Buried Foundations/ Subsurface obstructions	A small building is marked on the mapping. Buried foundations may still be present as a result of this development, however this is unlikely to be the case due to the subsequent levelling exercise and workings. Made Ground was identified during the previous site investigations. If this remains on site, obstructions such as buried concrete slabs may be present in the subsurface.

9 Conclusions and Recommendations

9.1 Conclusions

An initial Conceptual Site Model has been developed on the basis of the information contained within this report (with respect to ground contamination). This PRA has been undertaken in accordance with the Environment Agency Model Procedures (CLR 11).

The source – pathway – receptor linkages identified have been considered and the results of the PRA have identified MEDIUM potential risks arising from contamination at the site and surrounding area. The risks to human health, groundwater, buildings and structures are likely to be capable of mitigation through the implementation of health and safety procedures such as dust control, PPE and standard good practice.

The following potential sources of contamination were identified;

- Made Ground/Landfill (on-site);
- Mineral Extraction (on-site);
- Trail Bikes (on-site);
- Areas noted as potentially containing potential ACMs and tipped liquids of unknown origin (on-site);
- Farmland (on-site and adjacent to the north and east); and
- Quarrying (adjacent north, 80m north east, and 480m north east).

Potential pathways associated with these sources were identified as the following;

- Direct and dermal contact;
- Soil and dust ingestion;
- Ground gas, dust and vapour inhalation;
- Vertical and lateral migration of contaminants into controlled waters;
- Degradation of foundations and services from aggressive ground conditions; and
- Given the presence of the permeable geology directly underlying the site, there is the potential for any mobile contaminants within soils to impact groundwater.

Potential receptors were identified as the following;

- Groundwater in the underlying Principal Aquifer and the underlying Secondary (A) Aquifer;
- Current site users – walkers, trail bike users;
- Future site residents and neighbours;
- Construction workers;
- Future building foundations/buried concrete; and
- Local wildlife site in north western corner.

Based on the information contained in this report and with due regard to the proposed development, it is considered that the site represents a **Medium** risk with respect to contaminated land liability issues. It is the opinion of WSP that the site represents a **Medium - High** risk with respect to geotechnical issues, predominantly as a result of the potential presence of chalk dissolution features.

9.2 Recommendations

- It is recommended that a factual report and risk assessment using the national cavity database, as held by Peter Brett Associates, regarding natural and man-made cavities in the vicinity of the site is obtained, due to the potential presence of chalk solution features.
- CIRIA document C574, Engineering in Chalk, recommends that due to the potential for the creation of dissolution features, drainage infiltration solutions such as soakaways are advised to be avoided if at all possible, but, if unavoidable, will need to be sited at least 20m from any building footprint construction. The position of such infiltration and soakaway features should also be located away from areas of thick Made Ground at the site.
- The completion of an ecology survey to assess for the potential presence of invasive plant species (e.g. Giant Hogweed/Japanese Knotweed) and sensitive habitat/species;

- It is recommended that due to the presence of the Chalk and the need to identify any potential solution features, a Ground Investigation is undertaken. This would assist in the characterisation of the site, further delineate the lateral extent of the Made Ground, supplement existing contamination data and inform foundation design. This would comprise the following:
    - The advancement of deep cable percussive boreholes to obtain further coverage of deeper strata across the site and ascertain the presence of any potential water bearing strata.
    - The advancement of window sample boreholes to delineate the extent of the Made Ground and to undertake SPT testing.
    - CPT testing to assist in identifying the presence of solution features within the chalk.
    - The installation of ground gas and groundwater monitoring wells within the deep cable percussive boreholes and the window sample boreholes, with subsequent ground gas and groundwater monitoring visits undertaken to assess the risk to groundwater and the risk of ground gas emissions on site.
    - As a part of this ground investigation, the collection of soil and groundwater samples for geochemical and geotechnical analysis is advised to assess concentrations of contaminants in relation to current SGVs, GACs and Drinking Water Standards.
    - Based on the findings, a Remediation Method Statement should be prepared, supplemented by a watching brief during the groundworks phase of the construction. A Verification Report will then need to be prepared on completion of the development. Both the Remediation Method Statement and the Verification Report should be submitted to the Local Planning Authority for review and appeal.
- If any significant changes to the proposed development are made it may be necessary for the PRA undertaken as part of this report to be updated.

Appendices

Appendix A – Figures

File: Z:\#Projects\40001 - 50000\44968 - Land North of Welwyn Rd, Hertford\0001\(8) Report\Appendices\Figures\Figure 1 - Site Location Plan.pdf

Drawn By: A J Allen Date Modified: May 2014

WSP

TITLE:

Land North of Welwyn Road
Hertford
Site Location Plan

FIGURE No:

70002900 - Figure 1

Pedestrian Entrance

Ridge (1m height) Nettles

10-15m Drop Through Wood Into Farmland

Brambles

Woodland With Mature Trees (non-coniferous)

5m Drop

Potential Solution Features

Woodland With Mature Trees (coniferous)

Open Area With Flint & Gravel Paths

Raised Area With Weeds & Broad Leaved Plants

3-4m Mound

Pedestrian Entrance

Rusted Car

Area of Raised Ground With Flint & Gravel

Open Grass Area With Some Weeds & Broad Leaved Plants

Grassed Area (0.5m Lower)

Grassed Area

General Slope

Berm With Weeds & Small Plants

Raised Area (50cm) With Weeds & Broad Leaved Plants

Ditch

Notes:

- Evidence of burning having occurred on Eastern plateau.
- Across the site, visible timber, brick, concrete & tarmac in areas of raised earth.

NOT TO SCALE

WSP

TITLE:

Land North of Welwyn Road

Hertford

Annotated Site Plan

FIGURE No:

70002900-EF1 - Figure 2

Z:\#Projects\40001 - 50000\44968 - Land north of Welwyn Rd, Hertford\0001\(9) Drawings\Figure 2 - Annotated Site Plan.dwg

Appendix B – Photographic Record

Photo 1: The berm constituting the southern boundary of the site. Photo taken from the base of the ramp connecting the eastern and western plateaus.

Photo 2: The dry ditch within the berm, situated in the south east corner of the site. Photo taken from the top of the berm at the end of the dry ditch.

Photo 3: An overview of the eastern plateau. Picture taken from the top of the berm.

Photo 4: A large 3-4m tall earth mound, situated on the eastern plateau. Photo taken facing south in the northern section of the eastern plateau.

Photo 5: The wooden spur, as seen from the eastern plateau. Photo taken adjacent to the large earth mound, facing east.

Photo 6: An overview of the western plateau, facing north, towards the local wildlife site.

Photo 7: An overview of the eastern plateau, facing north east. The wooded spur is visible in the centre of the photo. Photo taken from the centre of the eastern plateau.

Photo 8: An overview of the local wildlife site with local gravel paths. Photo taken from the southern end of the wooded spur.

Photo 9: The rusted car and localised area of burning. Photo taken within the local wildlife site.

Photo 10: A potentially small solution hole noted in the woodland adjacent to the north of the site. Photo taken on the northern boundary of the site, adjacent to the local wildlife site. Approximate extent of solution hole marked by red line. The diameter is approximately 1m to 2m.

Appendix C – Historic Maps

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

Gravel Pit
Sand Pit
Other Pits
Quarry
Shingle
Orchard
Osiers
Reeds
Marsh
Mixed Wood
Deciduous
Brushwood
Fir
Furze
Rough Pasture
Arrow denotes flow of water
Trigonometrical Station
Site of Antiquities
Bench Mark
Pump, Guide Post, Signal Post
Well, Spring, Boundary Post
·285 Surface Level
Sketched Contour
Instrumental Contour
Main Roads
Fenced
Un-Fenced
Minor Roads
Fenced
Un-Fenced
Sunken Road
Raised Road
Road over Railway
Railway over River
Railway over Road
Level Crossing
Road over River or Canal
Road over Stream
Road over Stream
County Boundary (Geographical)
County & Civil Parish Boundary
Administrative County & Civil Parish Boundary
Co. Boro. Bdy. County Borough Boundary (England)
Co. Burgh Bdy. County Burgh Boundary (Scotland)
R.D. Bdy. Rural District Boundary
Civil Parish Boundary

Ordnance Survey Plan 1:10,000

Chalk Pit, Clay Pit or Quarry
Gravel Pit
Sand Pit
Disused Pit or Quarry
Refuse or Slag Heap
Lake, Loch or Pond
Dunes
Boulders
Coniferous Trees
Non-Coniferous Trees
Orchard
Scrub
Coppice
Bracken
Heath
Rough Grassland
Marsh
Reeds
Saltings
Building
Direction of Flow of Water
Shingle
Sand
Glasshouse
Pylon
Pylon
Electricity Transmission Line
Sloping Masonry
Cutting
Embankment
Standard Gauge Multiple Track
Road Under
Road Over
Level Crossing
Foot Bridge
Standard Gauge Single Track
Siding, Tramway or Mineral Line
Narrow Gauge
Geographical County
Administrative County, County Borough or County of City
Municipal Borough, Urban or Rural District, Burgh or District Council
Borough, Burgh or County Constituency
Shown only when not coincident with other boundaries
Civil Parish
Shown alternately when coincidence of boundaries occurs

BP, BS	Boundary Post or Stone	Pol Sta	Police Station
Ch	Church	PO	Post Office
CH	Club House	PC	Public Convenience
F E Sta	Fire Engine Station	PH	Public House
FB	Foot Bridge	SB	Signal Box
Fn	Fountain	Spr	Spring
GP	Guide Post	TCB	Telephone Call Box
MP	Mile Post	TCP	Telephone Call Post
MS	Mile Stone	W	Well

1:10,000 Raster Mapping

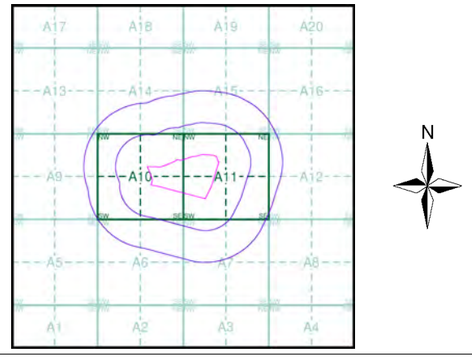
Gravel Pit
Refuse tip or slag heap
Rock
Rock (scattered)
Boulders
Boulders (scattered)
Shingle
Mud
Sand
Sand Pit
Slopes
Top of cliff
General detail
Underground detail
Overhead detail
Narrow gauge railway
Multi-track railway
Single track railway
County boundary (England only)
Civil, parish or community boundary
District, Unitary, Metropolitan, London Borough boundary
Constituency boundary
Area of wooded vegetation
Non-coniferous trees
Non-coniferous trees (scattered)
Coniferous trees
Coniferous trees (scattered)
Positioned tree
Orchard
Coppice or Osiers
Rough Grassland
Heath
Scrub
Marsh, Salt Marsh or Reeds
Water feature
Flow arrows
MHW(S) Mean high water (springs)
MLW(S) Mean low water (springs)
Telephone line (where shown)
Electricity transmission line (with poles)
BM 123.45 m Bench mark (where shown)
Triangulation station
Point feature (e.g. Guide Post or Mile Stone)
Pylon, flare stack or lighting tower
Site of (antiquity)
Glasshouse
General Building
Important Building

WSP

Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Hertfordshire	1:10,560	1884	2
Hertfordshire	1:10,560	1899	3
Hertfordshire	1:10,560	1925	4
Hertfordshire	1:10,560	1938	5
Historical Aerial Photography	1:10,560	1947 - 1949	6
Hertfordshire	1:10,560	1950 - 1951	7
Ordnance Survey Plan	1:10,000	1960	8
Ordnance Survey Plan	1:10,000	1960 - 1965	9
Ordnance Survey Plan	1:10,000	1978	10
Ordnance Survey Plan	1:10,000	1981 - 1989	11
Ordnance Survey Plan	1:10,000	1991	12
10K Raster Mapping	1:10,000	2006	13
VectorMap Local	1:10,000	2014	14

Historical Map - Slice A



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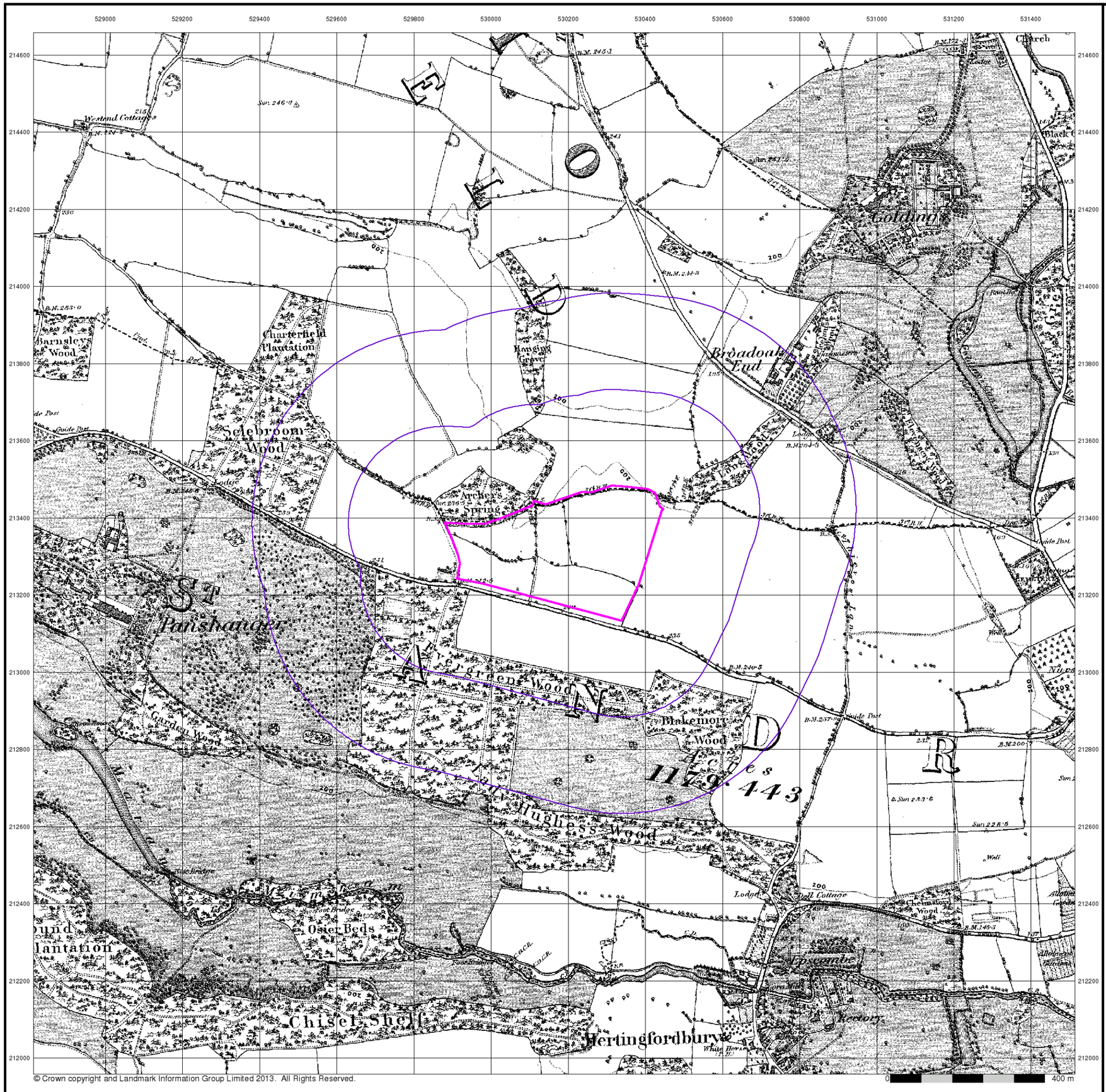
Customer Ref:	70002900-EF1
National Grid Reference:	530180, 213320
Slice:	A
Site Area (Ha):	12.58
Search Buffer (m):	500

Site Details

Land north of Welwyn Road, Hertford

Landmark Information Group
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



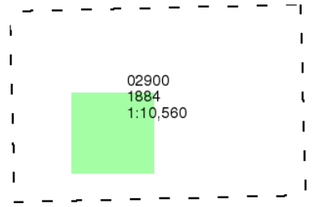
Hertfordshire

Published 1884

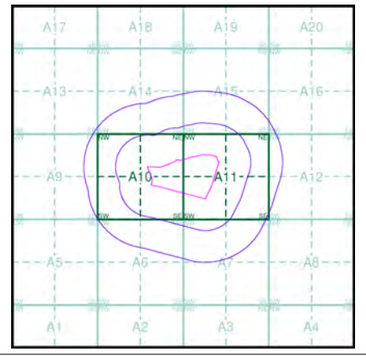
Source map scale - 1:10,560

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



Historical Map - Slice A



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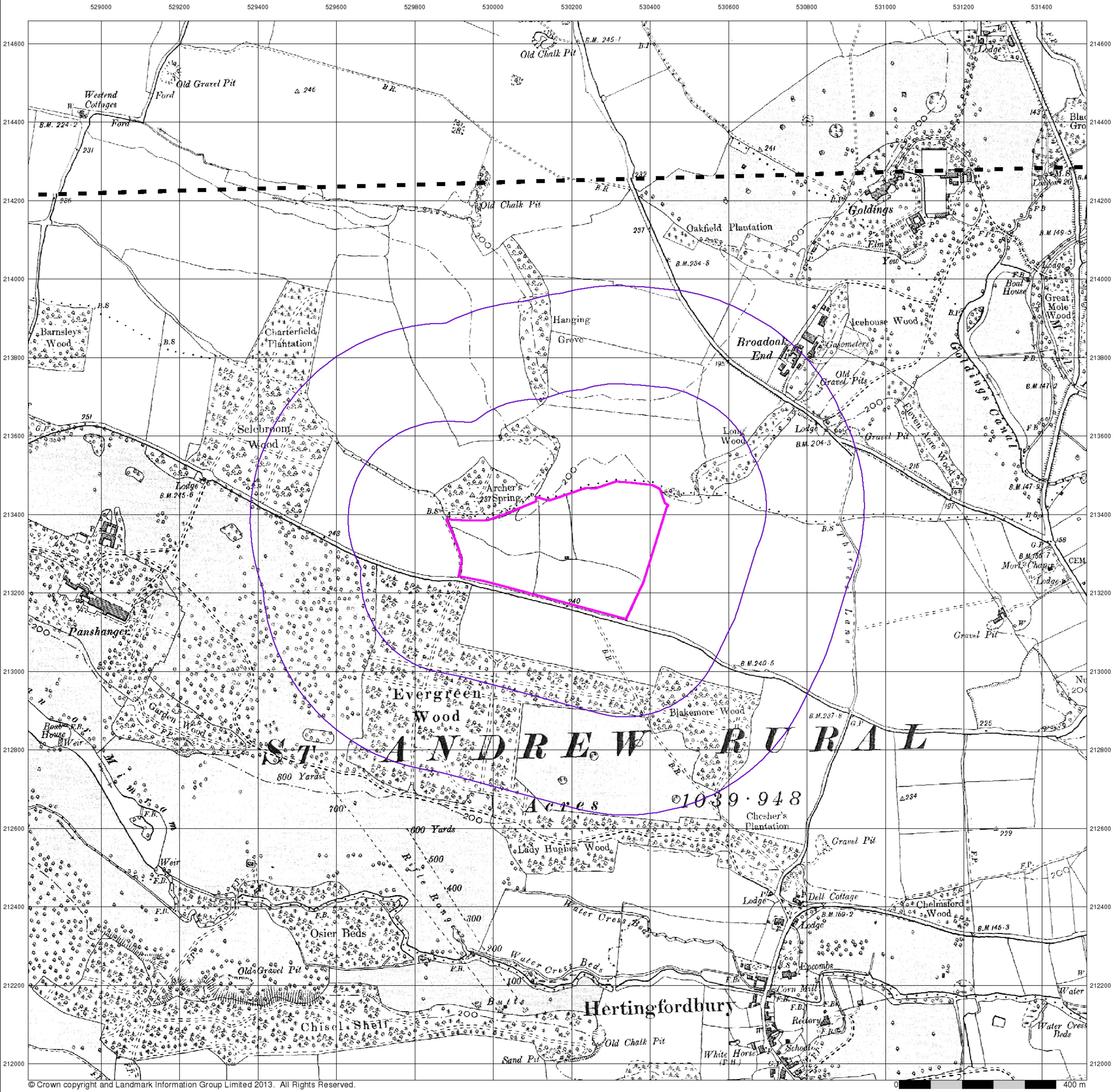

Hertfordshire

Published 1899

Source map scale - 1:10,560

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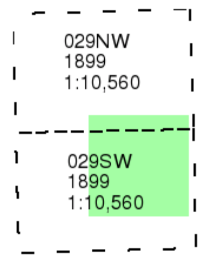

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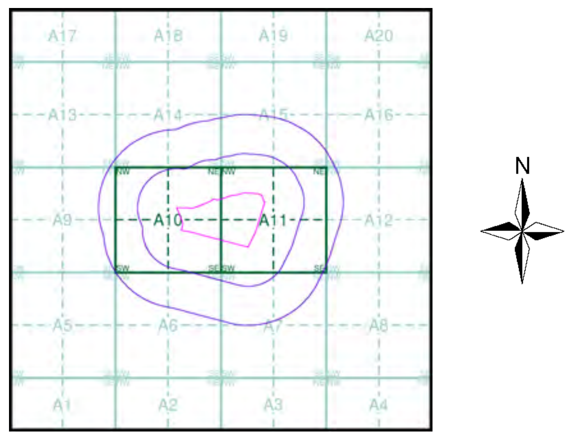

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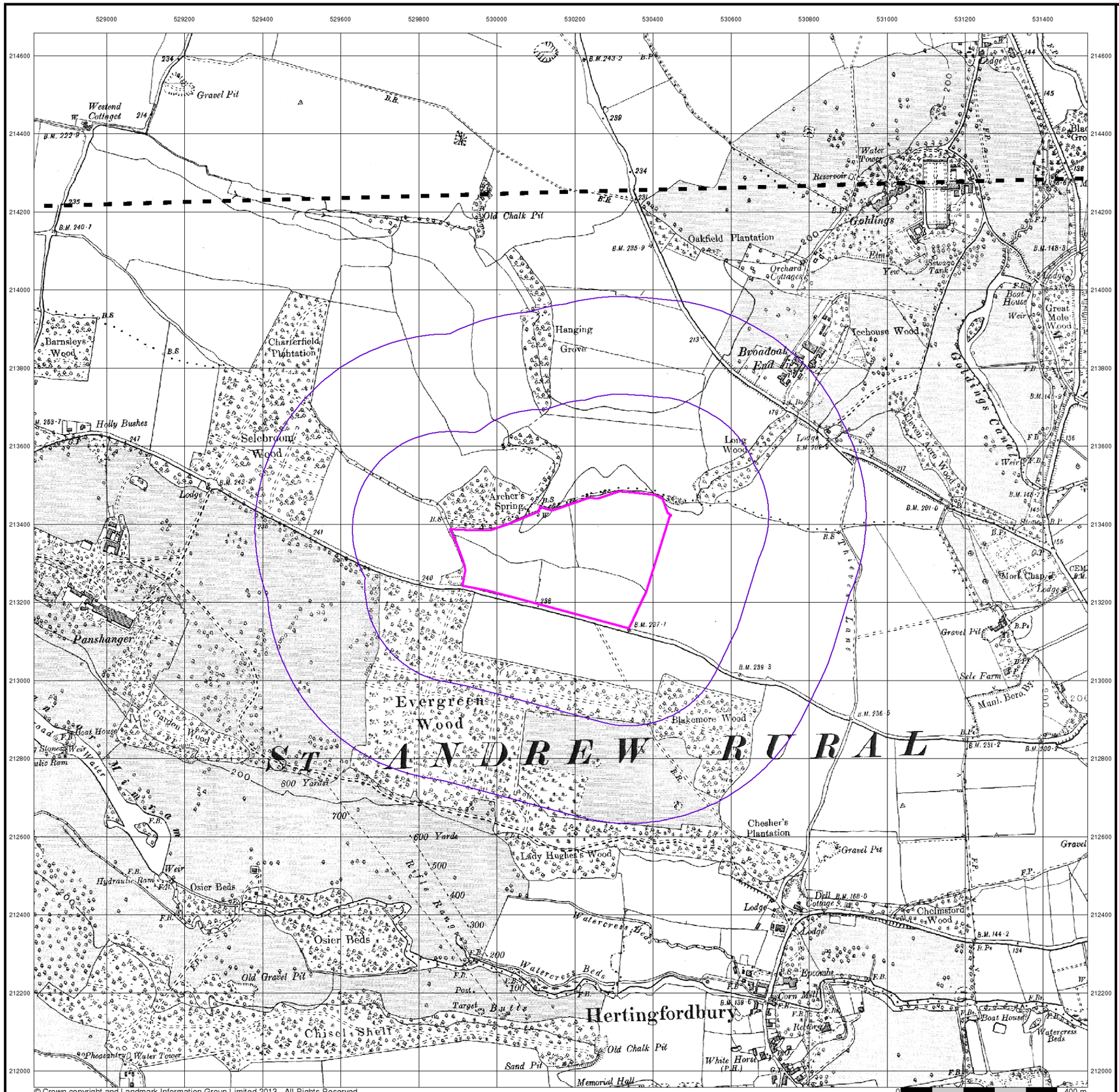

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Hertfordshire

Published 1925

Source map scale - 1:10,560

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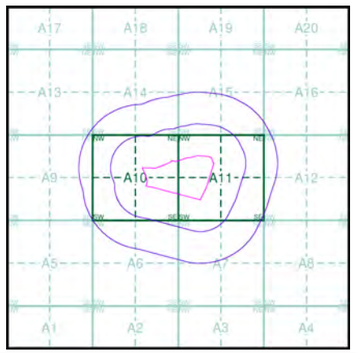
Map Name(s) and Date(s)

029NW
1925
1:10,560

029SW
1925
1:10,560

Historical Map - Slice A



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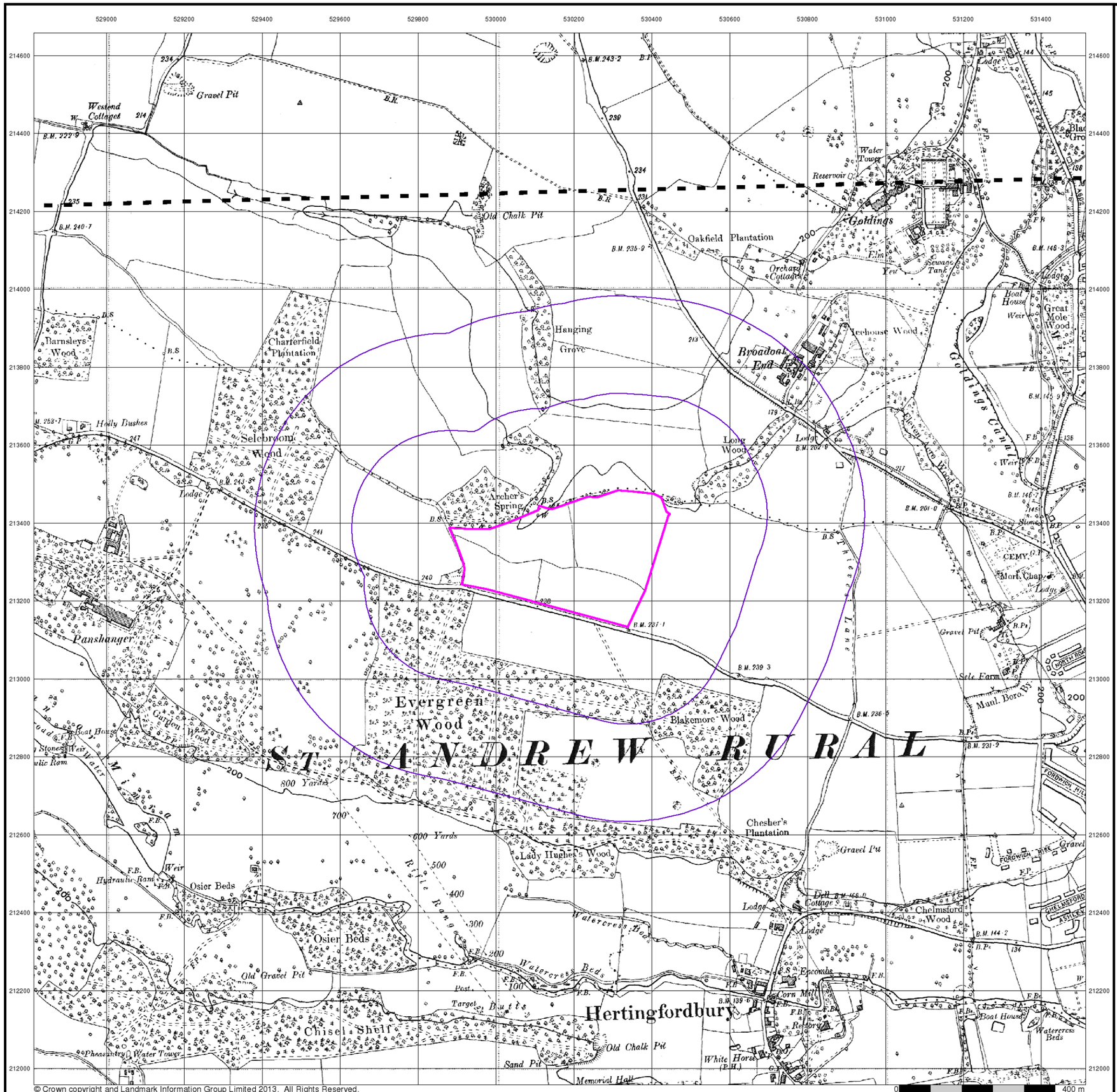

WSP

Hertfordshire

Published 1938

Source map scale - 1:10,560

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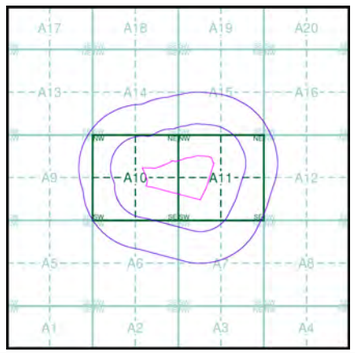
Map Name(s) and Date(s)

029NW
1938
1:10,560

029SW
1938
1:10,560

Historical Map - Slice A



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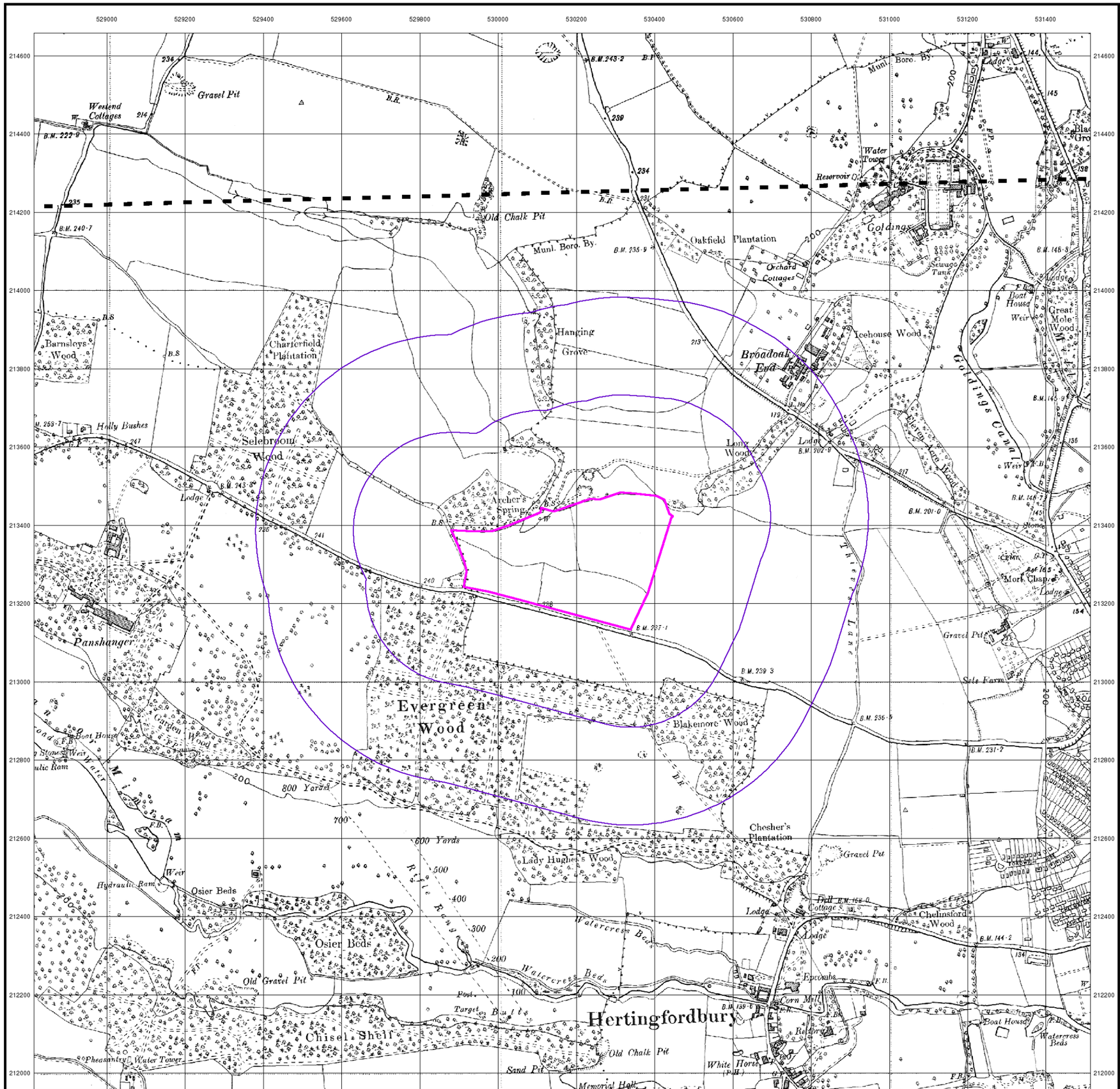

WSP

Hertfordshire

Published 1950 - 1951

Source map scale - 1:10,560

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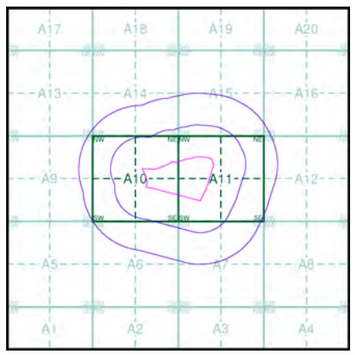
Map Name(s) and Date(s)

029NW
1950
1:10,560

029SW
1951
1:10,560

Historical Map - Slice A



Order Details

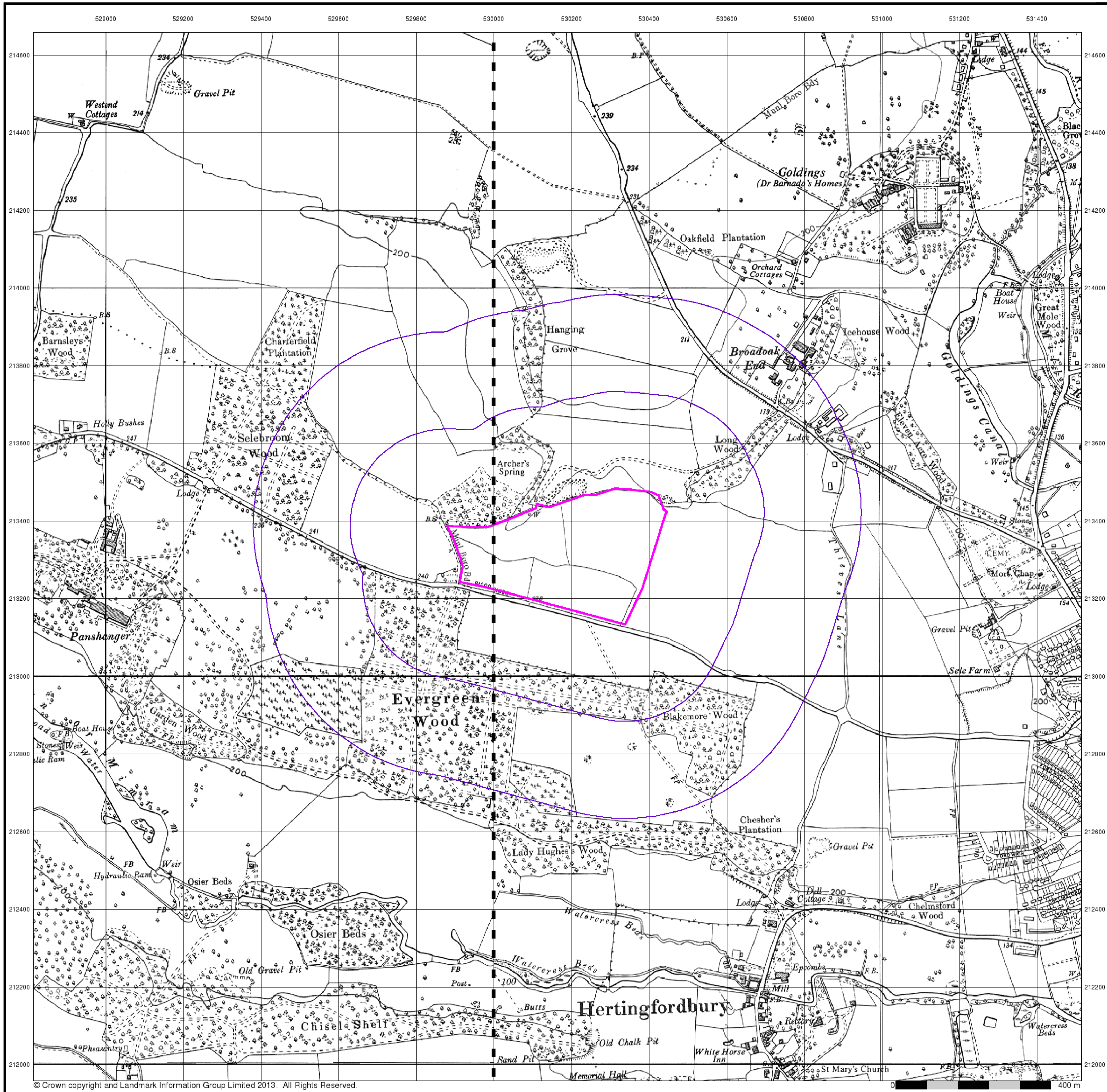
Order Number:	56213984_1_1
Customer Ref:	70002900-EF1
National Grid Reference:	530180, 213320
Slice:	A
Site Area (Ha):	12.58
Search Buffer (m):	500

Site Details

Land north of Welwyn Road, Hertford

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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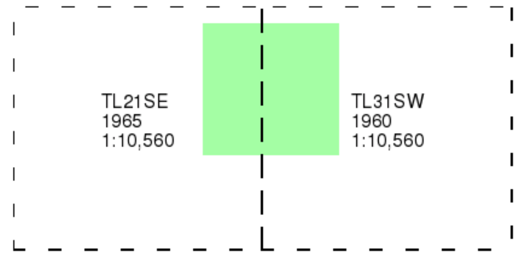
Ordnance Survey Plan

Published 1960 - 1965

Source map scale - 1:10,000

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)



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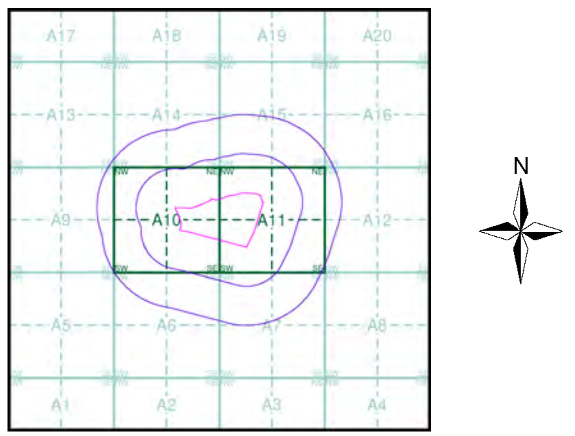

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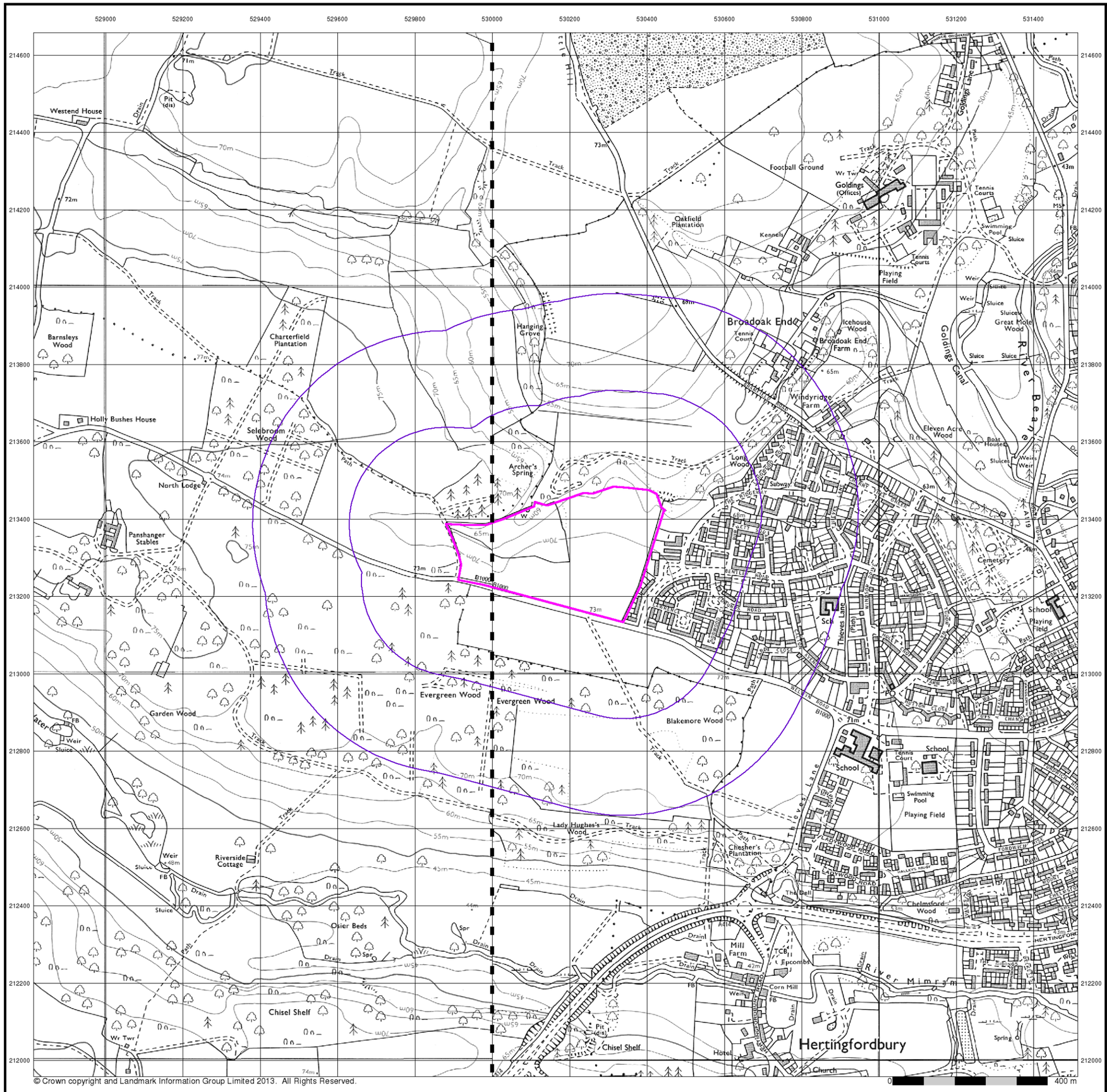

WSP

Ordnance Survey Plan

Published 1981 - 1989

Source map scale - 1:10,000

The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840`s. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940`s, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

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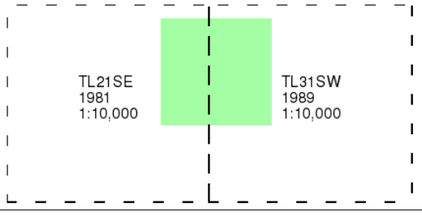

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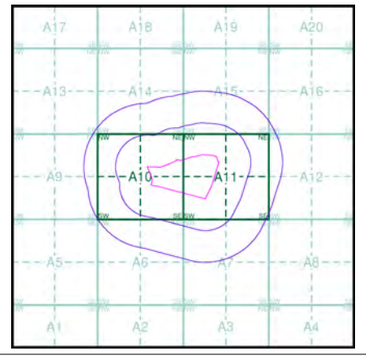

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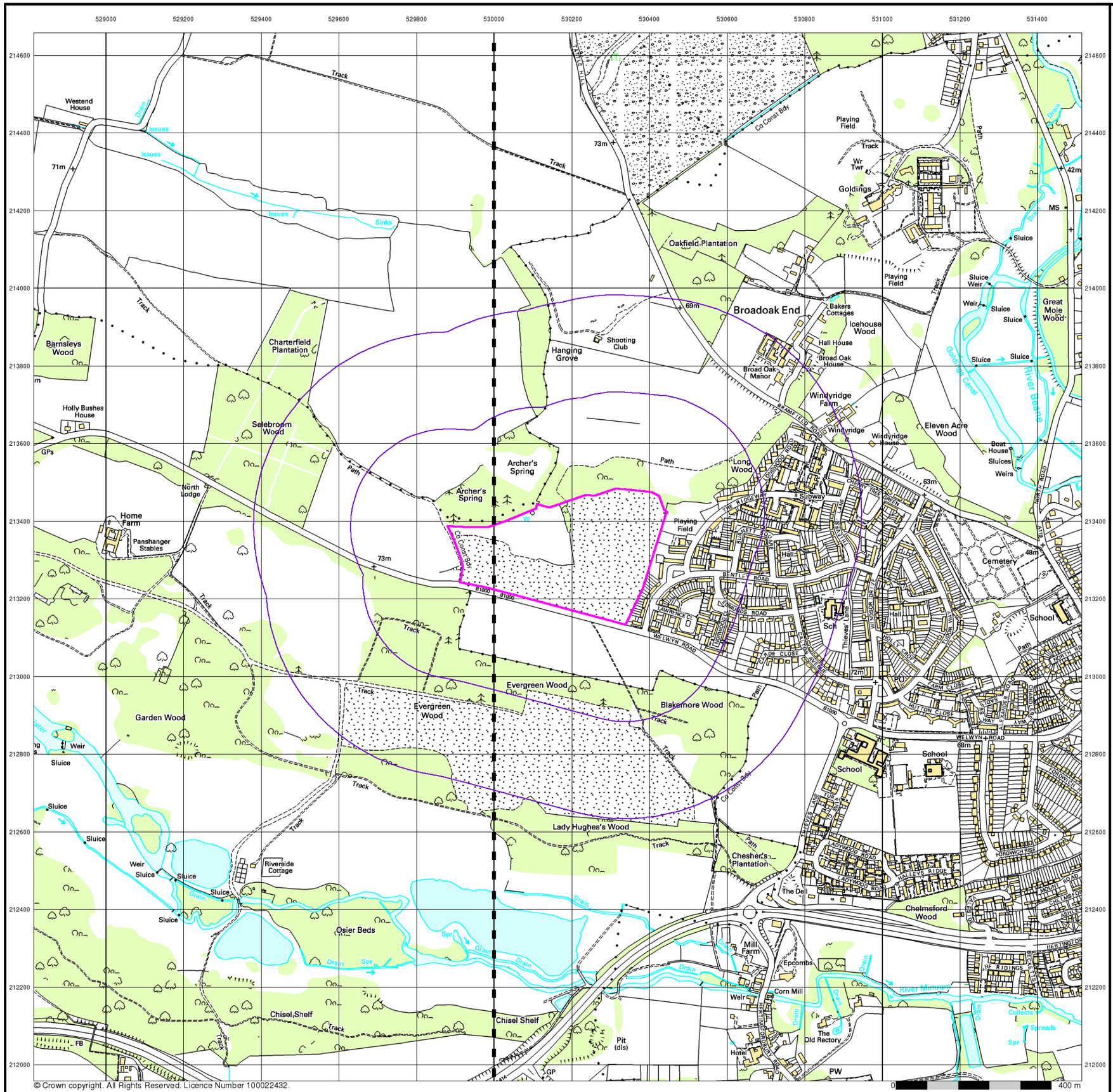


WSP

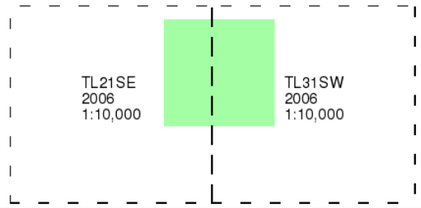
10k Raster Mapping

Published 2006

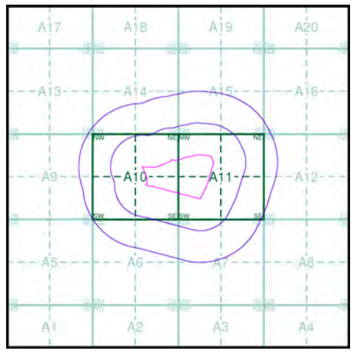
Source map scale - 1:10,000

The historical maps shown were produced from the Ordnance Survey`s 1:10,000 colour raster mapping. These maps are derived from Landplan which replaced the old 1:10,000 maps originally published in 1970. The data is highly detailed showing buildings, fences and field boundaries as well as all roads, tracks and paths. Road names are also included together with the relevant road number and classification. Boundary information depiction includes county, unitary authority, district, civil parish and constituency.

Map Name(s) and Date(s)



Historical Map - Slice A



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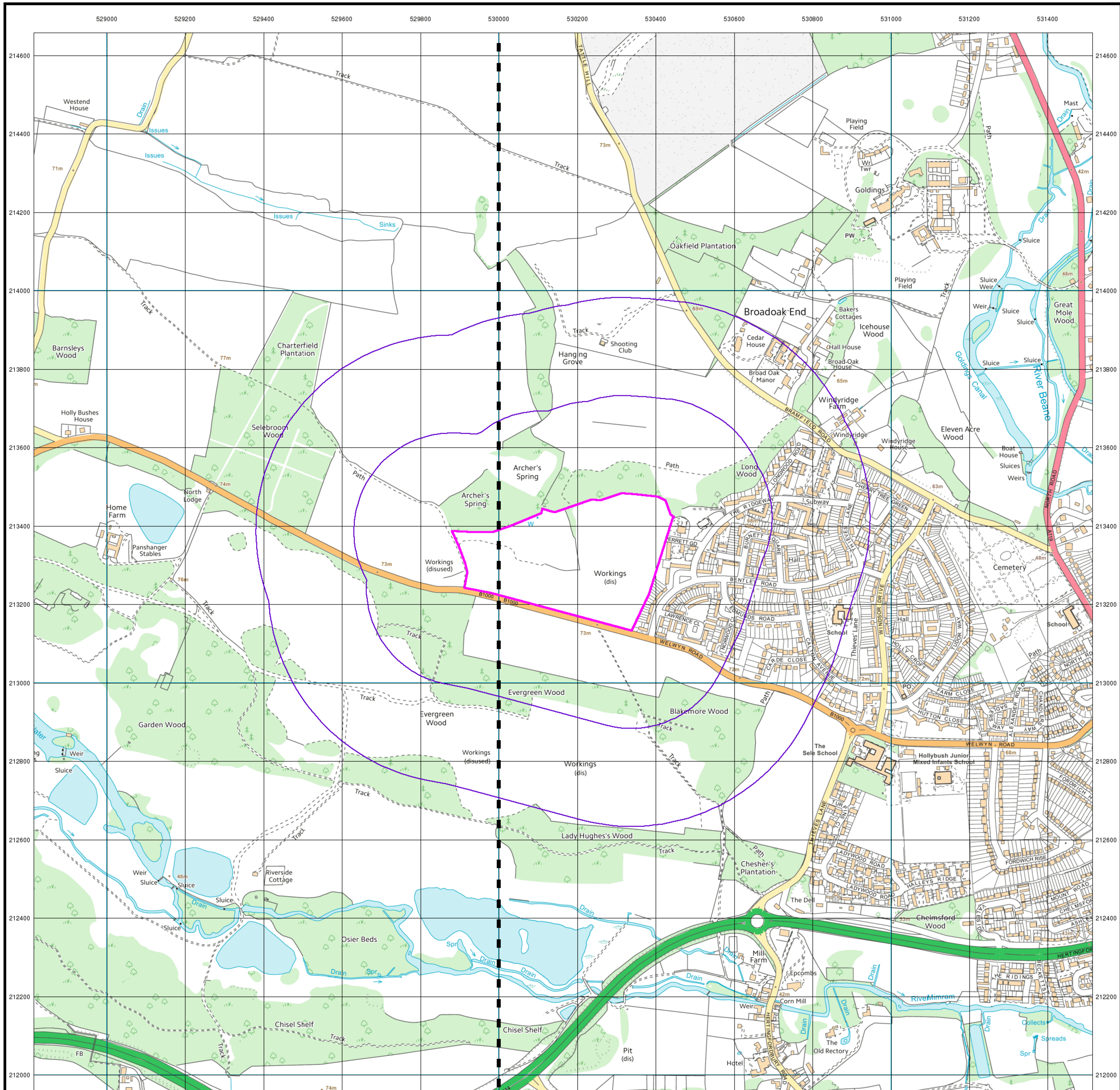


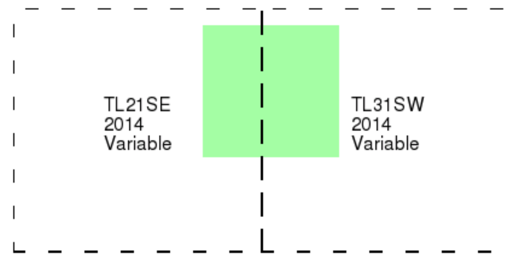
VectorMap Local

Published 2014

Source map scale - 1:10,000

VectorMap Local (Raster) is Ordnance Survey's highest detailed 'backdrop' mapping product. These maps are produced from OS's VectorMap Local, a simple vector dataset at a nominal scale of 1:10,000, covering the whole of Great Britain, that has been designed for creating graphical mapping. OS VectorMap Local is derived from large-scale information surveyed at 1:1250 scale (covering major towns and cities),1:2500 scale (smaller towns, villages and developed rural areas), and 1:10 000 scale (mountain, moorland and river estuary areas).

Map Name(s) and Date(s)



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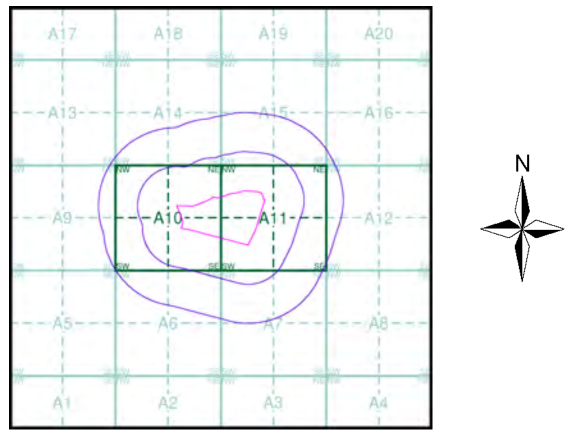

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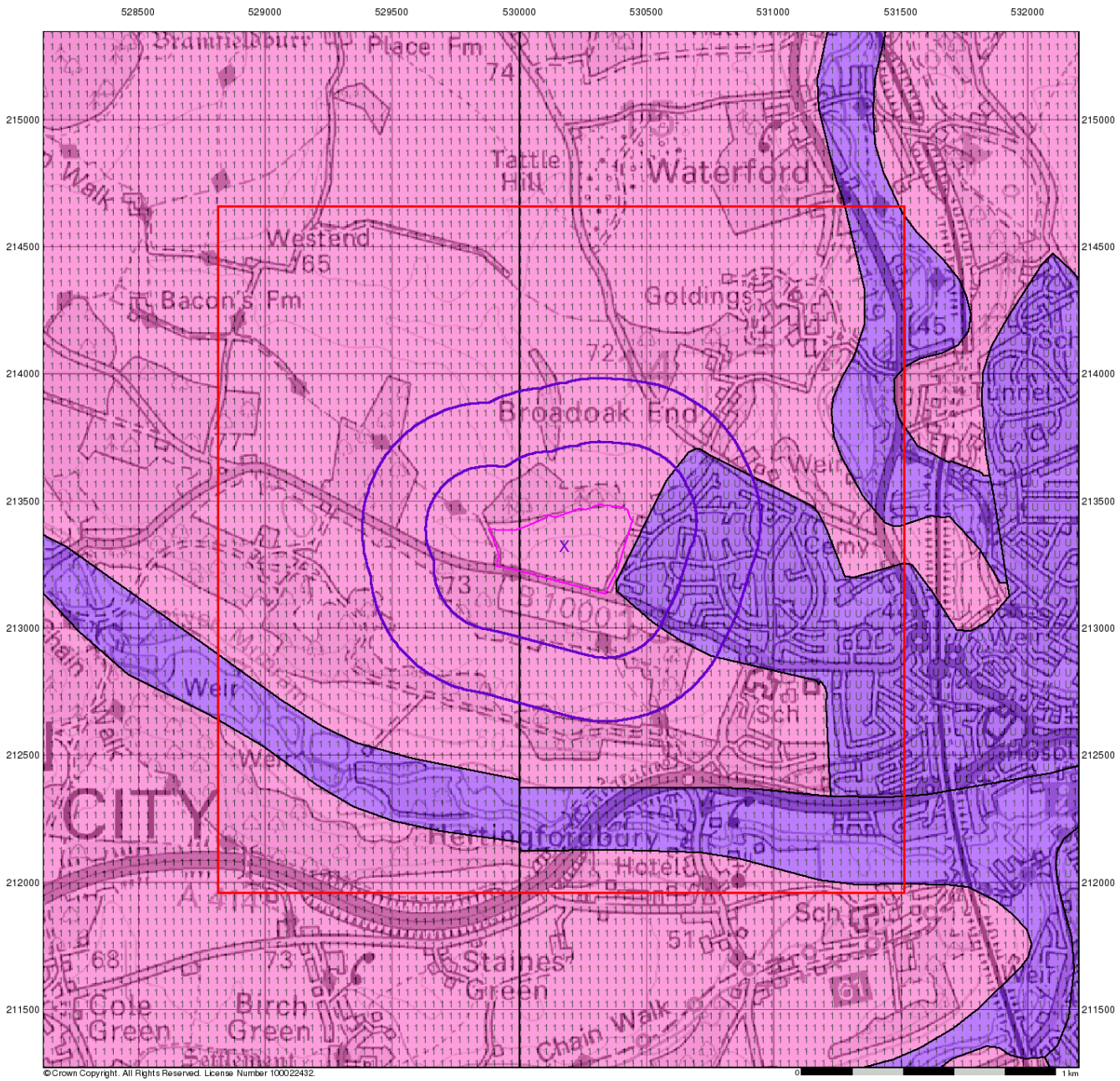
Appendix D – Landmark Report Summary



Groundwater Vulnerability

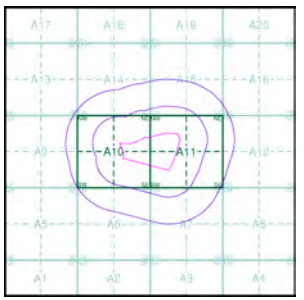
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes	Soil Classes
Major Aquifer (Highly Permeable)	High (H) 1, 2, 3, U
	Intermediate (I) 1, 2
	Low
Minor Aquifer (Variably Permeable)	High (H) 1, 2, 3, U
	Intermediate (I) 1, 2
	Low
Non Aquifer (Negligibly Permeable)	
Water or Sea	
Drift Deposit	

Site Sensitivity Context Map - Slice A



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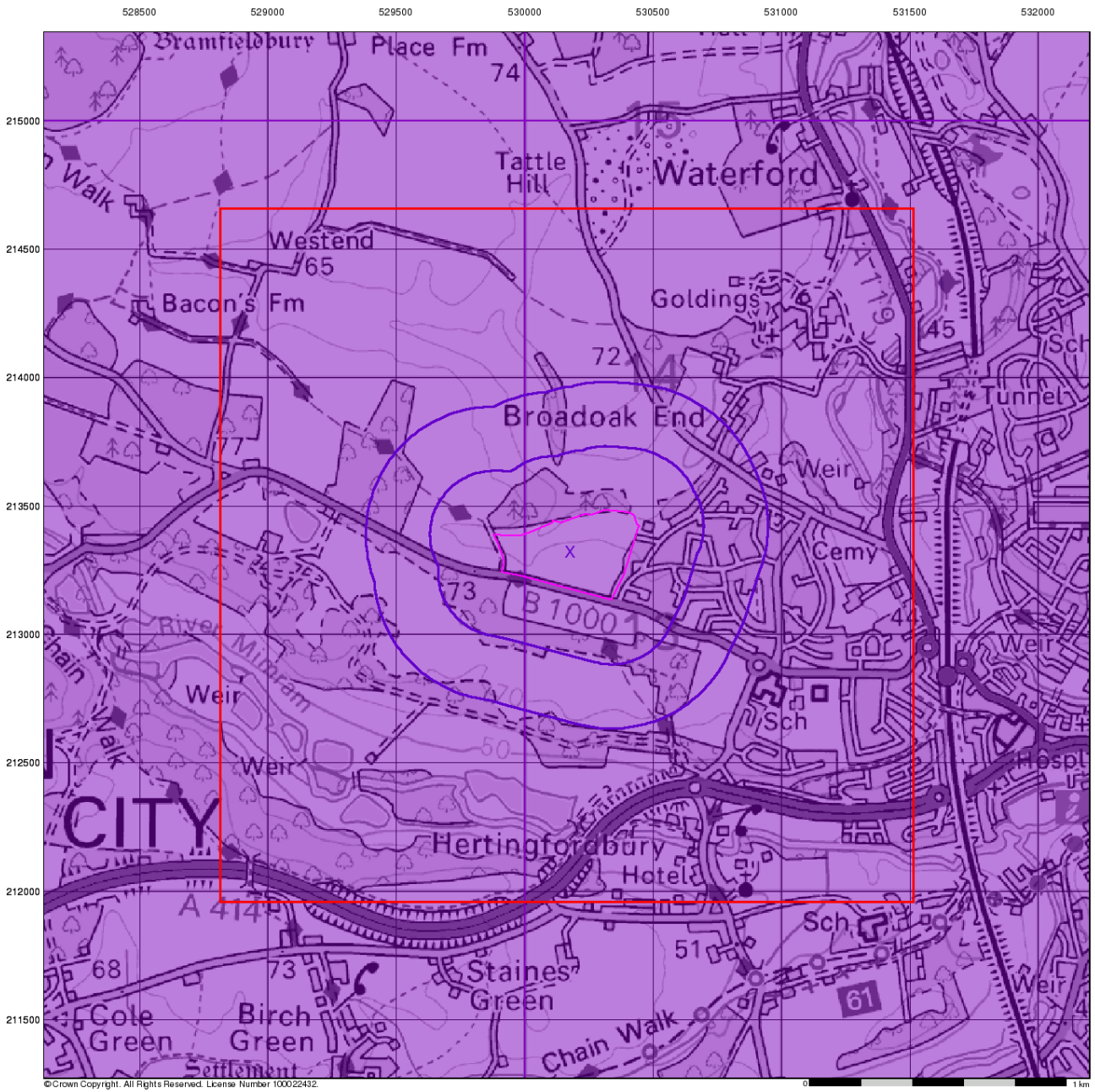


Bedrock Aquifer Designation

General

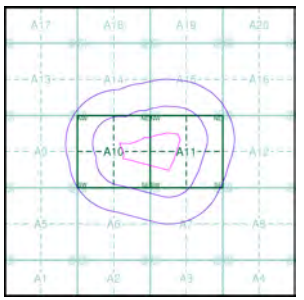
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown

Site Sensitivity Context Map - Slice A



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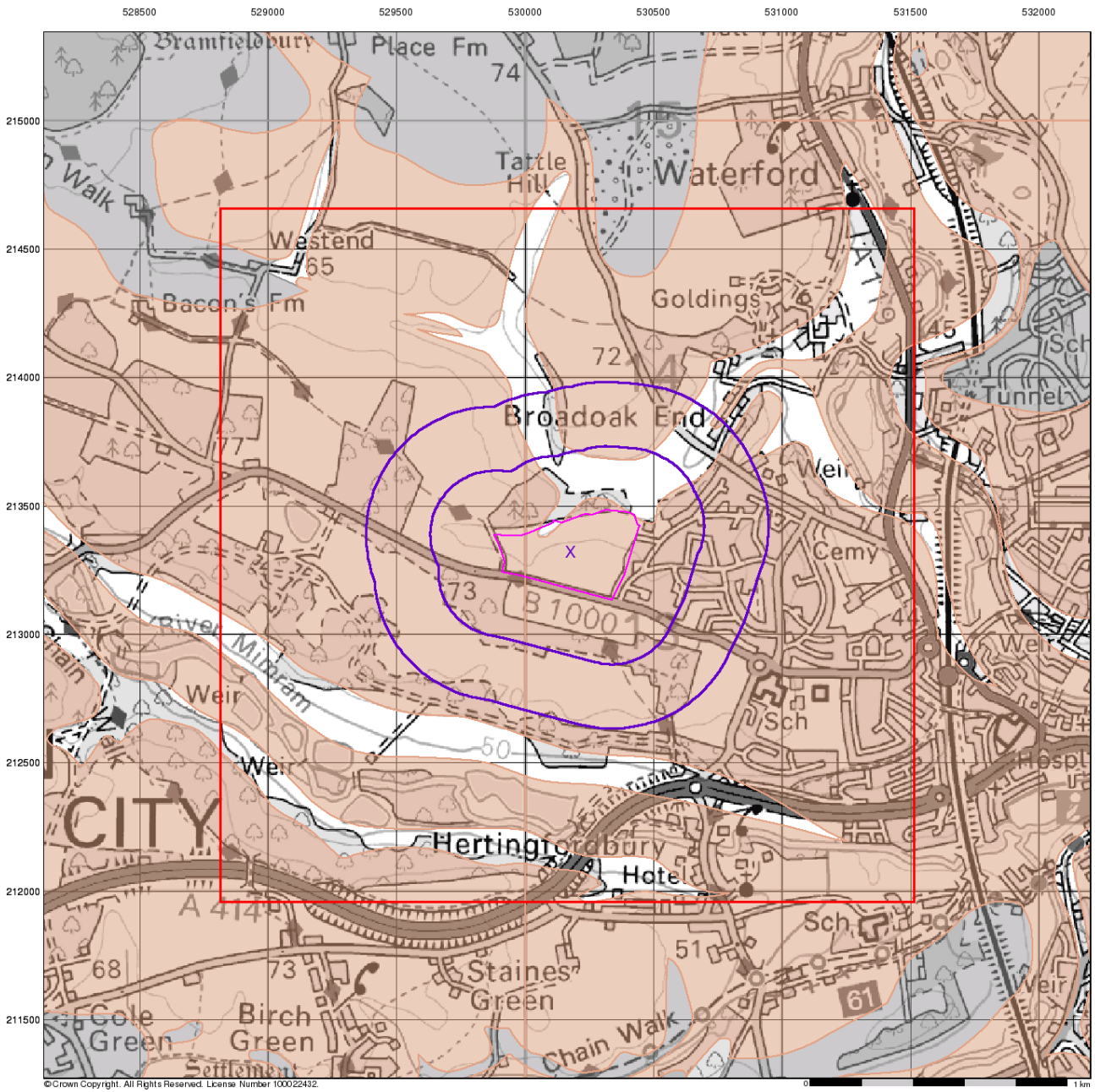


WSP

Superficial Aquifer Designation

General

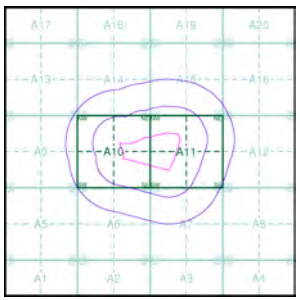
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown

Site Sensitivity Context Map - Slice A



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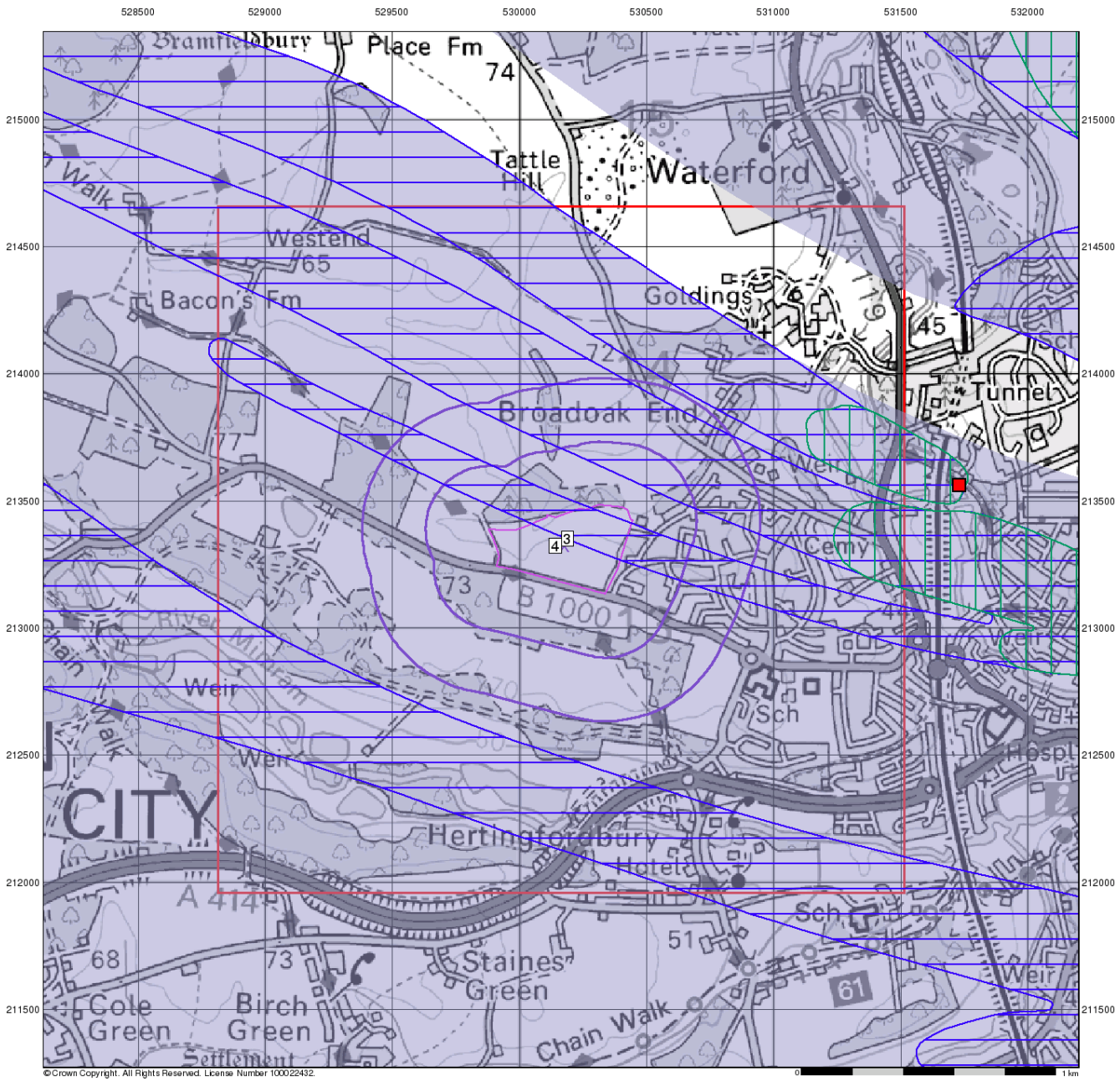


Source Protection Zones

General

Specified Site | Specified Buffer(s) | Bearing Reference Point

Slice | Map ID

Agency and Hydrological

Source Protection Zone I

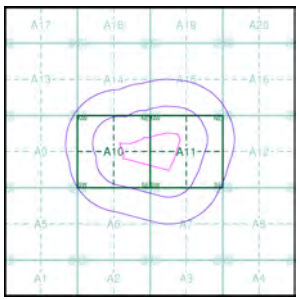
Source Protection Zone II

Source Protection Zone III

Zone of Special Interest

Source Protection Zone Borehole

Site Sensitivity Context Map - Slice A



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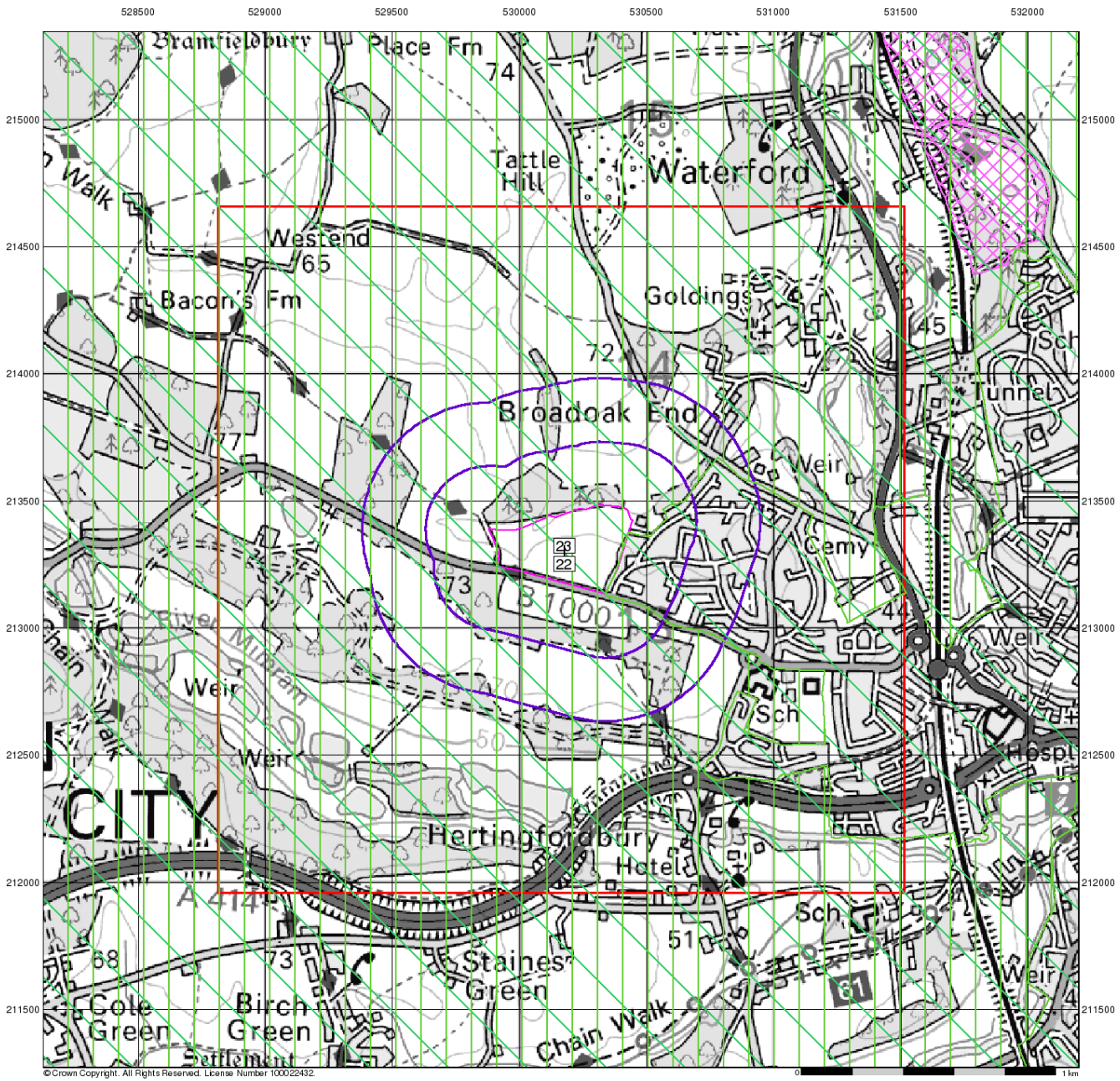


WSP

Sensitive Land Uses

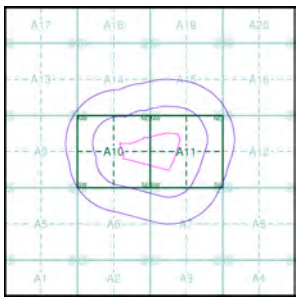
General

Specified Site | Specified Buffer(s) | Bearing Reference Point
Slice | Map ID

Sensitive Land Uses

- Area of Adopted Green Belt
- Area of Unadopted Green Belt
- Area of Outstanding Natural Beauty
- Environmentally Sensitive Area
- Forest Park
- Local Nature Reserve
- Marine Nature Reserve
- National Nature Reserve
- National Park
- Nitrate Sensitive Area
- Nitrate Vulnerable Zone
- Ramsar Site
- Site of Special Scientific Interest
- Special Area of Conservation
- Special Protection Area

Site Sensitivity Context Map - Slice A



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Appendix E – Environment Agency Classifications

Environment Agency Aquifer Classifications

From 1 April 2010 the Environment Agency (EA) Groundwater Protection Policy has used aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) but also their role in supporting surface water flows and wetland ecosystems. The aquifer designation data is based on geological mapping provided by the British Geological Survey. The EA will be updated regularly to reflect their ongoing programme of improvements to these maps. The maps are split into two different type of aquifer designation:

- Superficial (Drift) - permeable unconsolidated (loose) deposits. For example, sands and gravels.
- Bedrock -solid permeable formations e.g. sandstone, chalk and limestone.

The maps display the following aquifer designations:

1. **Principal Aquifer**

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

2. **Secondary Aquifer**

Secondary A - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers;

Secondary B - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.

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

3. **Unproductive Strata**

These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow and. can only support very minor abstractions if any. E.g. Mercia Mudstones, igneous rocks

Environment Agency Source Protection Zones

The EA definition of the shape and size of a zone depends on the condition of the ground, how the groundwater is removed and other environmental factors. The EA then develops a model of the groundwater environment on which to define the zones.

Zone 1 (Inner protection zone)

These are zones in which pollution can travel to the borehole within 50 days from any point within the zone is classified as being inside zone 1. This applies at and below the water table. This zone also has a minimum 50 metre protection radius around the borehole. These criteria are designed to protect against the transmission of toxic chemicals and water-borne disease.

Zone 2 (Outer protection zone)

The outer zone covers pollution that takes up to 400 days to travel to the borehole, or 25% of the total catchment area – whichever area is the biggest. This travel time is the minimum amount of time that the Environment Agency require for contaminants to be diluted, reduced in strength or delayed by the time they reach the borehole.

Zone 3 (Total catchment)

The total catchment is the total area needed to support removal of water from the borehole, and to support any discharge from the borehole.

Regulatory Information Sources

Reference has been made to the Landmark Information Group data provision service. This includes information and data collated from several organisations, including the EA, Department for Environment, Food & Rural Affairs, Health & Safety Executive, the Health Protection Agency, and the Coal Authority.

Appendix F - Limitations

LIMITATIONS FOR WSP LAND RESTORATION AND GROUND ENGINEERING DIVISION

General

WSP has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report. Unless explicitly agreed otherwise, in writing, this report has been prepared under WSP standard Terms and Conditions, as included within our proposal to the Client.

Project specific appointment documents may be agreed on a project by project basis, at our discretion. A charge may be levied for both the time to review and finalise appointments documents and also for associated changes to the appointment terms. WSP reserve the right to amend the fee should any changes to the appointment terms create an increase risk to WSP

The report needs to be considered in the light of the WSP proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report. The report is only valid for its originally intended purpose as set out in either our report or the proposal.

Phase 1 Geo Environmental and Preliminary Risk Assessments

The works undertaken to prepare this report comprised a study of available and easily documented information from a variety of sources (including the Client), together with (where appropriate) a brief walk over inspection of the Site and correspondence with relevant authorities and other interested parties. Due to the short timescales associated with these projects responses may not have been received from all parties. It is not standard, due to the timescales, to visit archives and local libraries as part of these works. WSP cannot be held responsible for any disclosures that are provided post production of our report and will not automatically update our report.

The opinions given in this report have been dictated by the finite data on which they are based and are relevant only for the purpose for which the report was commissioned. The information reviewed should not be considered exhaustive and has been accepted in good faith as providing true and representative data pertaining to site conditions. Should additional information become available which may affect the opinions expressed in this report, WSP reserves the right to review such information and, if warranted, to modify the opinions accordingly.

It should be noted that any risks identified in this report are perceived risks based on the information reviewed. Actual risks can only be assessed following intrusive investigations of the Site.

WSP does not warrant work / data undertaken / provided by others.

This section covers reports with the following titles or combination of titles: phase 1; Desk top study; geo environmental assessment; development appraisal; preliminary environmental risk assessment; constraints report; due diligence report; geotechnical development review; environmental statement; environmental chapter; geotechnical development risk register or baseline environmental assessment. The limitations associated with preliminary works apply when they are reported within an intrusive investigation report.

Intrusive Investigation Reports

The investigation has been undertaken to provide information concerning the type and degree of contamination present at the Site in order to allow a generic risk assessment to be undertaken or identification of the soil properties to allow for geotechnical development constraints to be identified.

The objectives of the investigation are limited to establishing the risks associated with potential contamination sources with the potential to cause harm to human health, building materials, the environment (including adjacent land), or controlled waters. For Geotechnical investigations the purpose is to broadly identify the development constraints associated with the physical property of the soils underlying the site.

The amount of exploratory work, soil property and chemical testing undertaken has necessarily been restricted by various factors which may include accessibility, the presence of services; existing buildings; current site usage or short timescales. The exploratory holes completed assess only a small percentage of the area in relation to the overall size of the Site, and as such can only provide a general indication of conditions. The number of sampling points and the methods of sampling and testing do not preclude the possible existence of localised "hotspots" of contamination where concentrations may be significantly higher than those actually encountered or ground conditions that vary from those identified. In addition, there may be exceptional ground conditions elsewhere on the site which have not been disclosed by this investigation and which have therefore not been taken into account in this report. For example these include spatial variations in soil properties; the varying thickness and physical nature of the strata identified and changes in groundwater levels or flow rates.

The inspection; testing and monitoring records relate specifically to the investigation points and the timeframe that the works were undertaken. They will also be limited by the techniques employed. WSP has interpreted between these points based upon assumptions to develop our interpretation and conclusions. The assumption made in forming our conclusions is that the ground and groundwater conditions (both chemically and physically) are the same as have been encountered during the works undertaken at the specific points of investigation.

On 1st April 2010, BS EN 1997-1:2004 (Eurocode 7: Geotechnical Design – Part 1) became the mandatory baseline standard for geotechnical ground investigations.

In terms of geotechnical design for foundations, slopes, retaining walls and earthworks, EC7 sets guidance on design procedures including specific guidance on the numbers and spacings of boreholes for geotechnical design, there are limits to methods of ground investigation and the quality of data obtained and there are also prescriptive methods of assessing soil strengths and methods of design. Unless otherwise explicitly stated, the work has not been undertaken in accordance with EC7. A standard geotechnical interpretative report will not meet the requirements of the Geotechnical Design Report (GDR) under Eurocode 7. A GDR can strictly only be prepared following confirmation of all structural loads and serviceability requirements. The design process requires close co-operation between the geotechnical engineer and the structural engineer and is iterative. Where a GDR is prepared using preliminary or assumed loadings and/or serviceability limits it should only be considered as an interim report and should not be relied upon for the procurement or construction of the works it describes.

During any build programme WSP should be consulted if alternative ground conditions are encountered. It assumes during any site works that the contractor will use their best endeavours to manage and control groundwater and other unforeseen ground conditions. WSP will not be liable for actions taken prior to consultation.

The scope of the investigation was selected on the basis of the specific development and land use scenario proposed by the Client and may be inappropriate to another form of development or scheme. If the development layout was not known at the time of the investigation the report findings may need revisiting once the development layout is confirmed.

The risk assessment and opinions provided are based on currently available guidance relating to acceptable contamination concentrations; no liability can be accepted for the retrospective effects of any future changes or amendments to these values. Specific assumptions associated with the WSP risk assessment process have been outlined within the body or associated appendix of the report.

Additional investigations may be required in order to satisfy relevant planning conditions or to resolve any engineering and environmental issues.

If costs have been included in relation to additional site works, and / or site remediation works these must be considered as indicative only and must, be confirmed by a qualified quantity surveyor.

The following report titles (or combination) may cover this category of work: geo environmental site investigation; geotechnical assessment; GIR (Ground Investigation reports); preliminary environmental and geotechnical risk assessment; geotechnical risk register.

Detailed Quantitative Risk Assessments and Remedial Strategy Reports

These reports either use primary data or build upon previous report versions and associated notes. The scope of the investigation; further testing and monitoring and associated risk assessments were selected on the basis of the specific development and land use scenario proposed by the Client and may not be appropriate to another form of development or scheme layout. The risk assessment and opinions provided are based on currently available approaches in the generation of Site Specific Assessment Criteria relating to contamination concentrations and are not considered to represent a risk in a specific land use scenario to a specific receptor. No liability can be accepted for the retrospective effects of any future changes or amendments to these values, associated models or associated guidance.

The outputs of the Detailed Quantitative Risk Assessments are based upon WSP manipulation of standard risk assessment models. Models are simulations based on the available data set and should not be used as predictions.

Where a remediation strategy is proposed, this is based on our interpretation of the risk assessment criteria and is specific to a particular location and a particular intended land use and configuration / layout. Prior to adoption they will need discussing and agreeing with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatory Authority engagement are not within the control of WSP. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.

Geotechnical Design Report (GDR)

A GDR can strictly only be prepared following confirmation of all structural loads and serviceability requirements. The design process requires close co-operation between the geotechnical engineer and the structural engineer and is iterative. Where a GDR is prepared using preliminary or assumed loadings and/or serviceability limits it should only be considered as an interim report and should not be relied upon for the procurement or construction of the works it describes. A GDR will be a standalone specifically entitled report.

Monitoring (including Remediation Monitoring reports)

These reports are factual in nature and comprise monitoring, normally groundwater and ground gas and data provided by contractors as part of an earthworks or remedial works.

The data is presented and will be compared with assessment criteria.

Asbestos in soils

Unless explicitly included for in our proposal, our investigation does not include for a formal asbestos assessment. The inspection for asbestos, either as asbestos containing materials (ACMs) lying on the surface or as ACMs and/or as loose asbestos fibres within made ground / stockpiles are excluded. Our report will include for the factual reporting of any soil screens that are collected. These results should be treated cautiously and should not be relied upon to provide detailed and representative information on the delineation, type and extent of bulk ACMs and/or trace loose asbestos fibres within the soil matrix at the site.

Where we indicate in our proposal that we will consider asbestos we will undertake screening of representative soil samples for the presences / absence of loose asbestos fibres. If these are found a further and more detailed specific investigation into asbestos in soils, will need to be undertaken which will include asbestos quantification testing. These investigations are associated with more rigorous monitoring of asbestos and health and safety provisions.

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