GSB
PROSPECTION Ltd

GEOPHYSICAL SURVEY REPORT
2007/68

M1 Junction 21-30 Improvement
Copt Oak

Client:

ARUP

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Specialising in Shallow and Archaeological Prospection

GSB Survey No. 07/68

M1 Junction 21-30 Improvement – Report on Geophysical Survey at Copt Oak

NGR	SK 479 130 (approximate centre)		
Location	The site is located immediately to the west of the M1 motorway, just to the north of Junction 22 and bound to the north by the Warren Hills road.		
District	North West Leicestershire	**Parish**	Bardon
Topography	Generally level.		
Current land-use	Pasture and recently cut silage.		
Soils	Salop association (711m) (*Soils of England and Wales Sheet 3, Midland and Western England.* Soil Survey of England and Wales. 1983).		
Geology	Triassic Keuper Marls and Sandstone.		
Archaeology	No information available.		
Survey Methods	Detailed Fluxgate Gradiometer survey.		

Aims

To determine whether any detectable archaeological remains exist within the survey area. The work forms part of a wider archaeological assessment being carried out by **OVE ARUP and Partners Ltd.**

Summary of Results*

Numerous pit type anomalies and trends of archaeological potential have been identified in the survey areas. Two linear alignments may indicate former field boundaries, however, it is more likely they correspond to field drains. The majority of the other responses in the data are weak and isolated and do not form any coherent patterns, therefore their archaeological potential is limited. Natural variations in the subsoil or agricultural practices could equally account for all, or some, of these responses

Modern features are responsible for the gaps and large ferrous responses in the data; these comprise wire fencing, pipes, manure heaps, a vehicle and a telegraph pole

Project Information

Project Co-ordinator: F Chester
Project Assistants: J Adcock, J Smith, C Stephens, G Taylor

Date of Fieldwork: 1st - 2nd October 2007
Date of Report: 31st October 2007

***It is essential that this summary is read in conjunction with the detailed results of the survey.**

Survey Specifications

Method

For all survey techniques: the survey grid was set out using tapes and tied in to the Ordnance Survey (OS) grid using a Trimble differential GPS, see tie-in diagram.

Technique	Traverse Separation	Reading Interval	Instrument	Survey Size
Magnetometer - Scanning (Appendix 1)	-	-	-	-
Magnetometer – Detailed (Appendix 1)	1m	0.25m	Bartington Grad 601-2	3.5ha
Resistance – Twin Probe (Appendix 1)	-	-	-	-
Ground Penetrating Radar (GPR) (Appendix 1)	-	-	-	-

Data Processing

	Magnetic	Resistance	GPR
Tilt Correct	Y	-	-
De-stagger	Y	-	-
Interpolate	Y	-	-
Filter	N	-	-

Presentation of Results

Report Figures (Printed & Archive CD):	Location plots, data plots and interpretation diagrams on base map (Figures 1-3). Tie-in information (Figure T1)
Reference Figures (Archive CD):	Data plots for reference and analysis at 1:500. Some of the areas have been subdivided for display at this scale. (See List of Figures).
Plot Formats:	See Appendix 1: Technical Information, at end of report

General Considerations

The ground conditions were generally good for survey across the majority of the area, with the fields comprising either short pasture or recently harvested silage. A narrow strip immediately adjacent to the motorway had been landscaped and planted with trees; the dense nature of the undergrowth in this area precluded survey.

Results of Survey

1. Magnetic Survey

Area 1

1.1 A gap in the survey area corresponds to an obstacle in the form of a large pile of manure through which it was not possible to survey. Numerous small scale ferrous responses lie in the vicinity of this obstruction and are probably associated with it. The ferrous responses along the edges of the survey area can be attributed to gates, buildings and modern wire fencing.

1.2 A few trends (A) show some regularity and therefore may be of interest; they are weak and although a few anomalies of archaeological potential have been highlighted in this area, given the proximity of the manure heap and other ferrous anomalies, they are unlikely to be significant.

1.3 Other trends and anomalies have been noted in this area, but they are generally weak and isolated, natural or agricultural activity is a more likely explanation for their presence

Area 2

1.4 Numerous small anomalies form two linear responses of archaeological potential (B) in the data. Whilst it is possible they indicate former field boundaries, as one of these responses is aligned with a division in the wood to the south, they are more likely to be field drains given the nature of the anomalies

1.5 A few trends have been highlighted but as the majority are approximately parallel to the northwestern field boundary they are likely to be agricultural in origin and may indicate the orientation of former ploughing.

1.6 Several large ferrous anomalies along the northeastern edge of the survey can be attributed to modern features, such as a telegraph pole and a trailer.

Area 3

1.7 Several anomalies whose form suggests some archaeological potential have been highlighted. However, the majority are weak and do not conform to any easily discernible pattern; it is likely they have an alternative origin, such as natural or pedological variations in the subsoil. There were numerous clumps of thistles and nettles in this field, the traversing of which may have contributed a small amount of noise to the data and therefore may also have caused some of the anomalies.

1.8 Various trends have also been noted and although they may be of interest, natural variations or agricultural practices could equally account for all or some of these responses

Area 4

1.9 The dominant response in this field is due to a pipe which bisects the area and appears in the data as a linear ferrous anomaly. The wire fence bounding the field accounts for the ferrous response along the eastern edge of the survey area.

1.10 A few isolated anomalies and weak trends have been identified in the data but as they do not form any coherent patterns, attributing archaeological potential to these responses is at best tentative; natural variations in the subsoil is more likely to account for their presence.

Area 5

1.11 A single anomaly of archaeological potential has been identified in the data from this field. However, an alternative explanation, such as agricultural activity could account for this response and for the two, weaker, trends in the southern portion of the survey area.

1.12 The other anomalies which have been highlighted on the interpretation diagram are all considered to be modern in origin. They comprise a linear ferrous response indicative of a pipe bisecting the survey area and a linear ferrous response along the edge of the survey area which is due to the barbed wire boundary fence

2. Conclusions

2.1 A few anomalies of archaeological potential have been identified within the survey areas Although two linear responses may indicate former field boundaries it is more likely they represent field drains Regular trends in the data are also more likely to be agricultural activity such as ploughing

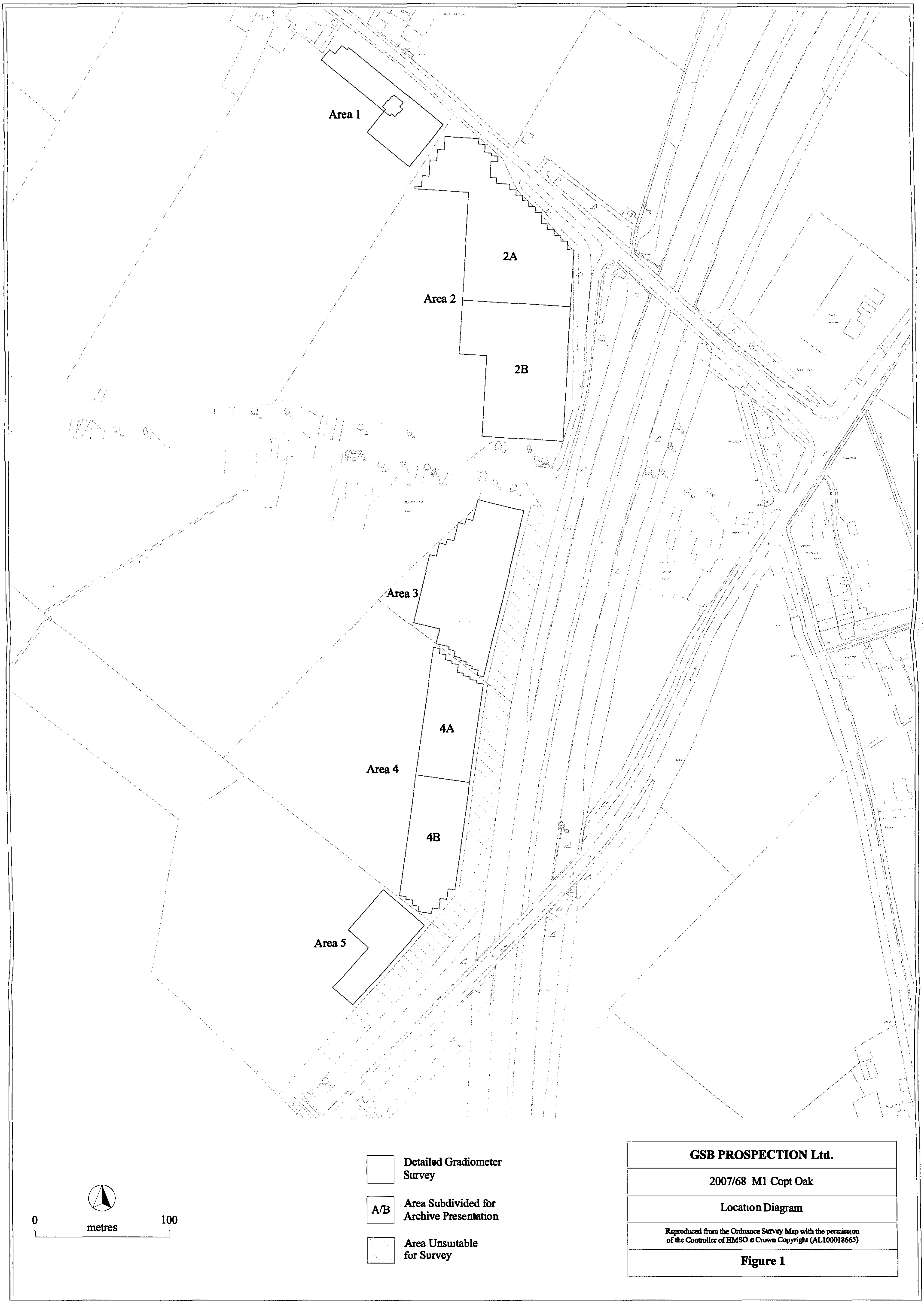
2.2 Small pit type responses scattered throughout the data may have some archaeological interest but as they are generally weak and isolated, natural variations in the subsoil are an equally plausible origin

2.3 Modern features, such as wire fences, telegraph poles, pipes and machinery have all contributed ferrous responses in the data; some of these are large enough to have obscured any weaker responses in their vicinity Gaps in the survey areas correspond to large piles of manure through which it was not possible to walk

List of Figures

Report Figures

Reference Figures on CD



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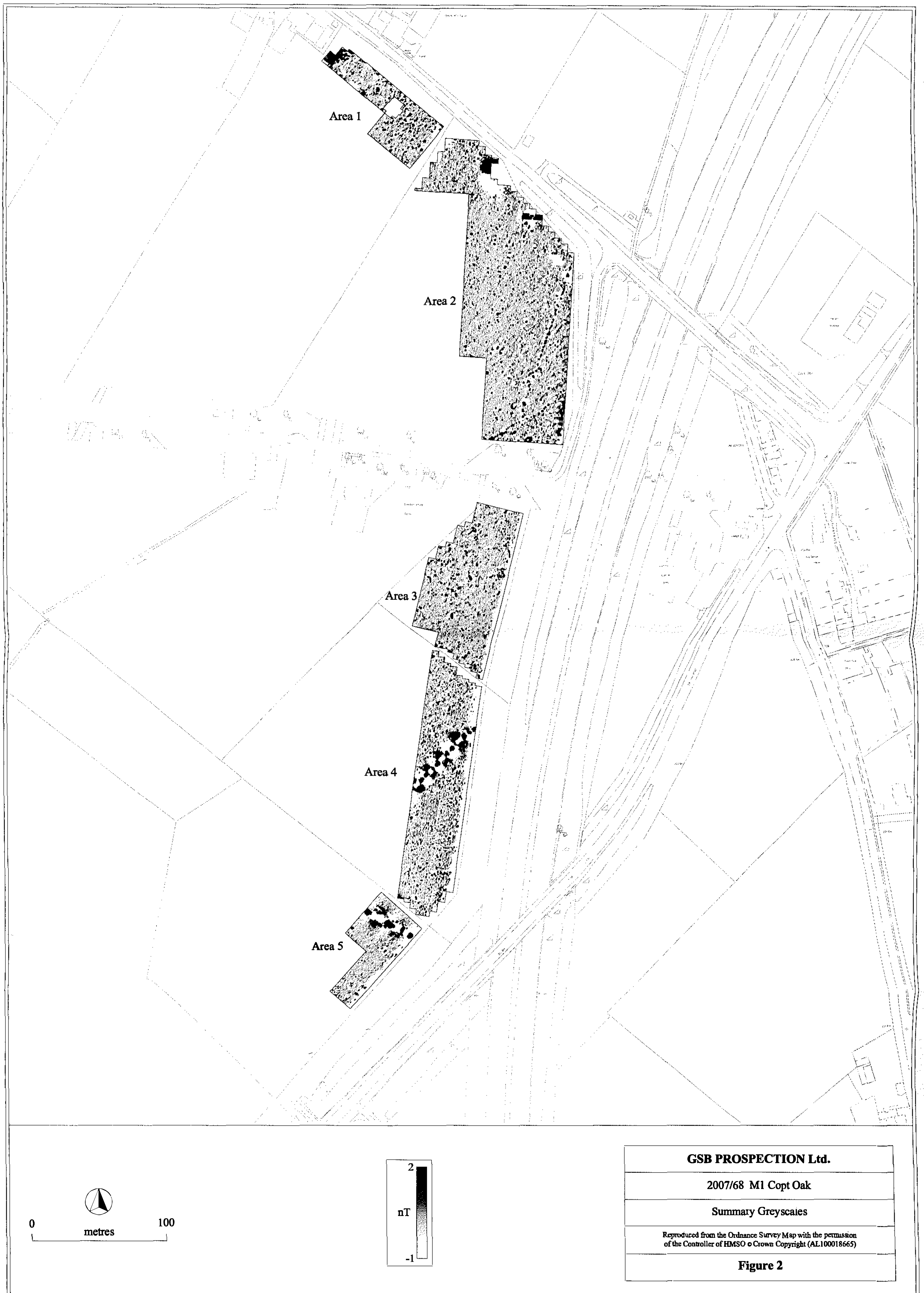
Location Diagram

Figure 1



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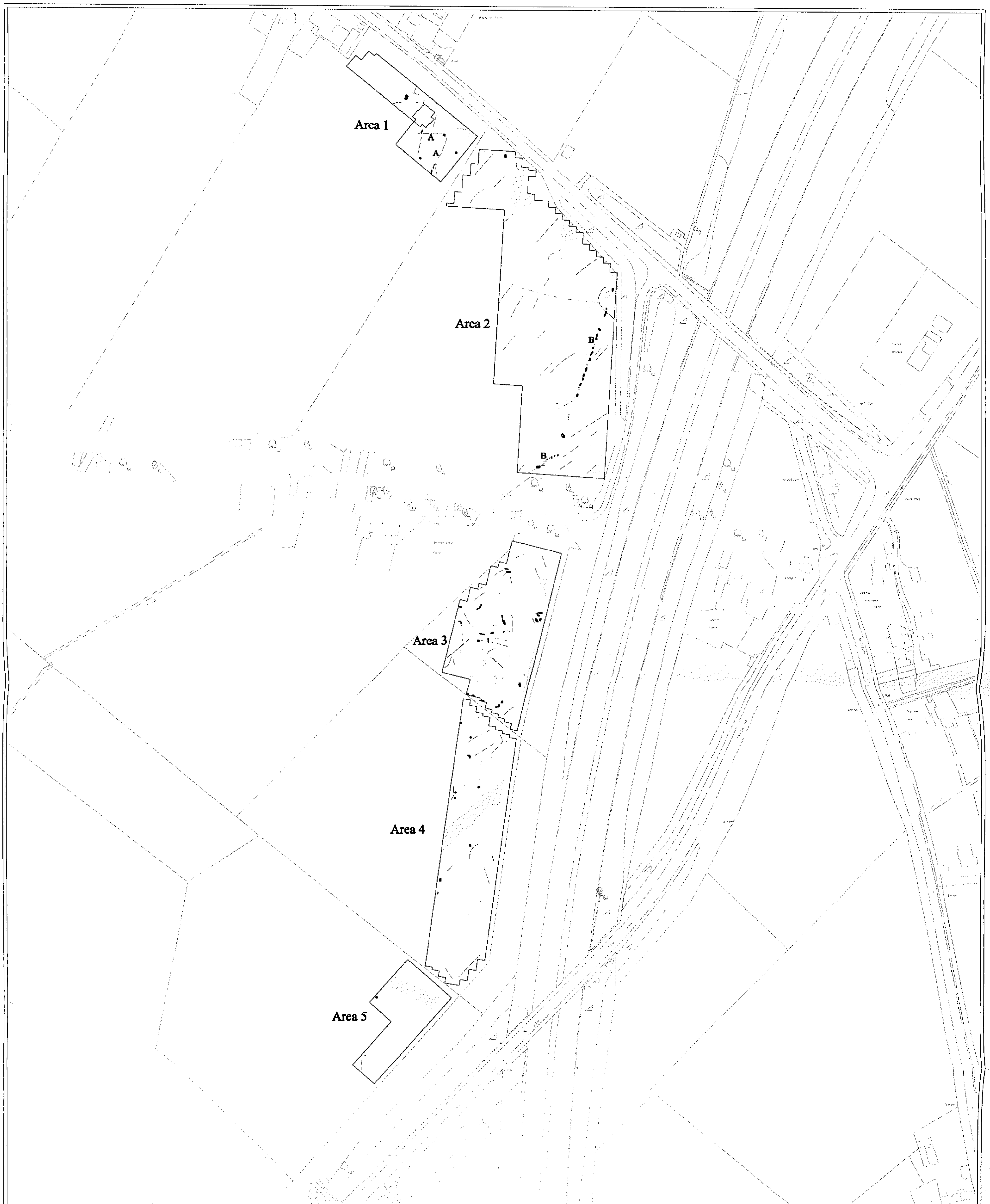
Summary Greyscales

Figure 2



0 metres 100

?Archaeology

Trend

Ferrous

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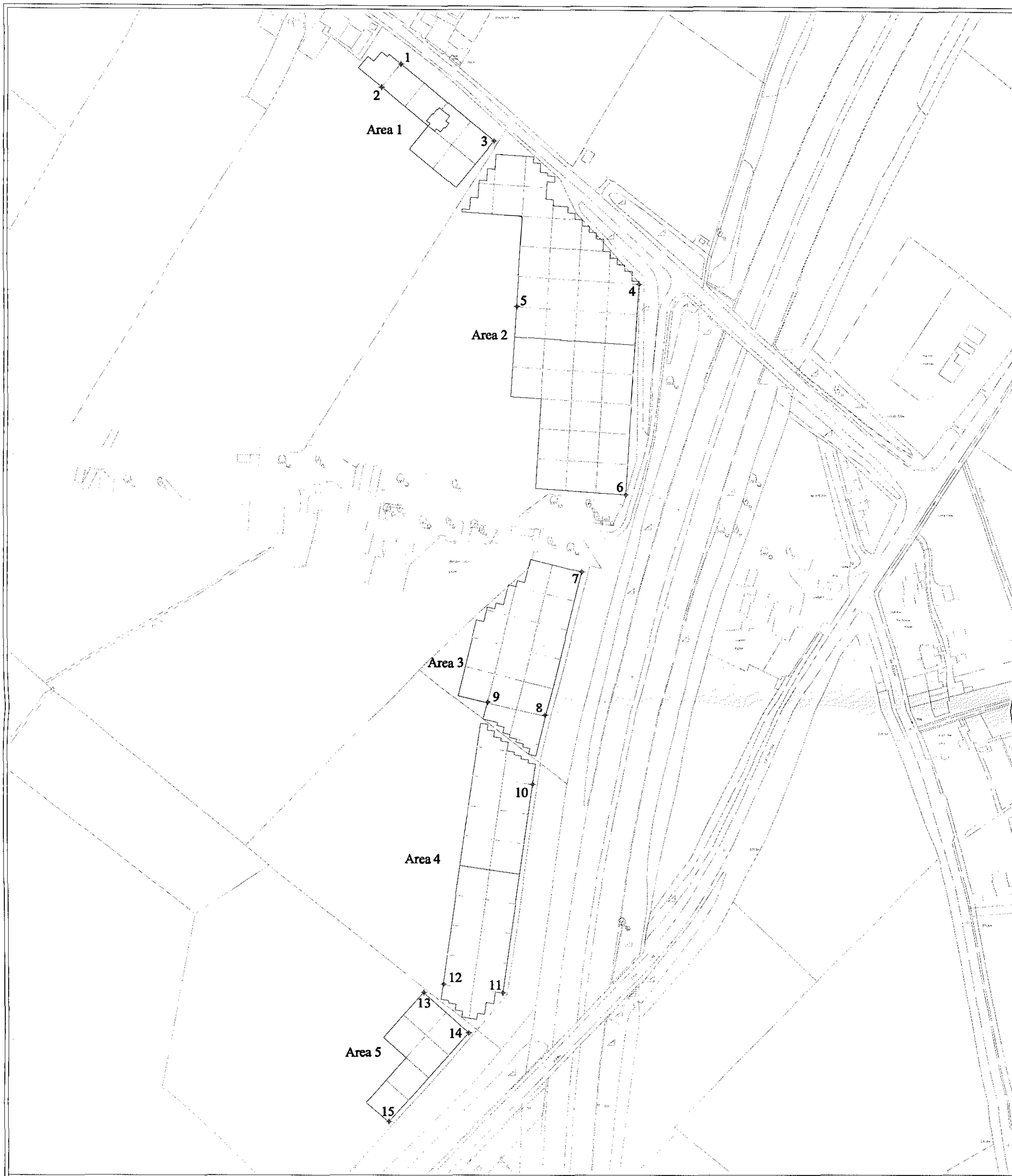
Summary Interpretation

Figure 3



Point	Easting	Northing	Notes
1	447841.00	313299.28	Area 1 Grid Point
2	447828.35	313283.75	Area 1 Grid Point
3	447903.03	313248.75	Area 1 Grid Point
4	447998.99	313154.03	Area 2 Grid Point
5	447918.10	313139.01	Area 2 Grid Point
6	447990.39	313014.30	Area 2 Grid Point
7	447961.05	312963.05	Area 3 Grid Point
8	447937.14	312866.58	Area 3 Grid Point
9	447898.82	312875.80	Area 3 Grid Point
10	447928.33	312819.42	Area 4 Grid Point
11	447908.57	312680.89	Area 4 Grid Point
12	447869.31	312686.71	Area 4 Grid Point
13	447855.80	312681.05	Area 5 Grid Point
14	447885.61	312654.49	Area 5 Grid Point
15	447832.82	312594.80	Area 5 Grid Point

not to scale

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Tie-in Diagram

Figure T1

Appendix 1: Technical Information

Instrumentation

Fluxgate Gradiometer: Geoscan FM36/256 and Bartington *Grad*601-2

Both the Geoscan and Bartington instruments comprise two fluxgate sensors mounted vertically apart; the distance between the sensors on the former is 500mm, on the latter 1000mm The gradiometers are carried by hand, with the bottom sensor approximately 100-300mm from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is measured in nanoTesla (nT). The sensitivity of the instrument can be adjusted; for most archaeological surveys the most sensitive range (0 1nT) is used. The fluxgate gradiometer suppresses any diurnal or regional effects. Generally, features up to 1m deep may be detected by this method Having two gradiometer units mounted laterally with a separation of 1000mm, the Bartington instrument can collect two lines of data per traverse.

Resistance Meter: Geoscan RM15

This instrument measures the electrical resistance of the earth, using a system of four electrodes (two current and two potential.) Depending on the arrangement of these electrodes an exact measurement of a specific volume of earth may be acquired This resistance value may then be used to calculate the earth resistivity. The most common arrangement is the Twin Probe configuration which involves two pairs of electrodes (one current and one potential): one pair remain in a fixed position, whilst the other measures the resistance variations across a grid. The resistance is measured in ohms and, when calculated, resistivity is in ohm-metres The resistance method as used for standard area survey employs a probe separation of 0.5m, which samples to a depth of approximately 0.75m. The nature of the overburden and underlying geology will cause variations in this depth.

GPR: Sensors & Software Noggin Smartcart

The Noggin system includes an onboard digital video logger (DVL III), 250 MHz or 500MHz antenna, an odometer wheel and battery It is, therefore, a fully integrated system The built-in software uses the integrated odometer to provide an accurate distance measurement to the response. The data are recorded in digital format and can be processed to produce depth slice maps, 2D sections or 3D cubes.

Display Options

XY Trace

This involves a line representation of the data Each successive row of data is equally incremented in the Y axis, to produce a stacked profile effect This display may incorporate a hidden-line removal algorithm, which blocks out lines behind the major peaks and can aid interpretation The advantages of this type of display are that it allows the full range of the data to be viewed and shows the shape of the individual anomalies. The display may also be changed by altering the horizontal viewing angle and the angle above the plane The output may be either colour or black and white.

Greyscale

This format divides a given range of readings into a set number of classes Each class is represented by a specific shade of grey, the intensity increasing with value All values above the given range are allocated the same shade (maximum intensity); similarly all values below the given range are represented by the minimum intensity shade. Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values The assigned range (plotting levels) can be adjusted to emphasise different anomalies in the data-set.

Relief Plot

This is a method of display that creates a three dimensional effect by directing an imaginary light source on a given data set Particular elements of the results are highlighted depending on the angle of strike of the light source. This display method is particularly useful when applied to resistance data to highlight subtle changes in resistance that might otherwise be obscured.

3D Surface Plot

This is similar to the XY trace, but in 3 dimensions. Each data point of a survey is represented in its relative position on the *x* and *y* axes and the data value is represented in the *z* axis. This gives a digital terrain, or topographic effect.

Radargram

Radar data comprise a record of reflection intensity against the time taken for the emitted energy to travel from the transmitter down to the reflector and back to the receiver. The resultant plot is effectively a vertical section through the ground along the line of the traverse, with time (depth) on the vertical axis, displacement on the horizontal axis and reflection intensity as a grey or colour scale.

Time Slice

If a number of radargrams are collected over a grid, or in conjunction with GPS data, it is possible to reconstruct the entire dataset into a 3D volume This can then be resampled to compile 'plan' maps of response strength at increasing time (or depth) offsets, thus simplifying the visualisation of how anomalies vary beneath the surface across a survey area.

Terms Commonly used in the Interpretation of Results

Magnetic

Archaeology	This term is used when the form, nature and pattern of the response are clearly or very probably archaeological These anomalies, whilst considered anthropogenic, could be of any age.
? Archaeology	The interpretation of such anomalies is often tentative, with the anomalies exhibiting either weak signal strength or forming incomplete archaeological patterns. They may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
Areas of Increased Magnetic Response	These responses show no visual indications on the ground surface and are considered to have some archaeological potential.
Industrial	Strong magnetic anomalies that, due to their shape and form or the context in which they are found, suggest the presence of kilns, ovens, corn dryers, metal-working areas or hearths It should be noted that in many instances modern ferrous material can produce similar magnetic anomalies.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions e g palaeochannels or magnetic gravels.
? Natural	These are anomalies that are likely to be natural in origin i e geological or pedological.
Ridge and Furrow	These are regular and broad linear anomalies that are presumed to be the result of ancient cultivation In some cases the response may be the result of modern activity.
Ploughing Trend	These are isolated or grouped linear responses. They are normally narrow and are presumed modern when aligned to current field boundaries or following present ploughing.
Trend	This is usually an ill-defined, weak, isolated or obscured linear anomaly of unknown cause or date.
Areas of Magnetic Disturbance	These responses are commonly found in places where modern ferrous or fired materials are present e.g. brick rubble. They are presumed to be modern.
Ferrous Response	This type of response is associated with ferrous material and may result from small items in the topsoil, larger buried objects such as pipes, or above ground features such as fence lines or pylons Ferrous responses are usually regarded as modern Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.

Resistance

Archaeology	High or low res responses are clearly or very probably archaeological These anomalies, whilst considered anthropogenic, could be of any age.
? Archaeology	The interpretation of such anomalies is often tentative, with the anomalies exhibiting either weak signal strength or forming incomplete archaeological patterns They may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions e g palaeochannels or magnetic gravels.
? Natural	These are anomalies that are likely to be natural in origin i.e. geological or pedological.
? Landscaping / topography	These are regular and broad linear anomalies that are presumed to be the result of ancient cultivation In some cases the response may be the result of modern activity.
Vegetation	These are isolated or grouped linear responses They are normally narrow and are presumed modern when aligned to current field boundaries or following present ploughing.
Trend	This is usually an ill-defined, weak, isolated or obscured linear anomaly of unknown cause or date.

GPR

Wall /Foundation/ /Vault /Culvert etc.	High amplitude anomaly definitions used when other evidence is available that supports a clear archaeological interpretation
Archaeology	Anomalies whose form, nature and pattern indicate archaeology but where little or no supporting evidence exists If a more precise archaeological interpretation is possible, for example the responses appear to respect known local archaeology, then this will be indicated in the accompanying text. As low amplitude responses are less obvious features it is unlikely that they would have a definitive categorisation.
? Archaeology	When the anomaly could be archaeologically significant, given its discrete nature, but where the distribution of the responses is not clearly archaeological Interpretation of such anomalies is often tentative, exhibiting either little contrast or forming incomplete archaeological patterns.
Historic	Responses showing clear correlation with earlier map evidence.
?Historic	Responses relating to features not directly recorded on earlier maps but which appear to respect features that are May form patterns suggestive of formal gardens, landscaping or footpaths.
Area of Anomalous Response	An area in which the response levels are very slightly elevated or diminshed with respect to the 'background'. Where no obvious surface features or documentary evidence can explain this spread of altered reflectivity it is assumed to denote some kind of disturbance, though the origins could be of any age and either anthropogenic or natural Possible explanations are changes in subsurface composition and groundwater 'ponding'.
Natural	Anomalies relating to natural sub-surface features as indicated by documentary sources, local knowledge or evidence on the surface.
?Natural	Responses forming patterns akin to subsoil/geological variations either attenuating or reflecting greater amounts of energy An archaeological origin such as rubble spreads or robbed out remains cannot be dismissed.
Trend	An ill defined, weak or isolated linear anomaly of unknown cause or date.
Modern	Reflections that indicate features such as services, rebar or modern cellars correlating with available evidence (maps, communications with the client, alignment of drain covers etc.).
?Modern	Reflections appearing to indicate buried services but where there is no supporting evidence Also applies to responses which form patterns, or are at a depth which suggests a modern origin. An archaeological source cannot be completely dismissed.
Surface	Responses clearly due to surface discontinuities, the effects of which may be seen to 'ring' down through radargrams and so incorrectly appearing in the deeper time-slices.

Data Processing

Zero Mean Traverse	This process which sets the background mean of each traverse within each grid to zero The operation removes striping effects and edge discontinuities over the whole of the data set It is usually only applied to gradiometer data.
Step Correction	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors
Interpolation	When geophysical data are presented as a greyscale, each data point is represented as a small square The resulting plot can sometimes have a 'blocky' appearance The interpolation process calculates and inserts additional values between existing data points. The process can be carried out with points *along* a traverse (the x axis) and/or *between* traverses (the y axis) and results in a smoother greyscale image.
Despike	In resistance survey, spurious readings can occasionally occur, usually due to a poor contact of the probes with the surface This process removes the spurious readings, replacing them with values calculated by taking the mean and standard deviation of surrounding data points It is not usually applied to gradiometer data.
High Pass Filter	Carried out over the whole a resistance data-set, the filter removes low frequency, large scale spatial detail, such as that produced by broad geological changes. The result is to enhance the visibility of the smaller scale archaeological anomalies that are otherwise hidden within the broad 'background' change in resistance. It is not usually applied to gradiometer data.