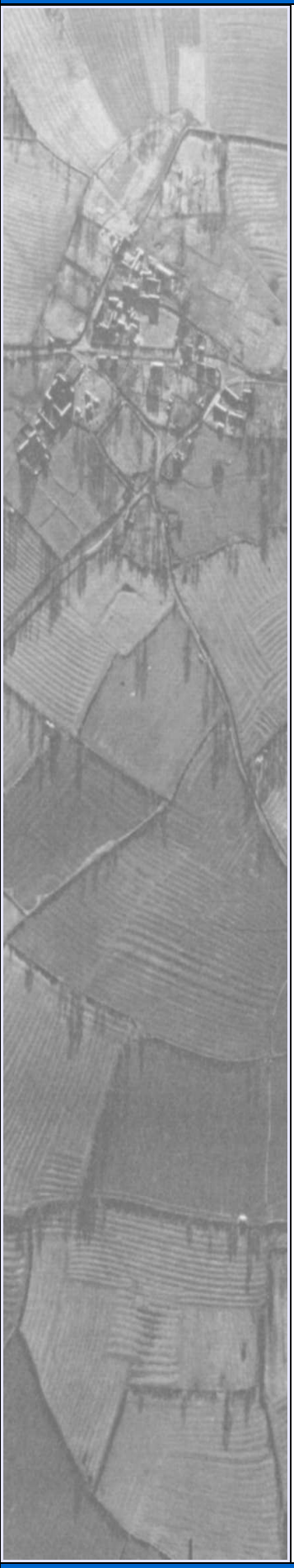

Land east of Highworth Road
Shrivenham
Phase II

MAGNETOMETER SURVEY REPORT

for

Welbeck Strategic Land II LLP

David Sabin and Kerry Donaldson

October 2014

Ref. no. 560

ARCHAEOLOGICAL SURVEYS LTD

Land east of Highworth Road
Shrivenham
Phase II

Magnetometer Survey Report

for

Welbeck Strategic Land II LLP

Fieldwork by David Sabin
Report by David Sabin BSc (Hons) MIFA and Kerry Donaldson BSc (Hons)

Survey dates – 28th & 29th August, 3rd, 15th, 17th, 19th & 25th September 2014
Ordnance Survey Grid Reference – **SU 23645 89500**

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SUMMARY

Archaeological Surveys Ltd carried out a detailed magnetometer survey of land to the east of Highworth Road, Shrivenham, on behalf of Welbeck Strategic Land II LLP. The survey formed part of a second phase of works within the site, and a previous survey carried out by Archaeological Surveys in 2013, located a number of ring ditches and enclosures that relate to Iron Age and possible Roman occupation immediately to the south. The results of the current survey indicate a continuation of the archaeological features with further ring ditches, linear ditches, enclosures, pits and a possible trackway. The survey also located former ridge and furrow, much of which has truncated the earlier archaeological features. Some evidence for quarry/clay pits has also been found, and widespread zones of naturally formed anomalies.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Welbeck Strategic Land II LLP, at the request of the Environmental Dimension Partnership (EDP), to undertake a magnetometer survey of an area of land at Shrivenham in Oxfordshire. The site has been outlined for a proposed residential development and the survey forms part of an archaeological assessment of the site.

1.1.2 The geophysical survey was carried on land immediately to the north west of a site subject to a previous survey (Archaeological Surveys, 2013). The current survey forms a second phase of works and the results of both surveys are considered together in order to aid interpretation. However, only the results of the current survey are fully reported on within this document.

1.1.3 The former survey located a number of anomalies that relate to ring ditches, linear ditches, enclosures and pits which appear to indicate a late prehistoric and possible Romano-British settlement site. Subsequent evaluation by Cotswold Archaeology (2013) dated these and other features to the Iron Age and Roman periods.

1.2 Survey objectives and techniques

1.2.1 The objective of the survey was to use magnetometry to locate geophysical anomalies that may be archaeological in origin so that they may be assessed prior to development of the site. The methodology is considered an efficient and effective approach to archaeological prospection.

1.2.2 The survey and report generally follow the recommendations set out by: English Heritage (2008) *Geophysical survey in archaeological field evaluation;* and Institute for Archaeologists (2002) *The use of Geophysical Techniques in*

Archaeological Evaluations. The work has been carried out to the Institute for Archaeologists (2011) *Standard and Guidance for Archaeological Geophysical Survey.*

1.3 Site location, description and survey conditions

1.3.1 The site is located east of Highworth Road and west of Pennyhooks Lane immediately north west of Shrivenham in Oxfordshire. It is centred on Ordnance Survey National Grid Reference (OS NGR) SU 23645 89500, see Figures 01 and 02.

1.3.2 The geophysical survey covers approximately 15.5ha within three separate arable fields. Area 1 forms the south western part of the site, Area 2 forms the central northern part and Area 3 encompasses the north eastern portion. The latter is a continuation of survey north easterly within the same field that formed the eastern part of the site formerly surveyed in 2013.

1.3.3 The ground conditions across the site were variable. Area 1 initially contained roughly cultivated soil that could not be satisfactorily traversed, more particularly so when wet. Subsequently, with the cooperation of the landowner, the field was smoothed and survey was possible in drier conditions. Area 2 was initially partially surveyed over stubble although this was abandoned due to the presence of large bales. The field was finally completed once the bales had been cleared and the soil cultivated. Survey in Area 3 was delayed by a wheat crop that was harvested late in the season with the work completed after cultivation. Weather conditions during the course of the work were variable with periods of heavy rain in August preventing survey, then followed by dry conditions in September.

Plate 1: Area 1 looking south east

1.4 Site history and archaeological potential

1.4.1 A previous geophysical survey carried out by Archaeological Surveys (2013), over land immediately to the south east, located a number of anomalies that appeared to relate to ring ditches, linear ditches, enclosures and pits from the late prehistoric and possible Roman periods. The results demonstrated that the majority of the features were within the western part of the site and they indicated that there was a high potential for them to extend northwards into the current survey area. There was also widespread evidence for truncation of the archaeological features by former ridge and furrow, with some quarrying on the far eastern side of the site. A subsequent evaluation by Cotswold Archaeology (2013) revealed a good correlation with the results of the geophysical survey. The excavation work indicated primarily Iron Age features with a smaller number of Roman cut features and artefacts, including the remains of a wooden chest or box with iron binding strips.

1.4.2 The Oxfordshire Historic Environment Record (HER) also records that there is evidence for a Roman Settlement just to the north west of the site (HER no 16067), with the nearest Scheduled Monument (No 20602), the Watchfield Anglo-Saxon Cemetery, located over 1km to the north east.

1.4.3 There is a very high potential from the results of the previous geophysical survey for the current site to contain a continuation of the archaeological features. Evidence for ridge and furrow cultivation and possible former quarrying is also possible.

1.4.4 The surface conditions within the site were considered suitable for the observation of cultural material during the course of the survey; however, the soil had not been weathered or subject to rainfall. No significant scatters were noted although a small number of sherds of Romano-British pottery were observed in the south western part of Area 1. Several small sarsen stones were also observed within the southern part of Area 1.

1.5 Geology and soils

1.5.1 The majority of the underlying geology is mudstone from the Ampthill Clay Formation, with ferruginous sandstone of the Red Down Sand member along the southern edge of Area 1 and Limestone from the Stanford Formation within the northern parts of Areas 2 and 3 (British Geological Survey, 2013). Occasional small sarsen stones were encountered within the site, particularly Area 1, and although these may be associated with former anthropogenic activity, it is possible that they represent the remnants of naturally occurring deposits. Within the locality, buried sarsen stones of considerable size and density of distribution are known to occur.

1.5.2 The overlying soil across the survey area is from the Kingston association, which is a typical stagnogley soil. It consists of a slowly permeable, seasonally waterlogged, fine, loamy over clayey soil (Soil Survey of England and Wales, 1983). Of note is a gradual change from clayey soil in the central part of the

site to a sandy loam soil along the southern edge. The variation can be accounted for by the underlying changes of the geology from clay to sandstone.

1.5.3 Magnetometry carried out over similar geology and soil has produced good results, although there can be low magnetic susceptibility within the mudstone areas. The site is, therefore, considered suitable for magnetic survey.

2 METHODOLOGY

2.1 Technical synopsis

2.1.1 Magnetometry survey records localised magnetic fields that can be associated with features formed by human activity. Magnetic susceptibility and magnetic thermoremnance are factors associated with the formation of localised fields. Additional details are set out below and within Appendix A.

2.1.2 Iron minerals within the soil may become altered by burning and the break down of biological material; effectively the magnetic susceptibility of the soil is increased, and the iron minerals become magnetic in the presence of the Earth's magnetic field. Accumulations of magnetically enhanced soils within features, such as pits and ditches, may produce magnetic anomalies that can be mapped by magnetic prospection.

2.1.3 Magnetic thermoremnance can occur when ferrous minerals have been heated to high temperatures such as in a kiln, hearth, oven etc. On cooling, a permanent magnetisation may be acquired due to the presence of the Earth's magnetic field. Certain natural processes associated with the formation of some igneous and metamorphic rock may also result in magnetic thermoremnance.

2.1.4 The localised variations in magnetism are measured as sub-units of the Tesla, which is a SI unit of magnetic flux density. These sub-units are nano Teslas (nT), which are equivalent to 10^{-9} Tesla (T).

2.2 Equipment configuration, data collection and survey detail

2.2.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXPDA 5 channel cart-based system. The instrument has 5 fluxgate gradiometers spaced 0.5m apart with readings recorded at 20 Hz. The gradiometers have a range of recording data between 0.1nT and 10,000nT. They are linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA computer system.

2.2.2 Data are collected along a series of parallel survey transects wherever possible. The length of each transect is variable and relates to the size of the survey area and other factors including ground conditions. A visual display allows accurate placing of transects and helps maintain the correct separation

between adjacent traverses.

2.3 Data processing and presentation

2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared and automatically compensated using SENSYS MAGNETO®DLMGPS software. Georeferenced raw data are then exported in ASCII format for further analysis and display using TerraSurveyor.

2.3.2 The data are collected at ±10000nT and clipped for display at ±20nT. Data are resampled to a resolution of effectively 0.5m between tracks and 0.15m along each survey track. Appendix C contains specific information concerning the survey and data attributes and is derived directly from TerraSurveyor. Reference should be made to Appendix B for further information on any processes, such as clipping, carried out on the data.

2.3.3 A TIFF file (OSGB36) is produced by TerraSurveyor software along with an associated world file (.TFW) that allows automatic georeferencing when using GIS or CAD software. The main form of data display used in the report is the minimally processed greyscale plot.

2.3.4 The raster images are combined with base mapping using ProgeCAD Professional 2014 and AutoCAD LT 2007, creating DWG file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. Quality can be compromised by rotation of graphics in order to allow the data to be orientated with respect to grid north; this is considered acceptable as the survey results are effectively georeferenced allowing relocation of features using GPS, resection method, etc.

2.3.5 An abstraction and interpretation is offered for all geophysical anomalies located by the survey. A brief summary of each anomaly, with an appropriate reference number, is set out in list form within the results (Section 3) to allow a rapid and objective assessment of features within each survey area. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing.

2.3.6 A digital archive is produced with this report, see Appendix D below. The main archive is held at the offices of Archaeological Surveys Ltd.

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over a total of three survey areas covering approximately 15.5ha.

3.1.2 Magnetic anomalies located can be generally classified as positive linear and

discrete positive responses of archaeological potential, positive and negative linear anomalies of an uncertain origin, anomalies relating to land management, anomalies associated with quarrying/ground disturbance, linear anomalies of an agricultural origin, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects and anomalies with a natural origin.

3.1.3 Anomalies located within each survey area have been numbered and are described below with subsequent discussion in Section 4.

3.2 Statement of data quality

3.2.1 Data are considered representative of the magnetic anomalies present within the site. Magnetic disturbance along the western edge of Area 1 has been caused by services and other ferrous objects. It has the potential to obscure anomalies within a very small part of the site adjacent to the field boundary. There is some evidence for lower magnetic susceptibility and, as a consequence, much weaker anomalies in parts of the site where the soil is more clayey; however, it is possible that this is only apparent due to the strong enhancement associated with areas subject to former habitation.

3.3 Data interpretation

3.3.1 The list of sub-headings below attempts to define a number of separate categories that reflect the range and type of features located during the survey. A basic explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, a basic key is indicated to allow cross referencing to the abstraction and interpretation plot. CAD layer names are included to aid reference to associated digital files (.dwg/.dxf). Sub-headings are then used to group anomalies with similar characteristics for each survey area.

Report sub-heading CAD layer names and plot colour	**Description and origin of anomalies**
Anomalies with archaeological potential AS-ABST MAG POS LINEAR ARCHAEOLOGY AS-ABST MAG POS DISCRETE ARCHAEOLOGY AS-ABST MAG POS CURVILINEAR RING DITCH 	Anomalies have the characteristics (mainly morphological) of a range of archaeological features such as pits, ring ditches, enclosures, etc..
Anomalies with an uncertain origin AS-ABST MAG POS LINEAR UNCERTAIN AS-ABST MAG NEG LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN AS-ABST MAG POS UNCERTAIN 	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.

Anomalies relating to land management AS-ABST MAG BOUNDARY	Anomalies are mainly linear and may be indicative of the magnetically enhanced fill of cut features (i.e. ditches). The anomalies may be long and/or form rectilinear elements and they may relate to topographic features or be visible on early mapping. Associated agricultural anomalies (e.g. headlands, plough marks and former ridge and furrow) may support the interpretation.
Anomalies associated with quarrying/ground disturbance AS-ABST MAG QUARRYING	Magnetically variable anomalies, which may be negative, indicating a response to geology/drift deposits and/or positive indicating an increased depth of topsoil.
Anomalies with an agricultural origin AS-ABST MAG AGRICULTURAL AS-ABST MAG RIDGE AND FURROW	The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing.
Anomalies associated with magnetic debris AS-ABST MAG DEBRIS AS-ABST MAG STRONG DIPOLAR	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. It often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with kilns, furnace structures, or hearths and may therefore be archaeologically significant. It is also possible that the response may be caused by natural material such as certain gravels and fragments of igneous or metamorphic rock. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin AS-ABST MAG DISTURBANCE AS-ABST MAG SERVICE	The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables, pylons etc.. Often a significant area around such features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present. Fluxgate sensors may respond erratically and with hysteresis adjacent to strong magnetic sources.
Anomalies with a natural origin AS-ABST MAG NATURAL FEATURES	Naturally formed magnetic anomalies are are caused by localised variability in the magnetic susceptibility of soils, subsoils and other drift or solid geologies. Anomalies may be amorphous, linear or curvilinear and may appear 'fluvial' or discrete; the latter are almost impossible to distinguished from pit-like anomalies with an anthropogenic origin. Fluvial, glacial and periglacial processes may be responsible for their formation within drift material and subsoil. Igneous and metamorphic activity can lead to anomalies within more solid geology.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Area 1

Area centred on OS NGR 423600 189435, see Figures 05 & 06.

Anomalies of archaeological potential

(1) – A number of positive curvilinear and rectilinear anomalies are clustered along the south eastern boundary to the survey area. They appear to relate to a number

of ring ditches and sub-rectangular enclosures that continue beyond the field boundary. Some of these anomalies appear to be associated with pits and others may have been truncated by later linear ditches.

(2) – To the north east of anomalies (1) are a further group of positive curvilinear anomalies relating to ring ditches. They have a diameter of approximately 12m, and are associated with a number of pits or areas of burning with a response of over 20nT. There is evidence that they have been subsequently cut by anomalies (3) and (4).

(3) – An irregularly shaped enclosure appears to truncate an earlier ring ditch and contains a small number of internal cut features. The response is up to 9nT along the southern side and only 1nT at the northern extent. This is likely to relate to the change in geology from sandstone to mudstone, as well as a possible habitation effect with the northern part of the enclosure further away from the core of the activity.

(4) – A positive linear anomaly extends for at least 300m along the southern part of the survey area. At the south western end the response is over 35nT and at the western end, 2nT where it is truncated by ridge and furrow and then cannot be clearly seen. It is possible that it continues north eastwards as anomalies (13) and (42) as the northern ditch of a possible trackway. It appears to have truncated a number of ring ditches and there is complexity, with a number of linear ditches extending parallel with it and towards it from the south (11). It is associated with anomaly (5).

(5) – A positive linear anomaly extends north north westwards from the south western end of anomaly (4). The response is over 25nT at the southern end and 1nT at the northern end. It appears to have some association with anomalies (6) (8), (9) and (10) to form the western edge of an enclosure or enclosures.

(6) – A strongly positive linear anomaly (35nT) is located parallel with anomaly (4) and extends towards anomaly (5). There is some possibility that it extends westwards beyond anomaly (5), but this is not clear. The strongest, clearest response appears to end at anomaly (8), but there is a complex and irregular extension eastwards towards anomaly (9).

(7) – Positive linear anomalies appear to form a square enclosure that may have truncated anomalies (4) and (6). One linear anomaly appears to extend northwards from the eastern edge of this enclosure, and it is possible that it continues further to the north as anomaly (10). Within the confines of the enclosure are a number of linear and rectilinear ditches and pits.

(8) – A positive linear anomaly extends northwards from anomaly (6). It is very weak (0.5-2nT) and indistinct, but it is parallel with other linear ditches in the vicinity, such as anomaly (9).

(9) – A positive linear anomaly may relate to a linear ditch forming the eastern edge of an enclosure associated with anomaly (5). The anomaly is strongest at its

southern end (10nT) and is very weak as it heads northwards (1nT). It is not visible for approximately 40m but then does appear again further to the north. It is possible that there is some association with anomaly(15) to the north west.

(10) – Positive linear anomalies appear to relate to linear or rectilinear ditches and may also have an association with anomalies (6) to (9) in the western part of the survey area.

(11) – Along the southern edge of the survey area are a number of positive linear and rectilinear anomalies. Many can be seen to be a continuation of linear anomalies seen to the south within the previous survey area.

(12) – Located at the south eastern corner of the survey area are a number of positive linear, possible curvilinear and discrete responses. The southernmost positive linear anomaly may extend north eastwards as anomaly (43) within Area 3 and appears to former a linear ditch parallel with anomaly (13). It is not clear if the positive curvilinear anomalies relate to ring ditches, but this is possible.

(13) – A positive linear anomaly continues north eastwards as anomaly (42) within Area 3 and may be a continuation of anomaly (4) seen further west. It may relate the the northern ditch of a trackway.

(14) – A positive linear anomaly, located in the central part of the survey area has been truncated by a former field boundary (23) and may relate to an earlier cut feature. It is parallel with the northern edge of anomaly (10) and it is possible that it is associated.

Anomalies with an uncertain origin

(15) – A positive linear anomaly is located close to the northern edge of the survey area. Although it is located close to former field boundary, anomaly (22), it is possible that it is associated with anomalies (5) and (9) to the south and an archaeological origin is therefore possible.

(16) – A positive linear anomaly is located in the western part of the survey area. It is located either side of a former pond (26) and although appears to be associated with anomaly (10), is more likely to relate to a drainage ditch inserted during the 1960s or 1970s.

(17) – A positive linear anomaly, with some irregularity, is located in the eastern part of the survey area. It is not possible to determine if this is associated with naturally formed features (29) or if it relates to a cut, ditch-like feature.

(18) – A short, positive linear or curvilinear anomaly in the north eastern part of the survey area appears to have been truncated by ridge and furrow and may relate to a cut feature.

(19) – A discrete positive anomaly with a response of up to 17nT is located close to anomaly (18) and may relate to a pit.

(20) – A positive linear anomaly appears to have been truncated by ridge and furrow, although this is not certain and an association with agricultural activity is possible.

(21) – A number of negative linear anomalies are located in the north eastern part of the survey area, with others oriented parallel and located close to the southern field boundary. It is possible that some relate to agricultural activity, although others appear to have a more complex form.

Anomalies relating to land management

(22) – Positive linear anomalies appear to be associated with a former field boundary mapped from 1879 and removed by 1993.

(23) – A negative linear anomaly relates to a former boundary removed prior to 1993. Magnetic debris at its northern end is associated with the boundary and possibly also a former pump or well recorded at the edge of the field.

Anomalies with an agricultural origin

(24) – A series of alternate positive and negative linear anomalies cross the majority of the survey area and are oriented parallel with the eastern field boundary. The negative anomalies appear to have truncated through the earlier archaeological features and are, therefore, likely to relate to the furrows.

(25) – In the north western part of the survey area are a series of parallel linear anomalies. They are less well defined than anomalies (24) but also relate to ridge and furrow oriented east north east to west south west.

Anomalies associated with magnetic debris

(26) – A patch of very strongly magnetic debris is associated with ferrous material used to infill a former pond.

(27) – The survey area contains a number of strong, discrete, dipolar anomalies which are a response to ferrous and other magnetically thermoremnant objects within the topsoil. All of the survey areas contain similar responses.

Anomalies with a modern origin

(28) – The western edge of the survey area is affected by very strong magnetic disturbance likely to be a response to a pipe or service.

Anomalies with a natural origin

(29) – The survey area contains zones of magnetically variable responses. Only those with the strongest response have been abstracted, but much of the survey area is affected. These relate to naturally formed features within the underlying

clay.

3.5 List of anomalies - Area 2

Area centred on OS NGR 423585 189610, see Figures 07 & 08.

Anomalies of archaeological potential

(30) – Located close to the north western edge of the survey area is a positive linear anomaly that appears to have been truncated, and therefore pre-date, the ridge and furrow. Although there are no immediately adjacent anomalies that are characterised as archaeological features, it is parallel with anomalies (4), (6) and (10) within Area 1 to the south. It is possible that this relates to a fragmented linear ditch and an archaeological origin should be considered.

Anomalies with an uncertain origin

(31) – The survey area contains a number of very short positive linear anomalies. It is not possible to determine if they relate to cut features.

(32) – The survey area contains a number of discrete positive responses, with a large cluster to the north and west of anomaly (36). Some have a response of 10-15nT and they appear to relate to pit-like features. An association with quarrying is possible; however, it is not possible to determine if they are anthropogenic or natural features.

(33) – A small patch of magnetically variable responses is located towards the north western corner of the survey area. This is within the vicinity of what appears to be two overlying orthogonal series of former ridge and furrow (37) and (38) and is therefore within an area of ground disturbance. However, it is not possible to determine whether the response has a natural or anthropogenic origin.

Anomalies relating to land management

(34) – An “L” shaped positive linear anomaly, with adjacent negative response, is likely to relate to an unmapped field boundary that was a continuation of anomaly (22) to the west. It was removed prior to the Ordnance Survey 1st Edition map in 1879.

(35) – A series of parallel negative linear anomalies located in the western part of the survey area appear to relate to land drains.

Anomalies associated with quarrying/ground disturbance

(36) – An irregularly shaped area of magnetically variable responses is located in the centre of the survey area and appears to relate to a former quarry/ clay pit.

Anomalies with an agricultural origin

(37) – A series of parallel linear anomalies are oriented north west to south east and relate to former ridge and furrow.

(38) – In the western part of the survey area is a series of parallel linear anomalies that are orthogonal to, and appear to cross anomalies (37) in the western corner. These also relate to ridge and furrow.

(39) – Linear anomalies that relate to the modern cultivation trend.

Anomalies associated with magnetic debris

(40) – A patch of magnetic debris at the south eastern corner of the survey area is related to modern ferrous material. The remains of a tent and bonfire surrounded by modern rubbish were visible in this part of the field prior to cultivation.

Anomalies with a natural origin

(41) – A zone of magnetically variable responses relate to natural features that appear to have been preserved under the former ridges and truncated by the former furrows (37).

3.6 List of anomalies - Area 3

Area centred on OS NGR 423770 189635, see Figures 07 & 08.

Anomalies of archaeological potential

(42) – A positive linear anomaly appears to be a continuation of anomaly (13) seen in Area 1 to the south west. It is more complete and well defined in the central and eastern part of the survey area and has a response of 5-8nT. It is fragmented, presumably truncated by ridge and furrow and is weaker, 1-2nT, and less well defined towards the west. It is generally parallel with and appears to be associated with anomalies (43) and (44) forming a series of linear ditches or a possible trackway.

(43) – A fragmented positive linear anomaly appears to relate to a linear ditch, parallel with anomaly (42). It appears to have been truncated in places by ridge and furrow and is weaker than anomaly (42) with a response of up to 2.5nT.

(44) – A fragmented positive linear anomaly is located parallel with and 27m from anomaly (42) and 24m from anomaly (43). It relates to a third parallel linear ditch, although it does not appear to extend further westwards than the centre of the survey area. Other pit-like responses to the east may be a continuation.

(45) – Located in the south west corner of the survey area is a fragmented positive

linear anomaly. It is possible that it is a continuation of a fragmented linear anomaly seen to the south west and located during the previous phase of survey. It is possible, but not certain, that it continues eastwards as anomaly (46).

Anomalies with an uncertain origin

(46) – A positive linear anomaly may be a continuation of anomaly (45). However, it is on edge of two series of former ridge and furrow, and it is not certain if it relates to a linear ditch or is associated with former ridge and furrow (55).

(47) – A narrow and weakly positive linear anomaly appears to extend towards anomaly (44) from the south west and may extend beyond it to the north east. Its weak and indistinct response prevents confident interpretation but it is possible that it relates to a cut, ditch-like feature.

(48) – A number of parallel positive linear anomalies are oriented east north east to west south west within the central part of the survey area. These are not parallel with the modern cultivation trend or the underlying ridge and furrow and it is possible that they relate to cut, ditch-like features.

(49) – An irregularly shaped zone of magnetically variable responses is located in the central part of the survey area. Although it is possible that it has a natural origin, it has slightly different morphological characteristics to others seen within the survey area (58) and its origin is uncertain.

(50) – Within the northern half of the survey area are a number of positive linear anomalies. They lie either site of anomaly (51) and may be associated. They may be associated with agricultural practices, although this is not certain.

(51) – A positive linear anomaly extends across the northern part of the survey,with an extension towards the north west. The response is broad and generally 5-7nT and although it is possible that it relates to a natural feature or former field boundary, its long axis is generally parallel with anomalies (42) to (44) to the south east.

(52) – The survey area contains a number of positive linear anomalies with no coherent form or pattern. Their origin is therefore uncertain.

(53) – A number of discrete positive responses have been located within the survey area. It is not possible to determine if they relate to pit-like features with a natural or anthropogenic origin.

Anomalies associated with quarrying/ground disturbance

(54) – A small zone of mainly positive response is located close to the north east edge of the survey area. A similar response can be seen right at the south east corner and these are typical of infilled former quarries.

Anomalies with an agricultural origin

(55 & 56) – The survey area contains two series of parallel linear anomalies, one oriented north east to south west (55) and one oriented north west to south east (56), that relate to former ridge and furrow.

(57) – Linear anomalies relating to the modern cultivation trend.

Anomalies with a natural origin

(58) – A zone of magnetically variable responses is located in the south western part of the survey area and relates to naturally formed features.

4 DISCUSSION

4.1.1 Area 1 contains evidence for a number of linear ditches, enclosures, ring ditches and pits that indicate a settlement dating to the Iron Age, with some possible continuation into the Romano-British period. The results of the survey demonstrate several phases of occupation at the site, with several ring ditches being truncated by linear and enclosure ditches. Much of the core zone of archaeological features occupies an area that is underlain by sandstone geology. Although there is continuation onto the mudstone geology, the anomalies are generally weaker and less well defined. There has also been truncation by later ridge and furrow. Several anomalies clearly represent a continuation of features seen immediately to the south within the results of a previous magnetometer survey (Archaeological Surveys, 2013).

4.1.2 Area 2 is located in the northern part of the site and may contain a positive linear anomaly with some archaeological potential. It appears to have been truncated by later ridge and furrow and an earlier date should be considered. The survey area contains a number of pit-like responses, but it is not possible to determine if they are natural or anthropogenic in origin. A large former quarry or clay pit is located in the central part of the survey area.

4.1.3 Area 3 lies on the eastern edge of the site and is a continuation northwards of a former magnetometer survey (Archaeological Surveys, 2013). A number of parallel positive linear anomalies have been located and they may relate to a former trackway associated with the archaeological features seen to the south west.

5 CONCLUSION

5.1.1 The magnetometer survey located a large number of linear ditches, enclosures, ring ditches and pits that are a continuation of similar features seen immediately to the south and located during an earlier survey. Together the features from both surveys extend over an area of approximately 10ha and include at least 14 ring ditches.

5.1.2 Within the current survey areas, the archaeological features extend for almost 6ha, with at least 7 ring ditches and a number of small square or irregularly shaped enclosures. Larger irregularly shaped, rectangular and square enclosures are located in the vicinity, and there is evidence for subsequent truncation of some of the ring ditches by later linear ditches and enclosures, indicating several phases of occupation. A number of parallel linear ditches extend north eastwards from the main core of the activity, and it is possible that these are associated with a trackway.

5.1.3 The core of the occupation is located within an area of sandstone and the features are well defined on this geology. Although there is some extension of the anomalies onto the mudstone geology, they are much weaker and less well defined. This is likely to be partly due to their distance from the main core of habitation but also partly due to the properties of the Ampthill Clay mudstone.

5.1.4 The survey area contains several series of former ridge and furrow which are not extant and have truncated many of the archaeological features. Several former field boundaries have also been located as well as evidence for quarrying.

6 REFERENCES

Archaeological Surveys, 2013. *Land at Shrivenham, Oxfordshire, Magnetometer Survey Report. Ref 479.* Unpublished typescript document.

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Cotswold Archaeology, 2013. *Land east of Highworth Road, Shrivenham, Oxfordshire, Archaeological Evaluation.* CA report: 13614. Unpublished typescript document.

English Heritage, 2008. *Geophysical survey in archaeological field evaluation. Research and Professional Service Guideline No.1.* 2nd ed. Swindon: English Heritage.

Institute for Archaeologists, 2002. *The use of Geophysical Techniques in Archaeological Evaluations*. IfA Paper No. 6. IfA, University of Reading.

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Appendix A – basic principles of magnetic survey

Iron minerals are always present to some degree within the topsoil and enhancement associated with human activity is related to increases in the level of magnetic susceptibility and thermoremnant material.

Magnetic susceptibility is an induced magnetism within a material when it is in the presence of a magnetic field. This can be thought of as effectively permanent due to the presence of the Earth's magnetic field.

Thermoremnant magnetism occurs when ferrous material is heated beyond a specific temperature known as the Curie Point. Demagnetisation occurs at this temperature with re-magnetisation by the Earth's magnetic field upon cooling.

Enhancement of magnetic susceptibility can occur in areas subject to burning and complex fermentation processes on biological material; these are frequently associated with human settlement. Thermoremnant features include ovens, hearths, and kilns. In addition thermoremnant material such as tile and brick may also be associated with human activity and settlement.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil can create an area of enhancement compared with surrounding soils and subsoils into which the feature is cut. Mapping enhanced areas will produce linear and discrete anomalies allowing an assessment and characterisation of hidden subsurface features.

It should be noted that areas of negative enhancement can be produced from material having lower magnetic properties compared to the topsoil. This is common for many sedimentary bedrocks and subsoils which were often used in the construction of banks and walls etc. Mapping these 'negative' anomalies may also reveal archaeological features.

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The SENSYS gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 65cm apart. The instrument is carried about 10-20cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength the magnetic field created by the buried feature. If no enhanced feature is present the field measured by both sensors will be similar and the difference close to zero.

There are a number of factors that may affect the magnetic survey and these include soil type, local geology and previous human activity. Situations arise where magnetic disturbance associated with modern services, metal fencing, dumped waste material etc., obscures low magnitude fields associated with archaeological features.

Appendix B – data processing notes

Clipping

Minimum and maximum values are set and replace data outside of the range with those values. Extreme values are removed improving colour or greyscale contrast associated with data values that may be archaeologically significant. It has been found that clipping data to ranges between ±15nT and ±10nT often improves the appearance of features associated with archaeology. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Appendix C – survey and data information

Area 1

COMPOSITE
Filename: J560-Area1-proc.xcp
Description: Imported as Composite from: J560-Area1.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):
Northwest corner: 423396.476166296, 189618.010640151 m
Southeast corner: 423827.876166296, 189217.060640151 m
Direction of 1st Traverse: 90 deg
Collection Method: Parallel
Sensors: 1
Dummy Value: 32702

Source GPS Points: 2785100

Dimensions
Composite Size (readings): 2876 x 2673
Survey Size (meters): 431 m x 401 m
Grid Size: 431 m x 401 m
X Interval: 0.15 m
Y Interval: 0.15 m

Stats
Max: 22.10
Min: -22.00
Std Dev: 7.29
Mean: 0.24
Median: 0.00
Composite Area: 17.297 ha
Surveyed Area: 8.4159 ha

Processes: 1
1 Base Layer

GPS based Proce3
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 Clip from -20.00 to 20.00 nT

Area 2

COMPOSITE
Filename: J560-Area2.xcp
Description: Imported as Composite from: J560-Area2.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):
Northwest corner: 423473.550848167, 189746.16914592 m
Southeast corner: 423707.850848167, 189508.56914592 m
Direction of 1st Traverse: 90 deg
Collection Method: Parallel
Sensors: 1
Dummy Value: 32702

Source GPS Points: 920900

Dimensions
Composite Size (readings): 1562 x 1584
Survey Size (meters): 234 m x 238 m
Grid Size: 234 m x 238 m
X Interval: 0.15 m
Y Interval: 0.15 m

Stats
Max: 22.10
Min: -22.00
Std Dev: 4.60
Mean: 0.16
Median: -0.02
Composite Area: 5.567 ha
Surveyed Area: 2.814 ha

Processes: 1
1 Base Layer

GPS based Proce3
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 Clip from -20.00 to 20.00 nT

Area 3

COMPOSITE
Filename: J560-mag-Area3.xcp
Description: Imported as Composite from: J560-mag-Area3.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):
Northwest corner: 423624.965593845, 189760.959288095 m
Southeast corner: 423957.515593845, 189482.859288095 m
Direction of 1st Traverse: 90 deg
Collection Method: Parallel
Sensors: 1
Dummy Value: 32702

Source GPS Points: 1109400

Dimensions
Composite Size (readings): 2217 x 1854
Survey Size (meters): 333 m x 278 m
Grid Size: 333 m x 278 m
X Interval: 0.15 m
Y Interval: 0.15 m

Stats
Max: 22.10
Min: -22.00
Std Dev: 5.21
Mean: 0.21
Median: 0.00
Composite Area: 9.2482 ha
Surveyed Area: 3.2992 ha

Processes: 1
1 Base Layer

GPS based Proce3
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36)
3 Clip from -20.00 to 20.00 nT

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire (see inside cover for address). Data are backed-up onto an on-site data storage drive and at the earliest opportunity data are copied to CD ROM for storage on-site and off-site.

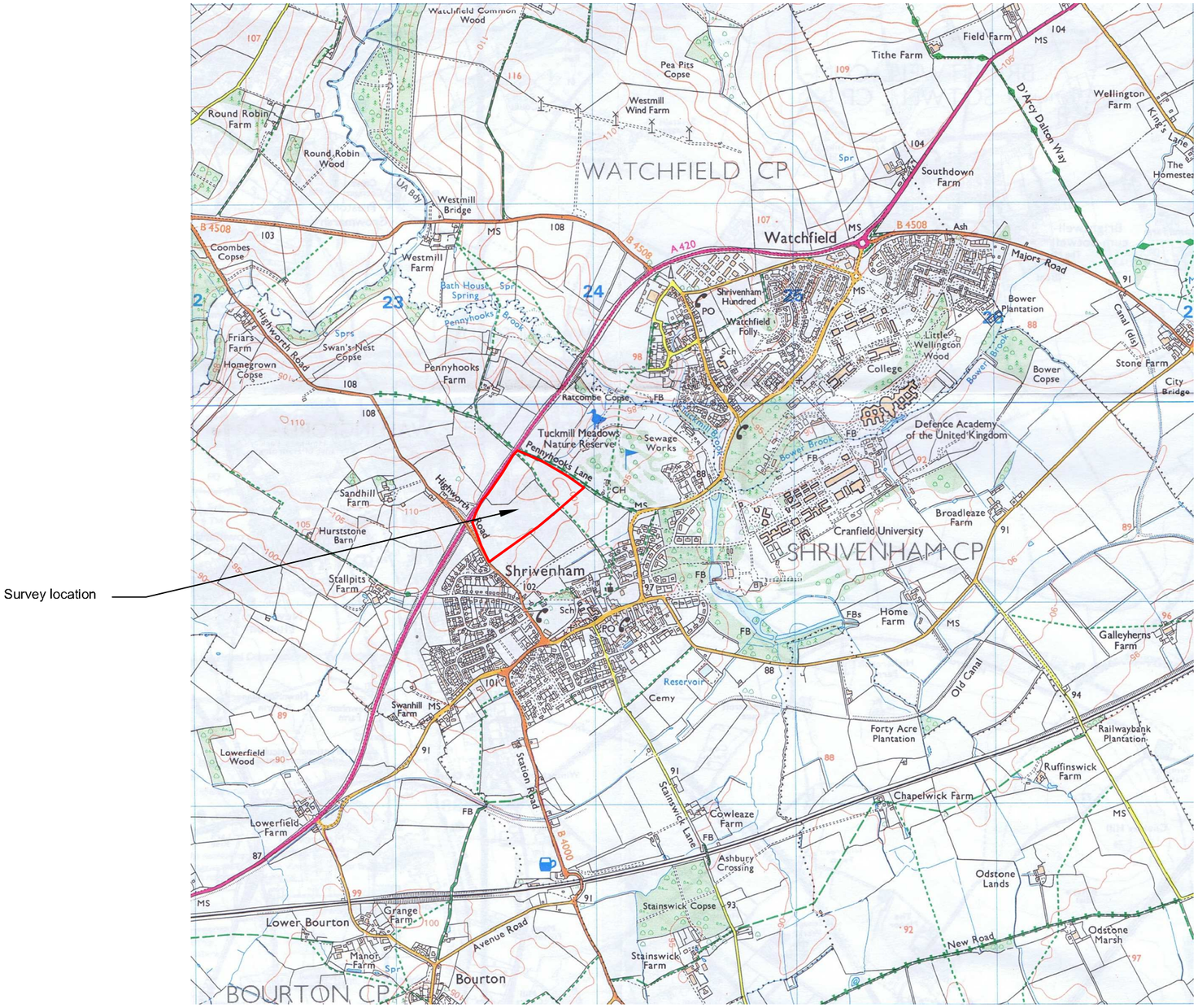
Surveys are reported on in hardcopy (recycled paper) using A4 for text and A3 for plots (all plots are scaled for A3). A digital copy (pdf) will be sent to the Oxfordshire County Archaeologist and a printed copy sent to the Oxfordshire HER and uploaded to Oasis upon request by the client.

This report has been prepared using the following software on a Windows XP platform:

- TerraSurveyor version 3.0.23.0 (geophysical data analysis),
- SENSYS MAGNETO®ARCH version 1.00-04(geophysical data analysis),
- ProgeCAD Professional 2014 (report graphics),
- AutoCAD LT 2007 (report figures),
- OpenOffice.org 3.0.1 Writer (document text),
- PDF Creator version 0.9 (PDF archive).

Digital data produced by the survey and report include the following files:

- TerraSurveyor grid and composite files for all geophysical data,
- CSV files for raw and processed composites,
- geophysical composite file graphics as Bitmap images,
- AutoCAD DWG files in 2000 and 2007 versions,
- report text as OpenOffice.org ODT file,
- report text as Word 2000 doc file,
- report text as rich text format (RTF),
- report text as PDF,
- PDFs of all figures.

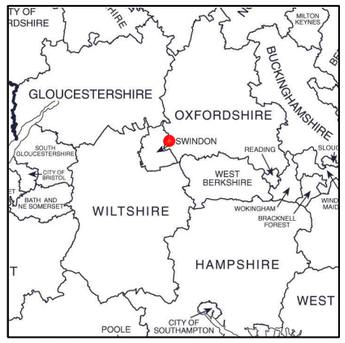


N

Archaeological Surveys Ltd

Geophysical Survey
Land east of Highworth Road
Shrivenham: Phase II

Map of survey area



● Survey location

Site centred on OS NGR
SU 23645 89500

SCALE 1:25 000

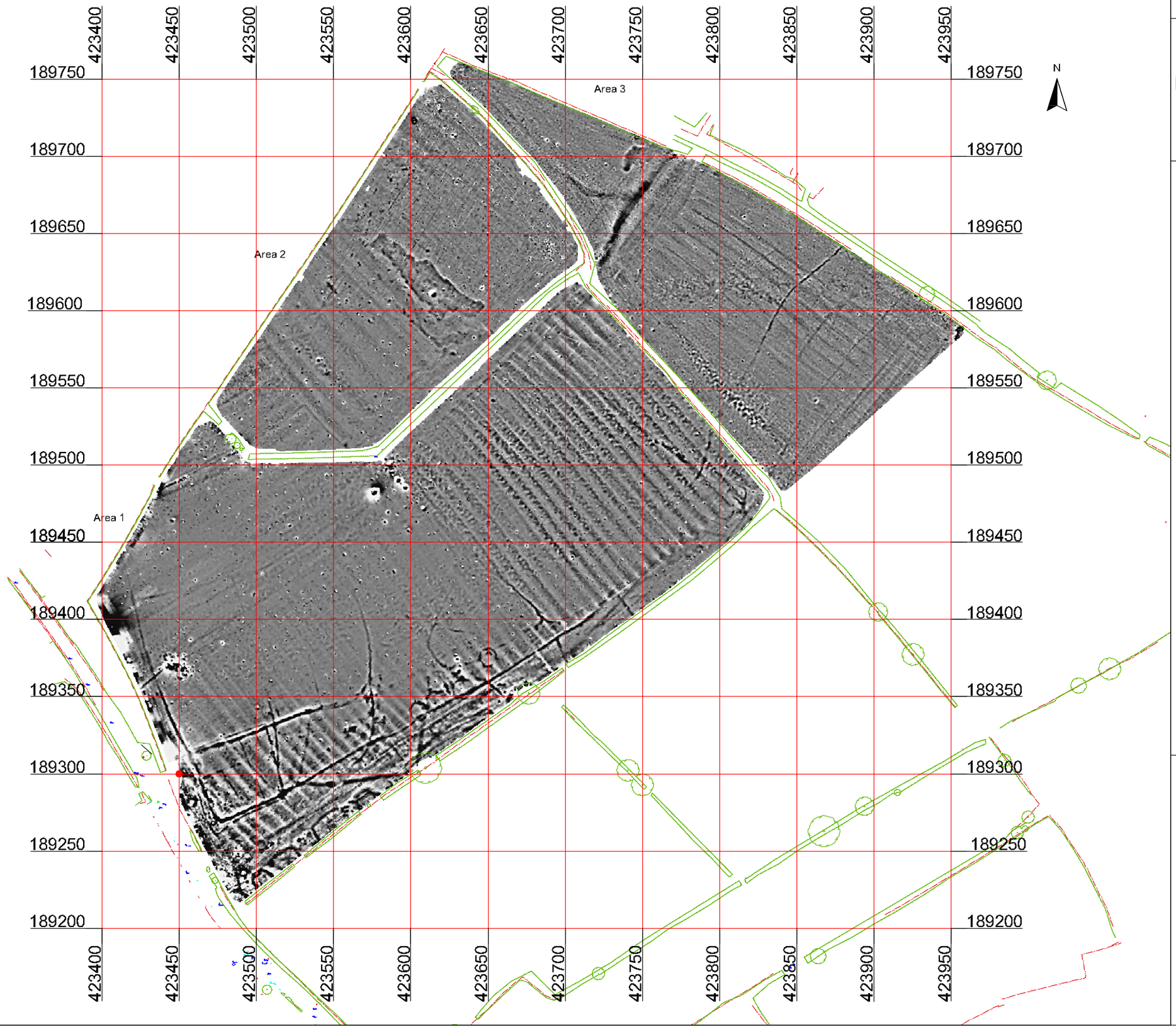
0m 500m 1000m

SCALE TRUE AT A3

FIG 01

Archaeological Surveys Ltd

Geophysical Survey
Land east of Highworth Road
Shrivenham: Phase II



Referencing information

Referencing grid to OSGB36 datum at 50m intervals

Data collected at 20Hz and georeferenced to ETRS89 zone 30 with conversion to OSGB36 using OSTN02

● 423450 189300

SCALE 1:2500

0m 50 100m

SCALE TRUE AT A0

FIG 02

Area 3

Area 2

Area 1

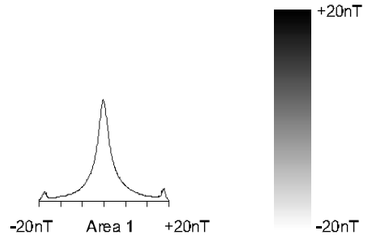
N

2013 geophysical survey (Phase I)

Archaeological Surveys Ltd

Geophysical Survey
Land east of Highworth Road
Shrivenham: Phase II

Greyscale plot of processed magnetometer data - Phases I & II



SCALE 1:2500

0m 50 100m

FIG 03

Area 3

Area 2

Area 1

N

2013 geophysical survey (Phase I)

Archaeological Surveys Ltd

Geophysical Survey
Land east of Highworth Road
Shrivenham: Phase II

Abstraction and interpretation of magnetometer anomalies - Phases I & II

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear anomaly - ring ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Linear anomaly - ridge and furrow
- Positive linear anomaly - possible former field boundary
- Negative linear anomaly - material of low magnetic susceptibility
- Negative linear anomaly - land drain
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material
- Variable magnetic response - of uncertain origin
- Variable magnetic response - associated with quarrying
- Variable magnetic response - of natural origin
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:2500

0m 50 100m

SCALE TRUE AT A3

FIG 04

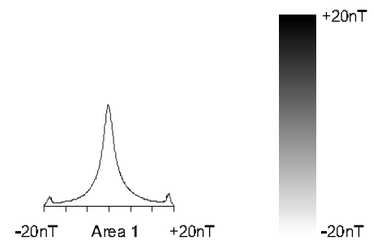
Area 1

N

Archaeological Surveys Ltd

Geophysical Survey
Land east of Highworth Road
Shrivenham: Phase II

Greyscale plot of processed magnetometer data - Area 1



SCALE 1:1500

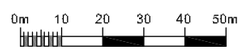


FIG 05

Archaeological Surveys Ltd

Geophysical Survey
Land east of Highworth Road
Shrivenham: Phase II

Abstraction and interpretation of magnetometer anomalies - Area 1

Area 1

N

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear anomaly - ring ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - ridge and furrow
- Positive linear anomaly - possible former field boundary
- Negative linear anomaly - material of low magnetic susceptibility
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Variable magnetic response - of natural origin
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 06

Area 3

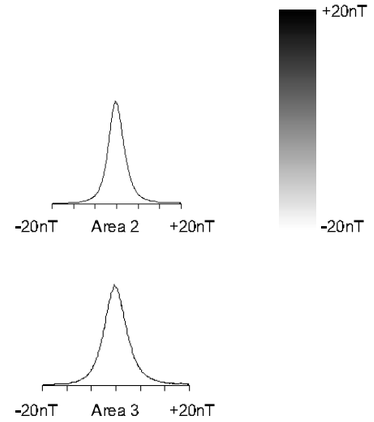
Area 2

N

Archaeological Surveys Ltd

Geophysical Survey
Land east of Highworth Road
Shrivenham: Phase II

Greyscale plot of processed magnetometer data - Areas 2 & 3



SCALE 1:1500

0m 10 20 30 40 50m

FIG 07

Area 2

Area 3

N

Archaeological Surveys Ltd

Geophysical Survey
Land east of Highworth Road
Shrivenham: Phase II

Abstraction and interpretation of magnetometer anomalies - Areas 2 & 3

- Positive linear anomaly - cut feature of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Linear anomaly - ridge and furrow
- Positive linear anomaly - possible former field boundary
- Negative linear anomaly - land drain
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material
- Variable magnetic response - of uncertain origin
- Variable magnetic response - associated with quarrying
- Variable magnetic response - of natural origin
- Magnetic debris - spread of magnetically thermoremnant/ferrous material

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 08