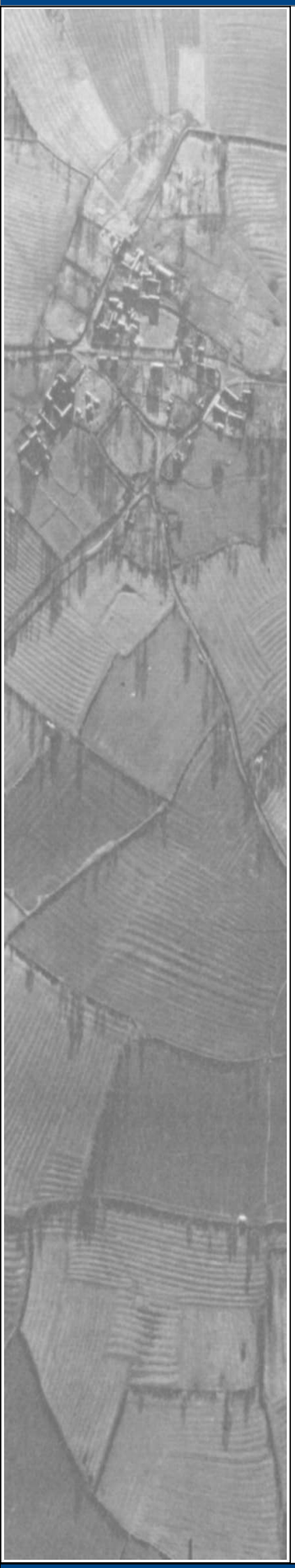

Burderop Down
Chiseldon
Swindon

MAGNETOMETER SURVEY REPORT

for

Wiltshire Council Archaeology Service

Kerry Donaldson & David Sabin

April 2023

Ref. no. J957

ARCHAEOLOGICAL SURVEYS LTD

Burderop Down
Chiseldon
Swindon

MAGNETOMETER SURVEY REPORT

for

Wiltshire Council Archaeology Service

Fieldwork by David Sabin BSc (Hons) MCIfA
Report by Kerry Donaldson BSc (Hons) MCIfA
Report checked by David Sabin
Primary archive location - Archaeological Surveys Ltd, Yatesbury, Wiltshire

Survey dates – 13th, 14th, 15th & 24th March & 3rd April 2023
Ordnance Survey Grid Reference – **SU 16040 76460**

Archaeological Surveys Ltd
1 West Nolands, Nolands Road, Yatesbury, Calne, Wiltshire, SN11 8YD
Tel: 01249 814231 Fax: 0871 661 8804
Email: info@archaeological-surveys.co.uk
Web: www.archaeological-surveys.co.uk

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SUMMARY

A magnetometer survey was carried out by Archaeological Surveys Ltd over an extant scheduled field system on Burderop Down, Chiseldon, Swindon. The field system exists as a series of linear and rectilinear earthworks up to 1.5m high with a long axis oriented north east to south west on a north facing chalk hillside. Surveying of the earthworks on the steep slope was very difficult and the resulting anomalies over the earthworks are associated with the movement of the sensors from their vertical alignment. A later enclosure cuts through the earthworks, but has preserved them within the interior. A small number of pit-like features can be seen within the interior and these could be associated with tree removal as a plantation of trees was mapped within the enclosure during the late 19th century. A small number of linear anomalies extend northwards away from the northern edge of the later enclosure, but their date and function are uncertain. In the northern part of the site, towards the base of the slope, there are a number of positive linear, discrete and curvilinear anomalies; however, these tend to lack a coherent morphology and cannot be confidently interpreted. Numerous anomalies at the top of the slope in the south western part of the site are associated with Clay-with-flints deposits and a number of quarry pits.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Wiltshire Council Archaeology Service to undertake a geophysical survey over the scheduled monument of the *Field system and earthwork enclosure on Burderop Down* (List Entry no: 1016383) (see Fig 1). The survey would provide information on the archaeological potential of the site which is on the Heritage at Risk register due to issues with off-road vehicles.

1.1.2 The survey was carried out with a licence, issued by Historic England under Section 42 of the 1979 Ancient Monuments and Archaeological Areas Act (as amended by the National Heritage Act 1983) prior to commencing the fieldwork.

1.2 Survey objectives and techniques

1.2.1 The objectives of the survey were to use non-intrusive geophysical techniques to establish the presence/absence, extent, condition, character, quality and possible date of any archaeological deposits within the scheduled monument area. The survey was carried out using detailed magnetometry which aims to provide information on the archaeological potential of the site to enhance the knowledge and understanding of the monument and help inform its future management.

1.3 Standards, guidance and recommendations for the use of this report

1.3.1 Archaeological Surveys Ltd is a Registered Organisation with the Chartered Institute for Archaeologists (CIfA) and both company directors are Members of the Chartered Institute for Archaeologists (MCIfA) and have therefore been assessed for their technical competence and ethical suitability and abide by the CIfA Codes of Conduct. The survey and report follow the recommendations set out by: European Archaeological Council (2015) Guidelines for the Use of Geophysics in Archaeology; Institute for Archaeologists (2002) The use of Geophysical Techniques in Archaeological Evaluations. The work has been carried out to the Chartered Institute for Archaeologists (2014, updated 2020) Standard and Guidance for Archaeological Geophysical Survey.

1.3.2 Archaeological Surveys Ltd provide a detailed geophysical survey report and it is recommended that where possible the contents should be considered in full. The Summary provides a brief overview of the results with more detail available in the Conclusion. The *List of anomalies* within the Results provides a detailed assessment of the anomalies within separate categories which can be useful in inferring a level of confidence to the interpretation. Quality and factors influencing the interpretation of anomalies is also set out within the results.

1.3.3 It is recommended that the full report should always be considered when using data and interpretation plots; where this is not possible, in the field for example, the abstraction and interpretation plots should retain their colour coding and be used with a corresponding legend.

1.4 Site location, description and survey conditions

1.4.1 The site is located on Burderop Down within the parish of Chiseldon on the southern edge of Swindon Borough. It is centred on Ordnance Survey National Grid Reference (OS NGR) SU 16040 76460, see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 14ha of grassland, with the majority of the site within a single, north-facing field and a small section within the confines of the Barbury Shooting School in the north eastern corner of the scheduled area. The survey aimed to cover as much as possible within the scheduled area, together with some of the eastern part of the site outside of the scheduled area.

1.4.3 Due to the very steep hillside, exacerbated by field system earthworks, survey was extremely difficult. Several small zones within the scheduled area were unsurveyable due to uneven ground associated with numerous animal burrows, small trees or bushes and hollows associated with quarrying and off-road vehicle activity. Close to the eastern edge of the scheduled monument, steep earthworks associated with a holloway were unsurveyable, and a

narrow strip between the holloway and the eastern scheduled monument boundary was not surveyed. The strip was also within range of a frequently used part of the shooting school. Due to the losses the survey area was made up by extending east along the southern side of the field as far as the eastern field boundary. This part of the field is somewhat flatter and is a hilltop ridge with a public right of way, it was also considered that there was perhaps a higher potential for the location of previously unknown archaeological features.

1.4.4 The ground conditions across the site were variable and survey was abandoned on a number of occasions due to very wet slippery grass on steep slopes. Weather conditions during the survey were variable but often very poor with periods of heavy rain, sleet, hail and high winds.

1.5 Site history and archaeological potential

1.5.1 The site contains the scheduled monument listed as *Field system and earthwork enclosure on Burderop Down* (List Entry no: 1016383). The scheduled monument covers 14ha and includes a coaxial field system which extends for approximately 600m across the north-facing slopes of Burderop Down with a north east to south west alignment oriented diagonally to the slope. The boundaries are well preserved banks ups to 1.5m high and 10m wide which define a number of land parcels. Although these are outlined in the official list entry by Historic England as “ranging in size fro 2ha to 3ha”, they are generally 0.2ha to 0.3ha in area. These are overlain by a sub-rectangular earthwork 120m wide by 96m long formed by a 0.6m high bank with a 5m wide and 0.4m deep external ditch. Such field systems can date from the Bronze Age to the end of the fifth century AD, with many dating to the Iron Age and Roman periods. A number of Romano-British pottery sherds have been located within the site, indicating that it was at least utilised during the Roman period. The enclosure date and function is uncertain, it has been interpreted as a medieval sheepfold and the 1888 map shows it enclosing a tree plantation which could suggest an 18th or 19th century date.

1.5.2 The field system lies 680m east of the Iron Age hillfort known as Barbury Castle (List entry no:1014557). The bivallate hillfort has two entrances, to the east and west and contains numerous pits and a several circular structures many of which are likely to be associated with settlement within the hillfort, although military activity during the Second World War has also caused pitting and ground disturbance.

1.6 Geology and soils

1.6.1 The underlying geology along the southern edge of the site at 258m AODN to 237m AODN is from the Lewes Nodular Chalk Formation (Upper Chalk). From 237 to 207 AODN the underlying geology is from the New Pit Chalk Formation (Middle Chalk) and to the north from 207m to 195m AODN, at the northern edge of the site, the underlying geology is from the Holywell Nodular Chalk

Formation (Lower Chalk). Just on the southern boundary of the site are Clay-with-flints deposits (BGS, 2023). A zone of former quarrying in the southern part of the site is associated with several unvegetated scars that reveal Clay-with-flints deposits extending further north than indicated by the BGS. However, it is unclear how thick these deposits are, what geology was being targeted and for what purpose. First Edition Ordnance Survey (1886) mapping labels one of the quarries as a gravel pit implying that the Clay-with flints was targeted, rather than the underlying chalk.

1.6.2 The overlying soil across the site is from the Upton 2 association (342b) and is a grey rendzina. It consists of a shallow, well drained, calcareous, silty soil over argillaceous chalk (Soil Survey of England and Wales, 1983). However, site observations of more extensive Clay-with-flints than mapped combined with slope processes, both natural and associated with early cultivation, as well as the lack of modern cultivation, would tend to infer more complexity than apparent on the Soil Survey mapping. The UK Soil Observatory indicates the potential for neutral to slightly acid soils in this area which is especially likely on land not cultivated for a long period.

1.6.3 The underlying geology and soils are frequently associated with low magnetic contrast and low levels of magnetic susceptibility. However, cut features of archaeological potential may be located where human activity has altered the magnetic characteristics of the soil sufficiently. The underlying geology and soils are, therefore, generally considered acceptable 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 (also known as thermoremanence) are factors associated with the formation of localised magnetic fields.

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 positive magnetic anomalies that can be mapped by magnetic prospection. In addition, where soil is displaced by material of comparatively low magnetic susceptibility, such as many types of sedimentary rock, anomalies of negative value may occur which could be indicative of structural remains.

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). Additional details are set out in 2.2 below and within Appendix A.

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 (FGM650) spaced 0.5m apart with readings recorded at 20Hz. The cart is pushed at walking speed and not towed. Each sensor is not zeroed in the field as the vertical axis alignment is precisely fixed leaving sensor offsets that are removed during data processing. The fixing of the vertical alignment ensures the sensors are not unduly influenced by localised magnetic fields and that the vertical component of a magnetic anomaly is measured. The gradiometers have a recorded range of ±3000nT, and resolution is approximately 0.1nT. They are linked to a Leica GS10 RTK GNSS with data recorded by SENSYS MonMX software on a rugged notebook computer system.

2.2.2 Due to the fixed offsets within the fluxgate sensors, as a result of the manufacturing and tensioning process, the survey data do not provide a visually useful dataset until a zero median traverse algorithm is applied. It is recognised that this has the potential to affect some anomalies detrimentally by removing linear features orientated parallel to survey transects. However, this has not been noted as a particular problem with the system due to the high resolution data collection, generally long length of traverses and variability within the magnetic characteristics of a linear anomaly.

2.2.3 Data are collected along a series of parallel survey transects to achieve 100% coverage of the surveyable land. 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. Data are not collected within fixed grids and data points are considered to be random even though the data are collected in a systematic manner covering all accessible areas (Aspinall, Gaffney and Schmidt, 2009).

2.2.4 Fluxgate sensors are highly sensitive to temperature change and this manifests as drift during the course of a survey. This can be particularly noticeable during the morning as temperatures rise and the equipment warms or cools. Sensor drift within the course of a traverse will appear as a line trending from negative to positive after processing with a zero median traverse algorithm. To remove the potential for temperature drift, data were collected after a 20 minute stabilisation period and traverses were limited to a time of generally <100s.

2.3 Data processing and presentation

2.3.1 Magnetic data collected by the MAGNETO®MXPDA cart-based system are initially prepared using SENSYS MAGNETO®DLMGPS software. The software effectively allocates a geographic position for each data point and can compensate for fixed offsets present within the FGM650 sensors. The offsets are positive or negative values present on all fluxgate gradiometer sensors. Some systems use manual or electronic balancing to effectively zero the sensors; however, this is a short term measure that is prone to drift through temperature changes and vibration and can easily be incorrectly set due to localised magnetic fields. The FGM650 sensors are very accurately aligned to the vertical magnetic gradient and are highly stable showing negligible drift on long traverses. The offset values are removed using TerraSurveyor software.

2.3.2 Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display within TerraSurveyor. The removal of the offset values (compensation) of the sensors is also carried out in TerraSurveyor using a zero median traverse function. Data are then considered to be minimally processed. Note: without the zero median traverse function it is not possible to create a meaningful data plot as all sensors have a different offset value. Although a zero median traverse algorithm can remove anomalies aligned with the survey tracks, in practice this rarely occurs due to the use of long traverses, high resolution measurement and variability within the magnetic susceptibility of long linear features.

2.3.3 The minimally processed data are collected between limits of ±3000nT and clipped for display at ±3nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.3.4 Additional data processing has been carried out in the form of high pass filtering. This effectively removes low frequency variation along a traverse that has been caused by large magnetic bodies, or rapid changes in temperature or terrain. Data treated to additional processing have been compared to unprocessed data to ensure that no significant anomalies have been removed.

2.3.5 Appendix C contains metadata concerning the survey and data attributes and is derived directly from TerraSurveyor. Reference should be made to Appendix B for further information on processing.

2.3.6 A TIF file is produced by TerraSurveyor software along with an associated world file (.TFW) that allows automatic georeferencing (OSGB36 datum) when using GIS or CAD software. The main form of data display used in the report is the minimally processed greyscale plot. Minimally processed data are considered by the manufacturer to be data that are compensated by SENSYS MAGNETO DLMGPS software, see 2.3.1 and 2.3.2. Note: traceplots are not considered to be appropriate as they do not provide an accurate or useful assessment of the magnetic anomalies due to the very high density of data collection. In addition, traceplots cannot be meaningfully plotted against base

mapping and in areas of complexity traces may be lost or highly confused. Traceplots may be used to demonstrate characteristic magnetic profiles across discrete features where it is considered beneficial.

2.3.7 The raster images are combined with base mapping using ProgeCAD Professional 2021, creating DWG (2018) file formats. All images are externally referenced to the CAD drawing in order to maintain good graphical quality. The CAD plots are effectively georeferenced facilitating relocation of features using GNSS, resection method, etc.

2.3.8 An abstraction and interpretation is drawn and plotted for all geophysical anomalies located by the survey. Anomalies are abstracted using colour coded points, lines and polygons. All plots are scaled to landscape A3 for paper printing. Appendix E sets out CAD layer names with colour and graphic content for each interpretation category, see 3.3.

2.3.9 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 the survey area.

2.3.10 The abstraction and interpretation procedure has been supported by analysis of a digital terrain model plot derived from the Environment Agency's LiDAR data. Shaded relief plots and contours are created using Surfer 15 (Azimuth:1150, Altitude:85, Z factor:10), (Fig 15).

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

2.4 Supplementary measurement of magnetic susceptibility

2.4.1 Magnetic susceptibility is an important factor in the formation of magnetic anomalies located by a magnetometry survey, see 2.1. Accurate measurement of the magnetic susceptibility of soil, subsoil and underlying geology may enhance the results of the magnetometry survey by providing an assessment of magnetic contrast within a site. Where sampling of topsoil only is possible, measurement may assist in understanding whether the soil is likely to be associated with strong, moderate or weak anomalies, which may be a result of low levels of iron minerals, waterlogging, etc. Accurate measurement may also assist in determining industrial activity and the presence of layers or features not visually or texturally apparent on excavation.

2.4.2 Supplementary measurement of soil magnetic susceptibility is not considered part of the main objective of the survey and is discussed in section 3.2 below as a factor influencing the formation of anomalies.

2.4.3 Measurements are achieved using a Bartington MS2 Magnetic Susceptibility Meter with MS2B sensor. Small soil samples are collected from outside of the

scheduled area and are measured in 10 cubic centimetre plastic pots after accurately weighing, generally each sample is subdivided and at least 3 separate measurements are made in order to provide a mean value, or assess variability due to ferrous contamination and other factors. Measurement can be made at low or high frequency, generally low frequency measurements are made but occasionally high frequency measurements are also recorded as the frequency dependence of a soil may be informative.

2.4.4 The measurements are converted to mass specific readings using SI units for bulk density. Archaeological Surveys express the measurements as X_{lf} or X_{hf} for low frequency or high frequency magnetic susceptibility respectively with units of $10^{-8}m^3kg^{-1.}$

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over approximately 14ha.

3.1.2 Magnetic anomalies located can be generally classified as anomalies associated with field system earthworks, positive anomalies of an uncertain origin, anomalies with a natural origin, anomalies associated with vehicle ruts, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects. Anomalies located within each survey area have been numbered and are described in 3.4 below.

3.2 Data quality and factors affecting the interpretation or formation of anomalies

3.2.1 Data are considered representative of the magnetic anomalies present within the site. However, over much of the area magnetic contrast is poor and system noise is high due to highly variable surface angles.

3.2.2 Poor magnetic contrast tends to occur with increasing distance to the north away from the Clay-with flints deposits in the southern part of the site, and it is considered likely that these deposits that overlie the chalk give rise to soils containing significantly more iron. They may also contain other nutrients that support the development of a loamy soil and combined with higher levels of iron, the natural base level of magnetic susceptibility may be higher than soils formed on chalk alone. Natural variability associated with the Clay-with-flints can produce discrete and amorphous anomalies typical of those encountered in the southern part of the site; these can be very similar to anomalies associated with anthropogenic features and interpretation can be problematic. The density of these anomalies may also confuse or obscure more significant features.

3.2.3 In order to provide further understanding of the magnetic characteristics of the

soil, two topsoil samples and one subsoil sample were taken from part of the field outside of the scheduled monument boundary to the east. Their mass specific magnetic susceptibility was measured, (see 2.4). A topsoil sample from the mid part of the slope produced an average low frequency mass specific magnetic susceptibility (X_{lf}) of 8.6 $10^{-8}m^3kg^{-1}$; a topsoil sample from the lower part of the slope produced an average low frequency mass specific magnetic susceptibility of 6.76 $10^{-8}m^3kg^{-1}$; a subsoil sample from the mid part of the slope produced an average low frequency mass specific magnetic susceptibility of 8.97 $10^{-8}m^3kg^{-1}$.

3.2.4 The small number of samples and their location outside the scheduled monument may not be representative; however, they are low but consistent with similar sites locally. The slightly higher values recorded from the higher mid-slope level may relate to closer proximity to the Clay-with-flints deposit. The slightly higher value of the subsoil may relate to slope processes or to leaching of iron to lower levels (illuviation); where this has been identified on other sites, magnetic anomalies often appear very weak and of very poor contrast.

3.2.5 The ancient field boundaries are visible due to the presence of linear banks and lynchets. Where soil of low magnetic susceptibility has forms earthwork features it is unlikely that magnetic anomalies are present. Infilled ditches may form magnetic anomalies if the soil fill is magnetically enhanced; however, sufficient enhancement may not occur in areas away from human settlement where agricultural activity is of relatively low intensity. It is unclear whether the field system is associated with former ditches, although holloways are extant near the eastern edge of the scheduled monument and associated with the later enclosure within the site; extant ditches often do not contain sufficient magnetically enhanced fill to produce anomalies.

3.2.6 The magnetic data demonstrate noise associated with rapid and variable tilt to the fluxgate gradiometers. It is possible that anomalies relating to the steeply sloping field boundary banks are mainly as a result of large changes to the tilt of the gradiometers within survey traverses, rather than to changes in the magnetic characteristics of the soil forming the banks. The steepness of the site and variability of the angle of the cart system when passing over earthworks was impossible to account for by the operator. Traverses were shortened to try to minimise system noise associated with changes to sensor angle but this made no appreciable difference. It was also considered that if anomalies were formed in this way, the outcome was at least useful in indicating the location of the field boundary banks.

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 general explanation of the characteristics of the magnetic anomalies is set out for each category in order to justify interpretation, see Table 1.

Interpretation category	Description and origin of anomalies
Anomalies relating to field system earthworks	Anomalies are mainly linear and generally relate to upstanding earthworks associated with field system boundaries and lynchets. The anomalies may be long and/or form rectilinear elements and they may relate to topographic features or be visible on early mapping.
Anomalies with an uncertain origin	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. Morphology may be unclear or uncharacteristic and there may be a lack of additional supporting information. 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 associated with magnetic debris	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. They often occur where there has been dumping or ground make-up and are 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, hearths and nail spreads from former wooden structures or rooves 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.
Anomalies with a modern origin	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 these 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 adjacent to strong magnetic sources. Buried services may produce characteristic multiple dipolar anomalies dependant upon their construction.
Anomalies with a natural origin	Naturally formed magnetic anomalies 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 distinguish 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 centred on OS NGR 416040 176460, see Figs 03 – 14.

Anomalies associated with field system earthworks

(1) – A number of linear and rectilinear anomalies are associated with the extant earthworks that relate to the field system. Although some are weakly positive and others slightly negative anomalies, the majority of the responses are mainly due to movement of the sensors from the vertical position during survey progress over the very steep banks and scarps of the earthwork boundaries. These have been well mapped from aerial photographs and LiDAR imagery (see Fig 15) and the survey has done little to add any further detail to their formation and distribution.

Anomalies associated with the later enclosure

(2) – An irregularly shaped bank and ditch has been cut through the underlying field system which remains within the confines of the enclosure. There is also some evidence of natural, pit-like features within the enclosure which may be associated with the removal of trees as it was mapped as enclosing a tree plantation in the late 19th century. The majority of the enclosure earthworks were unsurveyable, and the

eastern edge does not have a magnetic response but appears to be more an artefact of the sensor position moving from the vertical alignment of the sensors.

Anomalies with an uncertain origin

(3) – Two positive linear anomalies extend northwards from the northern edge of the later enclosure feature, with one appearing to extend partly into it. These are not on the general north east to south west orientation of the field system, and do appear to be directly associated with the later enclosure.

(4) – A broad, weak response with the same north to south orientation as anomalies (3) appears to extend northwards from the north eastern corner of the later enclosure (2) and could have a similar function.

(5) – A V-shaped feature lies to the north of anomaly (4) in the north western part of the site. Like anomalies (3) & (4) it does not appear to to have a surface expression associated with the field system boundaries.

(6) – A weakly positive, U-shaped anomaly is located at the north western edge of the site. It may relate to a cut feature with archaeological potential, but this is uncertain.

(7) – A weakly positive curvilinear anomaly is situated close to the northern edge of the site. It has a diameter of c13m and although such an anomaly could relate to a cut feature with archaeological potential, it has a similar form and dimensions to a circular zone of magnetic debris (12) situated 130m to the east and associated with the site of a former animal feeder.

(8) – A number of weakly positive short linear and discrete anomalies are located towards the north eastern corner of the site. They lack a coherent morphology for them to be confidently interpreted.

(9) – Positive anomalies are located within the confines of the shooting school. It is not possible to determine if they are associated with the field system, other archaeological features, or if they relate to later ground disturbance.

Anomalies with a natural origin

(10) – A large number of positive linear, discrete and amorphous responses can be seen with the main concentration towards the south western corner of the site. This corresponds to the mapped area of Lewes Nodular Chalk; however, Clay-with-flints is mapped just to the south. There are areas of quarry pits within this zone. The responses relate to soil-filled naturally formed depressions, such as solution features within the chalk. The fill may be remnants of the Clay-with-flints.

Anomalies associated with magnetic debris

(11) – Magnetic debris within the southern part of the site is related to material used within the infilling of some quarry pits as well as consolidation of the track that

extends along the southern edge of the site.

(12) – A curvilinear area of magnetic debris is associated with the former position of an animal feeder.

(13) – Strong, discrete, dipolar anomalies are responses to ferrous objects within the topsoil.

Anomalies with a modern origin

(15 & 16) – Negative linear anomalies are a response to vehicle ruts related to modern access tracks and former scramble tracks within the site.

(17) – Magnetic disturbance from ferrous fencing material.

4 CONCLUSION

4.1.1 The results of the geophysical survey indicated that the field system earthworks only have a weakly magnetic response and that the anomalies are generally associated with the tilt of the sensors away from the vertical during the process of surveying over the steep inclines. In the north of the site, towards the base of the north facing slope, there are a number of weakly positive anomalies that do not correspond to any surface expression; however, they tend to lack a coherent morphology and cannot be confidently interpreted. A curvilinear response could be associated with previous animal feeding.

4.1.2 The site contains an irregularly shaped enclosure that cuts the earlier field system which remains present as preserved earthworks within its interior. A small number of pit-like anomalies within the enclosure could be associated with tree removal. Several positive linear anomalies extend northwards, downslope from the northern edge of the enclosure and appear to be associated with it, they do not appear to have a surface expression.

4.1.3 In the south western part of the survey area there are a number of quarry pits that could not be surveyed and which are surrounded by numerous discrete, linear and amorphous anomalies which relate to soil-filled natural features within the underlying chalk geology. The purpose of the quarries is uncertain as it is unclear whether they were for extraction of chalk or Clay-with-flints; however, one of the larger quarry pits is recorded on 19th century Ordnance Survey mapping as a ‘Gravel Pit’ which would suggest the latter. Site observations suggest the Clay-with-flints is more extensive in the southern part of the site than mapped by the British Geological Survey. On the lower part of the slope, close to the north western corner of the site, a former quarry could not be surveyed; it is recorded on 19th century mapping as an ‘Old Chalk Pit’.

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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 magnetic field. The difference between the two sensors will relate to the strength of the magnetic field created by the buried feature.

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. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

High Pass Filter

Removes low frequency anomalies within the data that are not considered to be archaeologically significant and may be natural in origin. A window passes over the data, the mean of all the data within the window is subtracted from the centre value. The size of the window is adjusted as is the weighting which may be uniform or Gaussian. The process is used to improve the visibility of anomalies of interest.

Zero Median/Mean Traverse

The median (or mean) of data from each traverse is calculated ignoring data outside a threshold value, the median (or mean) is then subtracted from the traverse. The process is used to equalise differences between the offset values of the gradiometer sensors. The process can remove archaeological features that run along a traverse but with the high resolution datasets created by the Sensys FGM650 sensors and the method of data collection this has not been a notable problem. In fact, the removal of offsets using software avoids carrying out a balancing procedure on site, which inevitably can never be done in magnetically clean

conditions and results in improperly aligned fluxgate sensors and/or electronic adjustment values.

Appendix C – survey and data information

Minimally processed data
Filename: J957-mag-proc.xcp
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 415748.36, 176642.20m
Southeast corner: 416437.46, 176202.70 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Dimensions
Survey Size (meters): 689 m x 440 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 5693847, Recorded: 5693852

Stats
Max: 2.21
Min: -2.20
Std Dev: 0.79
Mean: 0.00
Median: 0.00
Composite Area: 30.286 ha
Surveyed Area: 13.715 ha
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (UTM to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -2.00 to 2.00 nT

Filtered data
Filename: J957-mag-proc-hpf.xcp
Stats
Max: 2.21
Min: -2.20
Std Dev: 0.70
Mean: 0.22
Median: 0.19

GPS based Proce5
1 Base Layer.
2 Unit Conversion Layer (UTM to OSGB36).
3 DeStripe Median Traverse:
4 High pass Uniform (median) filter: Window dia: 200
5 Clip from -2.00 to 2.00 nT

Appendix D – digital archive

Archaeological Surveys Ltd hold the primary digital archive at their offices in Wiltshire. 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.

A hard copy will be issued to Historic England South West Team, along with a PDF copy to the Historic England Inspector, Heritage at Risk Officer and Geophysics Team.

A PDF copy will be supplied to the Wiltshire Historic Environment Record with greyscale images and abstraction layers made available on request. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Archive contents:

File type	Naming scheme	Description
Data	J957-mag-**[area number/name]**.asc J957-mag-**[area number/name]**.xcp J957-mag-**[area number/name]**-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J957-mag-**[area number/name]**-proc.tif	Image in TIF format
Drawing	J957-**[version number]**.dwg	CAD file in 2018 dwg format
Report	J957 report.odt	Report text in LibreOffice odt format

Table 2: Archive metadata

Appendix E – CAD layers for abstraction and interpretation plots

The table below sets out Archaeological Surveys Ltd CAD layer names with associated colours and graphical content. Where CAD files are available layers may be extracted for further CAD/GIS use. Note: hatched polygon boundaries are contained within layers with the RGB colour code 254, 255, 255 (near white) in order to prevent their visibility.

Report sub-heading and associated CAD layer names	Colour with RGB index	Layer content
Anomalies with an uncertain origin		

AS-ABST MAG POS LINEAR UNCERTAIN		255,127,0	Line, polyline or polygon (solid)
AS-ABST MAG POS DISCRETE UNCERTAIN		255,127,0	Solid donut, point or polygon (solid)
AS-ABST MAG POS UNCERTAIN		255,127,0	Polygon (cross hatched ANSI37)
Anomalies relating to land management			
AS-ABST MAG ENCLOSURE BOUNDARY		127,0,0	Line, polyline or polygon (solid or cross hatched ANSI37)
AS-ABST MAG VEHICLE RUT/TRACK		0, 153,153	Line, polyline or polygon (solid or partly cross hatched ANSI38)
Anomalies with an agricultural origin			
AS-ABST MAG FIELD SYSTEM EARTHWORK		0,127,63	Line, polyline or polygon (cross hatched ANSI37)
Anomalies associated with magnetic debris			
AS-ABST MAG DEBRIS		132, 132, 132	Polygon (cross hatched ANSI37)
AS-ABST MAG STRONG DIPOLAR		132, 132, 132	Solid donut, point or polygon (solid)
Anomalies with a modern origin			
AS-ABST MAG DISTURBANCE		132, 132, 132	Polygon (hatched ANSI31)
Anomalies with a natural origin			
AS-ABST MAG NATURAL FEATURES		204,178,102	Polygon (cross hatched ANSI37)

Table 3: CAD layering

Appendix F – copyright and intellectual property

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Historic England

Historic England Geophysical Survey Summary Questionnaire

Survey Details

Name of Site: Burderop Down, Chiseldon

County: Swindon

NGR Grid Reference (Centre of survey to nearest 100m): **SU 16040 76460**

Start Date: 13th March 2023 **End Date: 3rd April 2023**

Geology at site (Drift and Solid):

Lewes Nodular Chalk Formation (Upper Chalk)
New Pit Chalk Formation (Middle Chalk)
Holywell Nodular Chalk Formation (Lower Chalk)

Known archaeological Sites/Monuments covered by the survey
(Scheduled Monument No. or National Archaeological Record No. if known)

Field system and earthwork enclosure on Burderop Down (List Entry no: 1016383).

Archaeological Sites/Monument types detected by survey
(Type and Period if known. "?" where any doubt).

Field system – prehistoric to Roman

Surveyor (Organisation, if applicable, otherwise individual responsible for the survey):
David Sabin, Archaeological Surveys Ltd

Name of Client, if any: Wiltshire Council Archaeology Service

Historic England

Purpose of Survey:

To provide information on the archaeological potential of the site which is on the Heritage at Risk register due to issues with off-road vehicles.

Location of:

a) Primary archive, i.e. raw data, electronic archive etc: Archaeological Surveys Ltd, 1 West Nolands, Nolands Road, Yatesbury, Calne, SN11 8YD

b) Full Report: As above. Report will also be issued to Historic England, Wiltshire HER and uploaded to OASIS.

Historic England

Technical Details

(Please fill out a separate sheet for each survey technique used)

Type of Survey (Use term from attached list or specify other):

Magnetometer

Area Surveyed, if applicable (In hectares to one decimal place):

14ha

Traverse Separation, if regular:

0.5m

Reading/Sample Interval:

20Hz

Type, Make and model of Instrumentation:

SENSYS MAGNETO MXPDA

Land use at the time of the survey (Use term/terms from the attached list or specify other):

Grassland - pasture

Additional Remarks (Please mention any other technical aspects of the survey that have not been covered by the above questions such as sampling strategy, non standard technique, problems with equipment etc.):

The site is located on a steep slope and contains the upstanding remains of the field system which caused the sensors to tilt from vertical while trying to survey the earthworks. The site is also in range of a live shooting school which prevented survey within 275m while the school was used for firing.

List of terms for Survey Type

Magnetometer (includes gradiometer)

Resistivity

Resistivity Profile

Magnetic Susceptibility

Electro-Magnetic Survey

Ground Penetrating Radar

Other (please specify)

Historic England

List of terms for Land Use:

Arable
Grassland - Pasture
Grassland - Undifferentiated
Heathland
Moorland
Coastland - Inter-Tidal
Coastland - Above High Water
Allotment
Archaeological Excavation
Garden
Lawn
Orchard
Park
Playing Field
Built-Over
Churchyard
Waste Ground
Woodland
Other (please specify)

www.archaeological-surveys.co.uk
info@archaeological-surveys.co.uk
Tel: 01249 814 231

Archaeological Surveys
Specialist Geophysical Surveyors

Geophysical Survey
Burderop Down
Chiseldon
Swindon

Map of survey area

Site centred on OS NGR
SU 16040 76450

SCALE 1:25 000

0m 500m 1000m

KTD	DJS	FIG 01

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Chiseldon
Swindon

Referencing information

Referencing grid to OSGB36 datum at 100m intervals

416000 176400

Survey tracks

Survey track start

Survey track stop

Scheduled monument boundary

SCALE 1:2500

0m 50 100m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 02

415700 415800 415900 416000 416100 416200 416300 416400

176700 176600 176500 176400 176300 176200 176100

N

Figs 06 - 08

Figs 09 - 11

Figs 12 - 14

Shooting School

Trough

Earthwork

Earthwork

Earthwork

Earthwork

Earthwork

Earthwork

Earthwork

Tree

Tree

Tree

Quarry

Quarry

Holloway

Archaeological Surveys
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Chiseldon
Swindon

Greyscale plot of minimally processed magnetometer data

N

Shooting School

-2nT +2nT

+2nT
-2nT

SCALE 1:2500

0m 50 100m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 03

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Greyscale plot of filtered magnetometer data

-3nT +3nT

+3nT -3nT

SCALE 1:2500

0m 50 100m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 04

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Abstraction and interpretation of magnetic anomalies

N

Shooting School

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16

- Curvilinear anomaly - enclosure earthwork
- Positive linear anomaly - of uncertain origin
- Negative linear anomaly - vehicle ruts/track
- Positive linear anomaly - of natural origin
- Discrete positive response - possible pit-like feature
- Discrete positive response - of natural origin
- Magnetically variable response - field system earthwork
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - possible former fence
- Strong dipolar anomaly - ferrous object

SCALE 1:2500

0m 50 100m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 05

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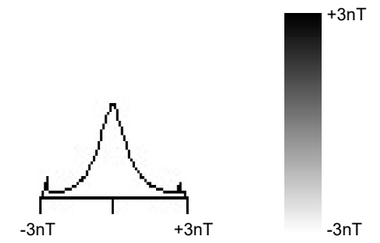
Greyscale plot of minimally processed magnetometer data - south west



SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 06

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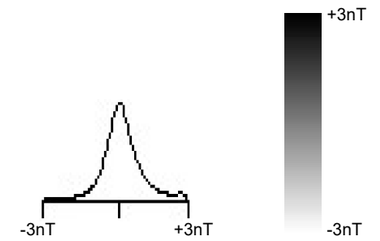
Specialist Geophysical Surveyors

Geophysical Survey
Burderop Down
Chiseldon
Swindon

Greyscale plot of filtered magnetometer data



SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 07

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Chiseldon
Swindon

Abstraction and interpretation of magnetic anomalies - south west

1

2

10

15

N

- Curvilinear anomaly - enclosure earthwork
- Negative linear anomaly - vehicle ruts/track
- Positive linear anomaly - of natural origin
- Discrete positive response - of natural origin
- Magnetically variable response - field system earthwork
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - possible former fence
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 08

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Chiseldon
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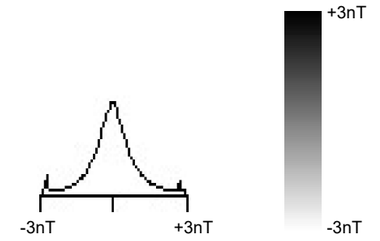
Greyscale plot of minimally processed magnetometer data - north west



SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 09

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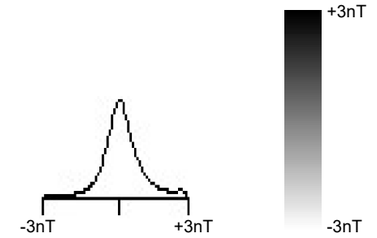
Greyscale plot of filtered magnetometer data - north west



SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 10

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Chiseldon
Swindon

Abstraction and interpretation of magnetic anomalies

N

1
2
3
3
4
5
6
7
13
14
16

- Curvilinear anomaly - enclosure earthwork
- Positive linear anomaly - of uncertain origin
- Negative linear anomaly - vehicle ruts/track
- Discrete positive response - of natural origin
- Magnetically variable response - field system earthwork
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 11

Shooting School

N

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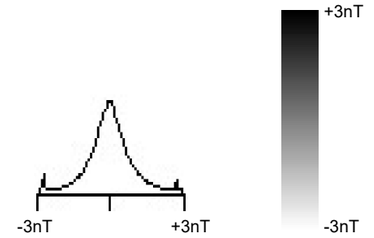
Chiseldon
Swindon

Greyscale plot of minimally processed magnetometer data - east



SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 12

Shooting School

N

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Chiseldon
Swindon

Greyscale plot of
filtered magnetometer data - east

+3nT

-3nT +3nT

-3nT

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 13

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Abstraction and interpretation of magnetic anomalies - east

Shooting School

N

12

9

8

1

13

- Positive linear anomaly - of uncertain origin
- Negative linear anomaly - vehicle ruts/track
- Discrete positive response - possible pit-like feature
- Discrete positive response - of natural origin
- Magnetically variable response - field system earthwork
- Positive anomaly - magnetically enhanced material
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 14

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Digital Terrain Model

Derived from Environment Agency's LiDAR data 1m resolution

SCALE 1:2500

0m 50 100m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 15