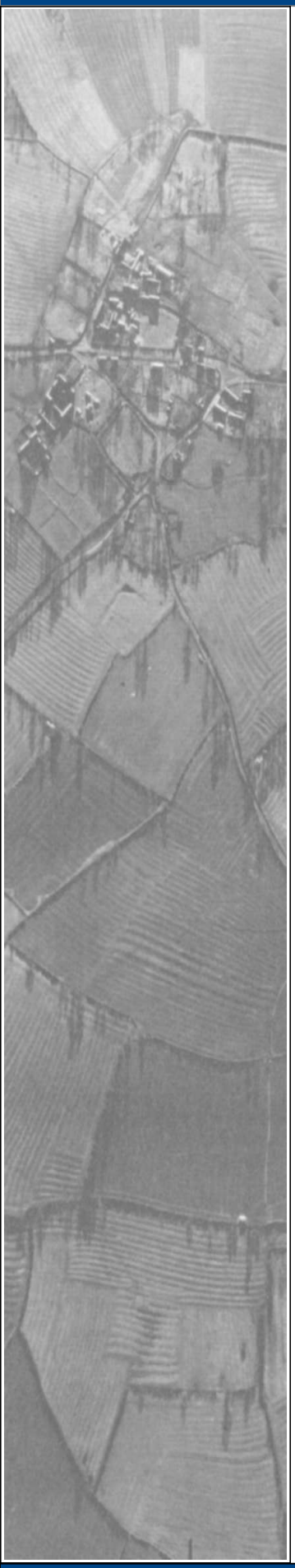

Blandford Hill Eco Hub
Winterborne Whitechurch
Dorset

MAGNETOMETER SURVEY REPORT

for

Naturalis Energy Developments Ltd

Kerry Donaldson & David Sabin

June 2021

Ref. no. J861

ARCHAEOLOGICAL SURVEYS LTD

Blandford Hill Eco Hub
Winterborne Whitechurch
Dorset

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Ordnance Survey Grid Reference – **ST 84900 00500**

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SUMMARY

Detailed magnetometry was carried out within four areas at Winterborne Whitechurch in Dorset. Three of the fields had been previously subject to partial geophysical survey, and the current survey was only conducted on the remaining areas, together with another field not within the former scheme. The results reveal the presence of two ring ditches within the western part of the site which could relate to prehistoric funerary or ritual monuments. Two partial rectilinear enclosures have also been located along with a number of linear and rectilinear anomalies that relate to former field boundaries associated with an earlier field system. There is also evidence for numerous pit-like features which could relate to former chalk extraction; however, an association with naturally formed solution features cannot be ruled out.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Naturalis Energy Developments Ltd to undertake a magnetometer survey of an area of land at Winterborne Whitechurch in Dorset. The site has been outlined for a proposed Eco Hub development which would include a solar farm with battery storage and an electric vehicle charging station. The survey forms part of an archaeological assessment of the site.

1.1.2 Part of the site has been previously subject to geophysical survey (Oxford Archaeotechnics, 2014) and the current project aims to complete the coverage within the areas that were not previously surveyed.

1.1.3 The geophysical survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by Archaeological Surveys (2021) and approved by Steve Wallis, Senior Archaeologist for Dorset Council, prior to commencing the fieldwork.

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 Geophysical survey can provide useful information on the archaeological potential of a site; however, the outcome of any survey relies on a number of factors and as a consequence results can vary. The success in meeting the aims and objectives of a survey is, therefore, often impossible to

predetermine.

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

1.3.1 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) *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 Discussion and/or 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.

1.3.4 Where targeting of anomalies by excavation is to be carried out, care should be taken to place trenches over solid lines or features visible on the abstraction and interpretation plots. Archaeological Surveys abstraction and interpretation avoids the use of dashed or dotted line formats, and broken or fragmented lines used in interpretive plots may well correspond closely with truncation of archaeological features.

1.4 Site location, description and survey conditions

1.4.1 The site is located 6km south west of Blandford Forum. It lies to the south of the A354 Blandford Hill at East Farm, Winterborne Whitechurch in Dorset. It is centred on Ordnance Survey National Grid Reference (OS NGR) ST 84900 00500, see Figs 01 and 02.

1.4.2 The geophysical survey covers approximately 21.75ha within four arable fields. Areas 1-3 have been partially subject to a previous geophysical survey (Oxford Archaeotechnics, 2014) and the present survey covers the remaining areas within the three fields, and a fourth field to the west.

1.4.3 Areas 1, 2 and 4 are located on elevated generally flat or gently sloping land with a slight southerly or south westerly aspect. Area 3 slopes down towards the south and contains a dry valley or combe which runs from north to south. Land boundaries are mainly hedgerows. Ground cover consisted of arable

crops varying in height from approximately 0.1m – 0.5m.

1.4.4 The ground conditions across the site were generally considered to be favourable for the collection of magnetometry data. Weather conditions during the survey were variable but often cold with heavy rain and sleet showers.

Plate 1: Survey Areas 1, 3 & 4 in the middle ground - looking north west

1.5 Site history and archaeological potential

1.5.1 A previous geophysical survey carried out within the site located linear anomalies associated with an earlier field system and a number of pits in the north eastern field (Area 2). Within fields beyond the current site, the geophysical survey located a number of other linear ditches, a ring ditch and a square ditched enclosure containing numerous pits of probable prehistoric origin (Oxford Archaeotechnics, 2014). The wider landscape contains a number of Bronze Age barrows and Iron Age linear ditches and enclosures. There is, therefore, potential for the survey to locate further archaeological features within the site.

1.6 Geology and soils

1.6.1 The underlying solid geology across the site is from the Tarrant Chalk Member with overlying head deposits within the south eastern corner of the southernmost field (Area 3) (BGS, 2017).

1.6.2 The overlying soil across the survey area is from the Andover 2 association and is a brown rendzina. It consists of a shallow, well drained, calcareous, silty

soil over chalk (Soil Survey of England and Wales, 1983).

1.6.3 Magnetometry carried out over similar geology and soil has produced good results. 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 (also known as thermoremanence) are factors associated with the formation of localised 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 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). 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 measurement range of ±8000nT, although the recorded range is ±3000nT, and resolution is around 0.1nT. They are linked to a Leica GS10 RTK GNSS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged PDA 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 ±5nT. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.15m along each survey track.

2.3.4 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.

2.3.5 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. With regard to the Sensys MXPDA, 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.

2.3.6 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.

2.3.7 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.

2.3.8 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. Where further interpretation is possible, or where a number of possible origins should be considered, more subjective discussion is set out in Section 4.

2.3.9 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 four survey areas covering approximately 21.75ha.

3.1.2 Magnetic anomalies located can be generally classified as positive and negative responses of archaeological potential, positive anomalies of an uncertain origin, anomalies associated with quarrying, linear anomalies of an agricultural origin, anomalies with a natural origin, areas of magnetic debris and disturbance, strong discrete dipolar anomalies relating to ferrous objects and strong multiple dipolar linear anomalies relating to buried services or pipelines.

3.1.3 Anomalies located within each survey area have been numbered and are described in 3.4 to 3.6 below with subsequent discussion in Section 4.

3.2 Statement of data quality and factors influencing the interpretation of anomalies

3.2.1 Data are considered representative of the magnetic anomalies present within the site. There are no significant defects within the dataset.

3.2.2 The soils across the site show moderate levels of magnetic susceptibility, probably relating to a comparatively high percentage of ferrous minerals within the topsoil in a form that can be readily enhanced by human activity. Chalk soils are often associated with much lower levels of susceptibility. Soil samples taken from Area 3, away from features of archaeological potential, were subject to mass specific magnetic susceptibility measurement using a Bartington MS2 with MS2B sensor. The average value (X_{lf}) obtained from a subset of the topsoil samples was 31.5 $10^{-8}m^3kg^{-1}$ which is significantly higher than many soils overlying chalk.

3.2.3 The very low magnetic susceptibility of the underlying chalk has resulted in strongly contrasting magnetic anomalies relating to soil-filled features. The magnetic contrast between the topsoil and chalk has, however, resulted in numerous linear anomalies caused by cultivation, as well as numerous discrete anomalies caused by naturally formed features. It may, therefore, not be possible to confidently separate pit-like anomalies of natural origin from those of archaeological potential.

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 with archaeological potential	Anomalies have the characteristics (mainly morphological) of a range of archaeological features such as pits, ring ditches, enclosures, etc. The category is used where there is a high level of confidence which may be due to additional supporting information where morphology is unclear or uncharacteristic.
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 with an agricultural origin	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. This category does not include agricultural features of early date or considered to be of archaeological potential (e.g. animal stockades, enclosures, farmsteads, etc).
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. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
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.
Anomalies associated with ground disturbance/quarrying	Magnetically variable anomalies which may be negative indicating a response to geology/drift deposits and/or positive indicating an increased depth of topsoil. Very strongly magnetic anomalies are a response to highly magnetic material of modern origin which can be used to infill a quarry depression. It should be considered that former quarry pits may be of archaeological potential.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Areas 1 & 4

Area 1 centred on OS NGR 384735 100560, Area 4 centred on OS NGR 384540 100440 see Figs 05 & 06.

Anomalies of archaeological potential

(1) – A positive curvilinear anomaly is located close to the north western corner of Area 1. It relates to a penannular ring ditch with an 18.5m outer diameter, and ditch of up to 2m wide. There appears to be a deliberate 1.65m gap or causeway on the

southern side, and the morphology indicates that it relates to a prehistoric monument such as a round barrow ditch or possibly a hengiform monument. However, it is not possible to determine if there is any associated bank or internal mound.

(2) – Situated 200m south west of anomaly (1) is a second ring ditch. This is less well defined than anomaly (1) and has an outer diameter of 13m, which could suggest an association with a prehistoric round house. However, the response to the ditch shows a continuous ring, without any obvious entrance and it is possible that this relates to a small Bronze Age round barrow. It may contain at least one internal pit-like feature.

(3) – An L-shaped positive rectilinear lies at the south eastern corner of Area 4 and does not appear to extend into the south western corner of Area 1 so presumably has a southern return on or near the extant field boundary. It appears to relate to two sides of a rectilinear enclosure that may extend southwards beyond the limit of the survey. It contains a number of pit-like anomalies and the northern enclosure ditch appears to have been truncated by a large pit (13).

(4) – A C-shaped positive rectilinear anomaly is situated 70m north west of enclosure (3) and 37m north north east of ring ditch (2). It appears to be a response to three sides of a small rectilinear enclosure. There is no evidence for the eastern side.

(5) – Positive linear anomalies extend across Area 4 with no obvious continuation into Area 1. There is some similarity in the north east to south west orientation of the northern part of the feature to anomalies (18) and (25) seen 350-400m to the east within Areas 2 and 3. The anomalies may relate to boundary ditches associated with a former field system.

(6 & 7) – An L-shaped positive linear anomaly (6) could form an irregular enclosure with anomalies (5); however, the orientation of the long axis is east to west, similar to several linear anomalies within Area 1 (7) and (19 & 20) further east in Area 2. These also appear, therefore, to relate to former field system boundary features.

(8-10) – A number of clusters of pit-like anomalies can be seen in Area 1. Anomalies (8) are situated close to ring ditch (1) and the proximity could suggest an association. Anomalies (9) lie 50m to the south east and could be associated with possible chalk extraction, but have a strong response, possibly suggesting an archaeological origin. Situated 45m to the south of this is another cluster of pits, which again could be of archaeological origin.

Anomalies with an uncertain origin

(11 & 12) – An irregularly shaped magnetically variable anomaly could be a response to an infilled former chalk extraction pit (11). Elsewhere there are a large number of more circular, discrete, positive responses (12) that could also relate to former chalk pits, or dew ponds. It is not certain if these anomalies have an archaeological origin, or if they have an association with naturally formed solution

features. They do not have a surface expression and so they appear to be of some antiquity.

(13) – A large pit-like anomaly is very similar to others (12) that can be seen throughout the site. However, anomaly (13) appears to have truncated enclosure ditch (3), which suggests that it may be of archaeological origin. It is possible, therefore, that the other large pit-like responses have a similar origin.

(14) – A small number of discrete, pit-like anomalies can be seen within Areas 1 and 4. It is not clear if they are of anthropogenic or natural origin.

(15) – An amorphous, weakly positive anomaly can be seen in the eastern part of Area 1, and it appears to extend south eastwards into Area 2. The anomaly is irregular in shape and its origin is uncertain.

Anomalies with an agricultural origin

(16) – The survey areas contain parallel linear anomalies that relate to agricultural activity. Only a small number have been abstracted in order not to obscure other anomalies.

3.5 List of anomalies – Area 2

Area 2 centred on OS NGR 385065 100765, see Figs 07 - 10.

Anomalies of archaeological potential

(17) – Positive rectilinear anomalies are a continuation of those located during the previous geophysical survey. These had been interpreted as associated with an earlier field system; however, they perhaps appear slightly more complex, possibly suggesting small enclosures, rather than large field enclosures.

(18) – Positive and negative anomalies are a continuation of field system boundary features previously located during the 2014 survey. The are on a similar orientation to, and are likely to be a continuation of, anomalies (25) seen within Area 3, 125m to the south west.

(19 & 20) – A broad negative anomaly, with a positive response to the north relates to an east to west oriented former field boundary bank. Positive linear anomalies (20) to the north also have a similar east to west and north to south orientation as linear and rectilinear anomalies that appear to relate to a former field system seen within Area 1 to the west.

Anomalies with an uncertain origin

(21) – A small number of positive discrete and linear anomalies are located in the south western corner of Area 2. It is not possible to determine their origin.

(22) – The survey area contains a number of circular or oval pit-like anomalies that range from 4-12m across, similar to (12) seen within Area 1.They do not have a surface expression, indicating that they are not likely to be of relatively modern date; however, it is not clear if they relate to substantial pits with an anthropogenic or archaeological origin, such as former dew ponds or chalk extraction pits, or if they relate to a series of naturally formed infilled solution hollows within the underlying chalk. A number are situated within a zone of numerous naturally formed pit-like responses (24), while others lie outside of this zone, across the entire site.

(23) – A small number of weakly positive linear anomalies can be seen in the north eastern part of Area 2. It is likely that they relate to natural soil-filled features within the underlying geology, but this is uncertain.

Anomalies with a natural origin

(24) – The eastern part of Area 2 contains zones of widespread and numerous pit-like responses. They relate to naturally formed pits within the underlying geology.

3.6 List of anomalies – Area 3

Area 3 centred on OS NGR 384855 100230, see Figs 11 - 14.

Anomalies of archaeological potential

(25) – Two broad, positive linear anomalies are spaced 30m apart and oriented north east to south west and situated within the base of a shallow valley. There is some evidence for a negative response to the west of one, and internal divisions towards the south. Similar anomalies were identified during the previous geophysical survey immediately to the south and they appear to relate to continuation of boundary ditches and banks (18 & 19) associated with the former field system that extends northwards into Area 2.

(26) – A narrow, fragmented weakly positive linear anomaly is oriented east to west and appears to extend towards, but not eastwards beyond, anomalies (25). It is likely to be associated with the former field system and is similar to others seen to the north (7 & 20).

(27) – In the southern part of Area 3 is a broad, curvilinear anomaly with two narrow linear anomalies at the north western end. This type of response is similar to the broad field system boundaries seen to the north and an association is likely.

Anomalies associated with quarrying

(28) – A magnetically variable response in the northern part of Area 3 corresponds to an extant depression within the ground surface. Such depressions are visible on Lidar imagery across the wider vicinity and are likely to relate to former chalk pits

and/or dew ponds.

Anomalies with an uncertain origin

(29) – Area 3 contains a large number of positive and magnetically variable responses, similar to those seen elsewhere (12 & 23). They are numerous, although generally situated along the northern, southern and western edges of the survey area and have a similar response to the fill of the extant depression (28), although these do not have a surface expression. While the response could indicate the fill within former chalk extraction pits, the response could also relate to infilled natural solution hollows and so it is not certain if these are of anthropogenic or natural origin.

(30) – The survey area contains a number of pit-like responses with several appearing to form a line of pits along the side of the shallow valley, following the contour. Again it is not clear if these are natural in origin, or if they have archaeological potential.

Anomalies with a natural origin

(31) – A zone of numerous pit-like anomalies in the southern part of Area 3 relates to natural features within the underlying geology.

Anomalies associated with magnetic debris

(32) – Magnetic debris in the north eastern and south eastern corners of the survey area relate to modern dumped material used for ground consolidation within gateways.

(33) – Strong, discrete, dipolar anomalies relate to ferrous and other magnetically thermoremnant objects within the topsoil. All areas have these anomalies.

4 DISCUSSION

4.1.1 The geophysical survey located two ring ditches in the northern part of the site. One is penannular (1) and located towards the summit of a south west facing spur of land. The ring ditch has an outer diameter of 18.5m and is up to 2m wide. There appears to be a deliberate 1.6m gap or causeway facing south west. The response is generally 7-10nT, with some discrete responses within the south eastern part of the ditch that are over 17nT, indicating that there is more magnetically enhanced material within the south eastern terminus. It is not clear from the data if there is any internal or external bank or mound. Situated 200m to the south west is a second ring ditch (2), with a 13m diameter and a 0.75m wide ditch without any obvious gap or entrance. It is possible that there is at least one internal discrete anomaly. The diameters of the ring ditches are not large, and although it is possible that such anomalies could relate to round houses, they are not generally associated

with other anomalies that suggest settlement, although there are two enclosures (3 & 4) and field system boundaries within 100m. While anomaly (1) does appear to have an entrance, the wide ditch would suggest a Bronze Age barrow ditch, or perhaps earlier hengiform monument as indicated by the entrance. Anomaly (2) could relate to a round house, due to its size and narrow ring ditch; however, there is no obvious entrance gap or other associated settlement features.

4.1.2 Across the site are numerous linear and rectilinear anomalies that relate to former boundary features. Several have an east to west and north to south orientation, and are generally a response to a narrow linear ditch (7). Others have a general north east to south west orientation and relate to broad boundary ditches and associated broad boundary banks (18 & 25). Several examples of the two types of anomaly do appear to join and intersect.

4.1.3 All of the survey areas also contain a number of circular, oval or amorphous positive and magnetically variable responses. One of these (28) corresponds to an extant shallow depression, several of which are visible in the wider landscape, and is likely to relate to a former chalk extraction pit. The remaining anomalies are widespread, and many are moderately enhanced indicating that they could contain material associated with human activity, although they do not contain ferrous material indicative of modern infilled pits. They do not have any surface expression which indicates that they are of some antiquity. It is, however, not clear if they relate to extraction pits with an archaeological origin, or if they relate to naturally silted up solution features within the underlying chalk. One such example (13) appears to have truncated the centre of the northern part of an enclosure ditch (3), indicating that an archaeological origin should be considered.

5 CONCLUSION

5.1.1 The detailed magnetometry survey was conducted over 21.75ha within four fields. Three of the areas had previously been subject to partial geophysical survey and the remaining parts of these fields were completed.

5.1.2 The results indicate the presence of two ring ditch features in the western part of the site which could relate to prehistoric monuments such as Bronze Age round barrows, but their date and function is uncertain. Also within the western part of the site there are two rectilinear enclosures and throughout the site there are linear and rectilinear anomalies that relate to boundaries associated with earlier field systems.

5.1.3 Numerous circular, oval and amorphous positive responses have been located across the site; however, due to the widespread nature of the responses, it is not clear if these relate to natural solution features, or if they relate to former chalk extraction quarries and pits.

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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.

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

Area 1
Filename: J861-mag-Area1-proc.xcp
Instrument Type: Sensys DLMGPS
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 384592.285, 100707.731 m
Southeast corner: 384866.035, 100400.081 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Dimensions
Survey Size (meters): 274 m x 308 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 1278190, Recorded: 1278190
Stats
Max: 5.53
Min: -5.50
Std Dev: 1.41
Mean: 0.04
Median: 0.01
Composite Area: 8.4219 ha
Surveyed Area: 4.5176 ha
PROGRAM
Name: TerraSurveyorPre
Version: 3.0.36.24
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -5.00 to 5.00

Area 2
Filename: J862-mag-Area2-proc.xcp
Northwest corner: 384828.441, 100969.979 m
Southeast corner: 385340.091, 100507.229 m
Dimensions
Survey Size (meters): 512 m x 463 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 2037353, Recorded: 2037353
Stats
Max: 5.53
Min: -5.50
Std Dev: 1.22
Mean: 0.05
Median: 0.00
Composite Area: 23.677 ha
Surveyed Area: 6.9366 ha
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -5.00 to 5.00

Area 3
Filename: J862-mag-Area3-proc.xcp
Northwest corner: 384745.398, 100532.437 m
Southeast corner: 384947.298, 99934.687 m
Dimensions
Survey Size (meters): 202 m x 598 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 1897545, Recorded: 1897545
Stats
Max: 5.53
Min: -5.50
Std Dev: 1.41
Mean: 0.03
Median: 0.01
Composite Area: 12.069 ha
Surveyed Area: 6.8535 ha
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -5.00 to 5.00

Area 4
Filename: J862-mag-Area4-proc.xcp
Northwest corner: 384415.268, 100584.330 m
Southeast corner: 384656.018, 100292.880 m
Dimensions
Survey Size (meters): 241 m x 291 m
X&Y Interval: 0.15 m
Source GPS Points: Active: 1180972, Recorded: 1180972
Stats
Max: 5.53
Min: -5.50
Std Dev: 1.62
Mean: 0.04
Median: 0.01
Composite Area: 7.0167 ha
Surveyed Area: 4.0882 ha
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to UTM).
3 DeStripe Median Traverse:
4 Clip from -5.00 to 5.00

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 PDF copy will be supplied to the Dorset 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	J861-mag-**[area number/name]**.asc J861-mag-**[area number/name]**.xcp J861-mag-**[area number/name]**-proc.xcp	Raw data as ASCII CSV TerraSurveyor raw data TerraSurveyor minimally processed data
Graphics	J861-mag-**[area number/name]**-proc.tif	Image in TIF format
Drawing	J861-**[version number]**.dwg	CAD file in 2018 dwg format
Report	J861 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 archaeological potential		
AS-ABST MAG POS DISCRETE ARCHAEOLOGY	Red 255,0,0	Solid donut, point or polygon (solid)
AS-ABST MAG POS LINEAR ARCHAEOLOGY	Red 255,0,0	Polyline or polygon (solid)
AS-ABST MAG POS CURVILINEAR RING DITCH	Magenta 255,0,255	Polyline or polygon (solid)
AS-ABST MAG NEG LINEAR ARCHAEOLOGY	127,0,255	Line, polyline or polygon (solid)
AS-ABST MAG POS ENCLOSURE DITCH	127,0,255	Line, polyline or polygon (solid)
Anomalies with an uncertain origin		
AS-ABST MAG POS LINEAR UNCERTAIN	255,127,0	Line, polyline or polygon (solid)
AS-ABST MAG NEG LINEAR UNCERTAIN	Blue 0,0,255	Line, polyline or polygon (solid)
AS-ABST MAG POS DISCRETE UNCERTAIN	255,127,0	Solid donut, point or polygon (solid)
AS-ABST MAG NEG DISCRETE UNCERTAIN	Blue 0,0,255	Solid donut, point or polygon (solid)
AS-ABST MAG POS UNCERTAIN	255,127,0	Polygon (cross hatched ANSI37)
Anomalies with an agricultural origin		
AS-ABST MAG AGRICULTURAL	Green 0,255,0	Line or polyline
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)
AS-ABST MAG SERVICE	132, 132, 132	Line or polyline
Anomalies with a natural origin		
AS-ABST MAG NATURAL FEATURES	Yellow 255,255,0	Polygon (cross hatched ANSI37)
Anomalies associated with ground disturbance/quarrying		
AS-ABST MAG QUARRYING/ GROUND DISTURBANCE	204,178,102	Polygon (net)

Table 3: CAD layering

Appendix F – copyright and intellectual property

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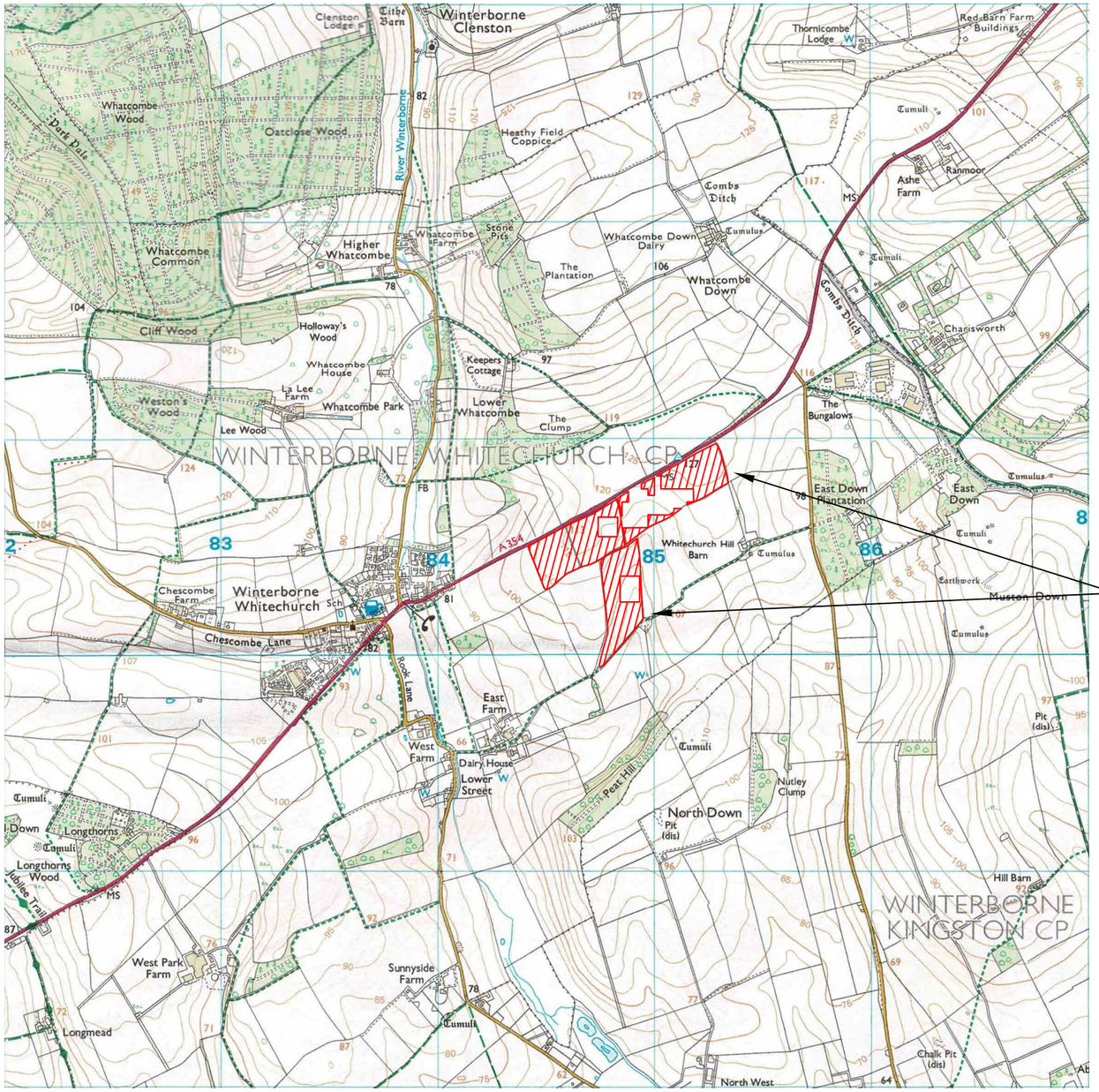
Tel: 01249 814 231



N

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Specialist Geophysical Surveyors

Geophysical Survey
Blandford Hill Eco Hub
Winterborne Whitechurch
Dorset

Map of survey area

Survey location

Site centred on OS NGR
ST 84900 00500

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 01

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Winterborne Whitechurch
Dorset

Referencing information

Referencing grid to OSGB36 datum at 100m intervals

- 384900 100500
- Survey tracks
- Survey track start
- Survey track stop

SCALE 1:4000

0m 40 80 120 160 200m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 02

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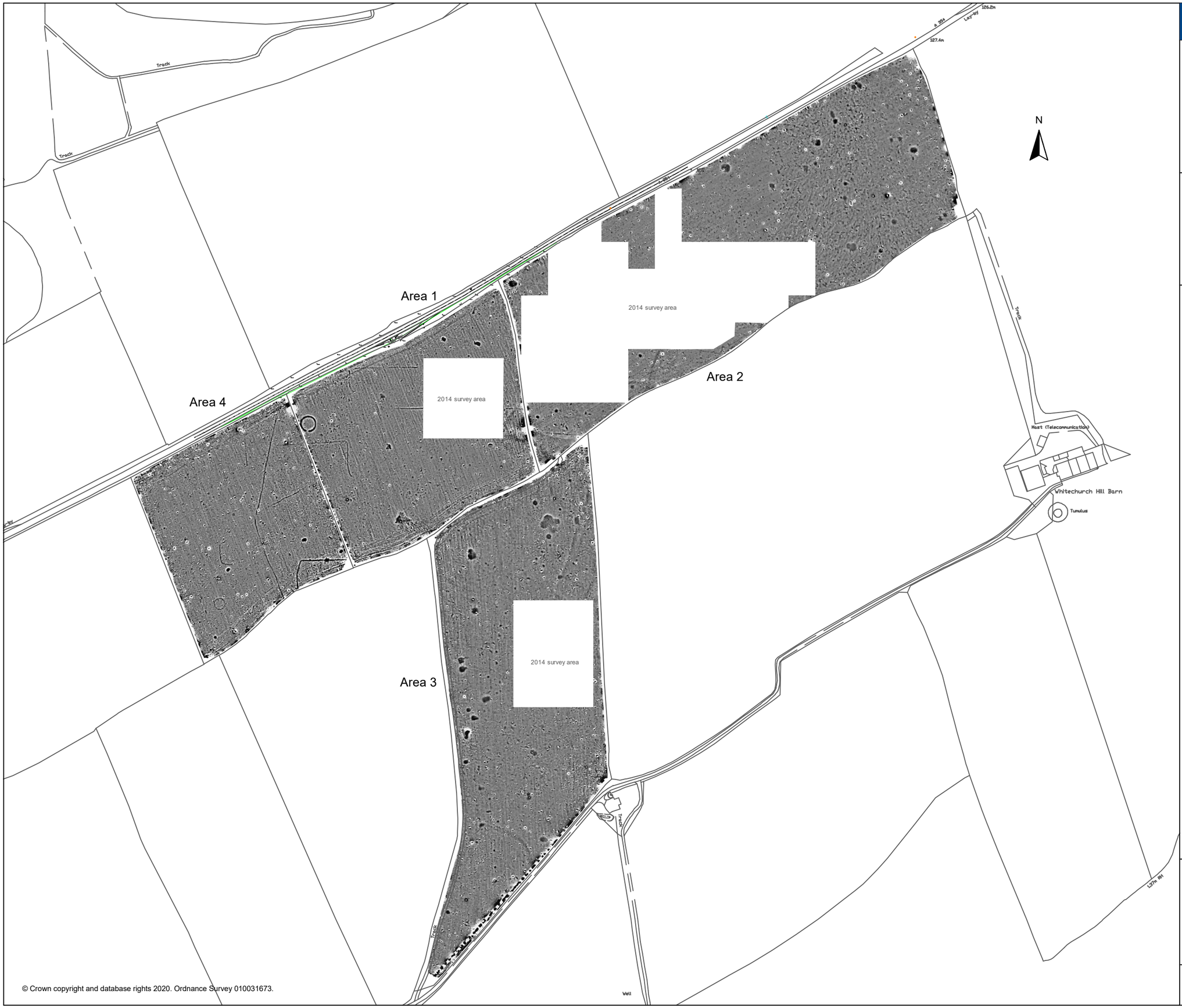
Winterborne Whitechurch
Dorset

Greyscale plot of minimally processed magnetometer data



+5nT

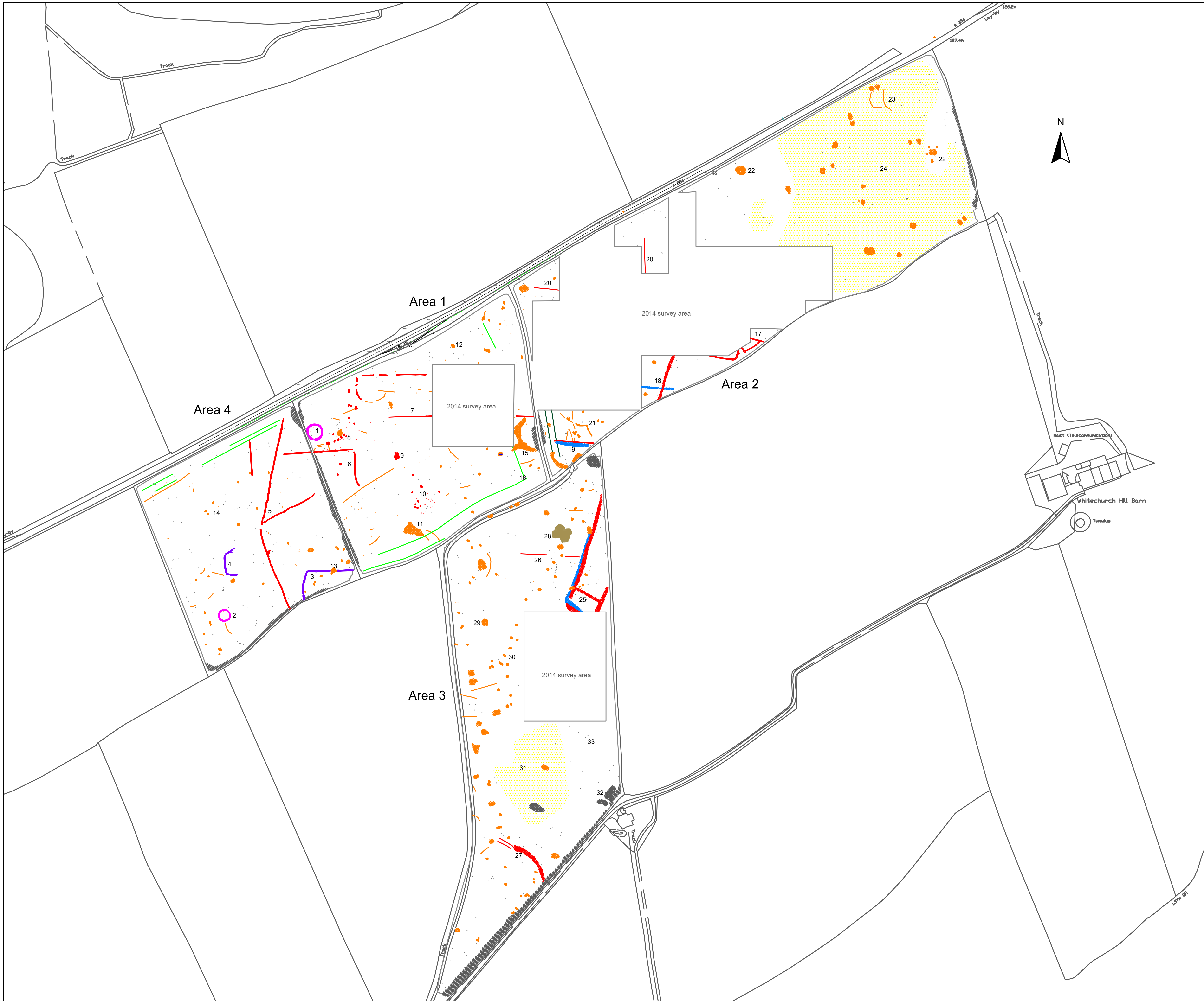
-5nT

SCALE 1:4000

0m 40 80 120 160 200m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 03



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Geophysical Survey
Blandford Hill Eco Hub
Winterborne Whitechurch
Dorset

Abstraction and interpretation of magnetic anomalies

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear anomaly - ring ditch
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive linear anomaly - possible ditch-like feature
- Negative linear anomaly - material of low magnetic susceptibility
- Linear anomaly - of agricultural origin
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - boundary ditch associated with field system
- Negative anomaly - boundary bank associated with field system
- Positive anomaly - magnetically enhanced material
- Positive anomaly - magnetically enhanced material within former chalk pit
- Zone of numerous pit-like responses - of natural origin
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:4000

0m 40 80 120 160 200m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 04

Area 1

Area 4

N

2014 survey area

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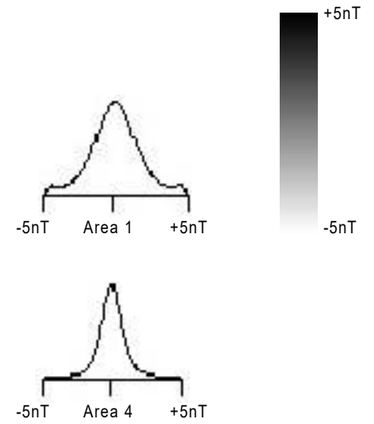
Greyscale plot of minimally processed magnetometer data - Areas 1 & 4



SCALE 1:1500

0m 10 20 30 40 50m

KTD	DJS	FIG 05

Area 1

Area 4

2014 survey area

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1
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Abstraction and interpretation of magnetic anomalies - Areas 1 & 4

- Positive linear anomaly - cut feature of archaeological potential
- Positive curvilinear anomaly - ring ditch
- Positive curvilinear/rectilinear anomaly - enclosure ditch
- Positive linear anomaly - possible ditch-like feature
- Linear anomaly - of agricultural origin
- Discrete positive response - cut feature of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 06

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Greyscale plot of minimally processed magnetometer data - Area 2 west

+5nT
-5nT
+5nT
-5nT

SCALE 1:1500

0m 10 20 30 40 50m

KTD	DJS	FIG 07

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Abstraction and interpretation of magnetic anomalies - Area 2 west

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A 354

MS

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2014 survey area

17

18

Area 2

21

19

15

16

vey area

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- Positive linear anomaly - cut feature of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Discrete positive response - possible pit-like feature
- Positive anomaly - boundary ditch associated with field system
- Negative anomaly - boundary bank associated with field system
- Positive anomaly - magnetically enhanced material within pit-like feature
- Zone of numerous pit-like responses - of natural origin
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 08

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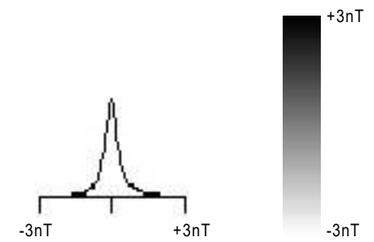
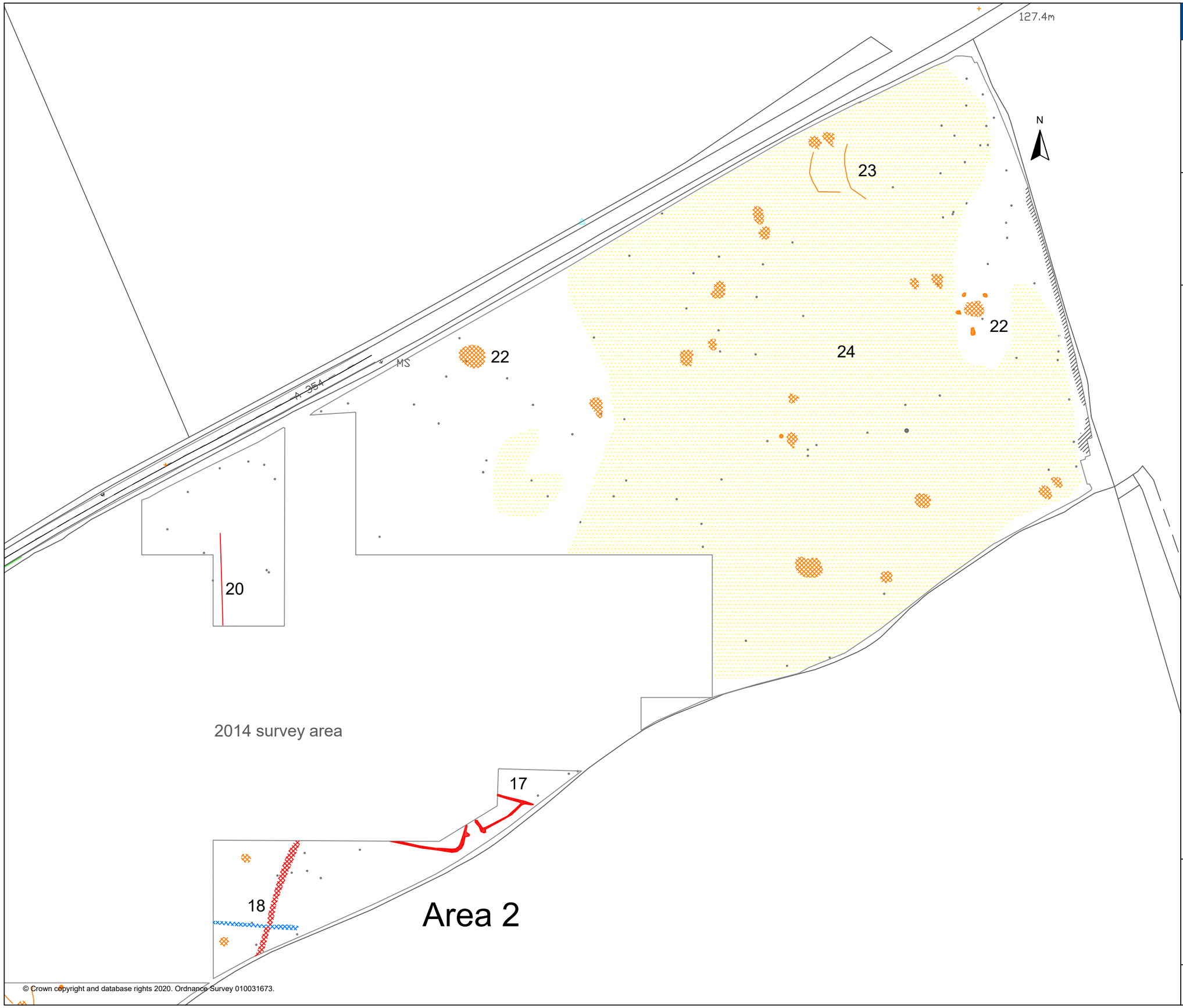
Greyscale plot of minimally processed magnetometer data - Area 2 east



SCALE 1:1500

0m 10 20 30 40 50m

KTD	DJS	FIG 09



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Abstraction and interpretation of magnetic anomalies - Area 2 east

- Positive linear anomaly - cut feature of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Discrete positive response - possible pit-like feature
- Positive anomaly - boundary ditch associated with field system
- Negative anomaly - boundary bank associated with field system
- Positive anomaly - magnetically enhanced material within pit-like feature
- Zone of numerous pit-like responses - of natural origin
- Magnetic disturbance from ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 10

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Greyscale plot of minimally processed magnetometer data - Area 3 north

+3nT
-3nT
-3nT
+3nT

SCALE 1:1500

0m 10 20 30 40 50m

KTD | DJS | FIG 11

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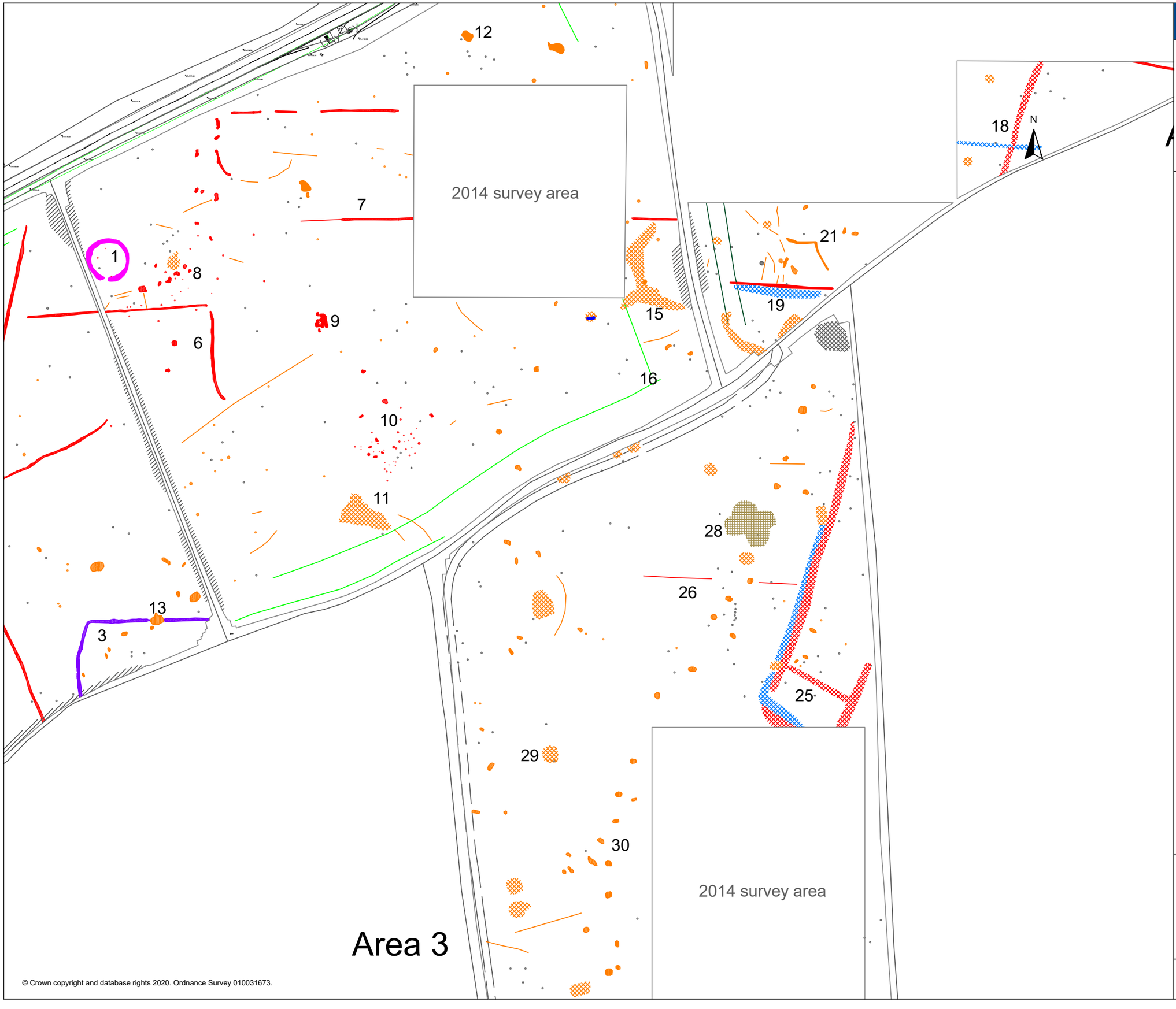
Abstraction and interpretation of magnetic anomalies - Area 3 north



- Positive linear anomaly - cut feature of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Discrete positive response - possible pit-like feature
- Positive anomaly - boundary ditch associated with field system
- Negative anomaly - boundary bank associated with field system
- Positive anomaly - magnetically enhanced material within pit-like feature
- Positive anomaly - magnetically enhanced material within former chalk pit
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 12

Area 3

2014 survey area

N

Track

Track

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Greyscale plot of minimally processed magnetometer data - Area 3 south

+3nT
-3nT
-3nT
+3nT

SCALE 1:1500

0m 10 20 30 40 50m

KTD	DJS	FIG 13

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Geophysical Survey
Blandford Hill Eco Hub
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Dorset

Abstraction and interpretation of magnetic anomalies - Area 3 south

- Positive linear anomaly - cut feature of archaeological potential
- Positive linear anomaly - possible ditch-like feature
- Positive anomaly - magnetic enhancement of archaeological potential
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material within pit-like feature
- Zone of numerous pit-like responses - of natural origin
- Magnetic debris - spread of magnetically thermoremnant/ferrous material
- Magnetic disturbance from ferrous material
- Strong multiple dipolar linear anomaly - pipeline / cable / service
- Strong dipolar anomaly - ferrous object

SCALE 1:1500

0m 10 20 30 40 50m

SCALE TRUE AT A3

DRAWN BY	CHECKED BY	
KTD	DJS	FIG 14