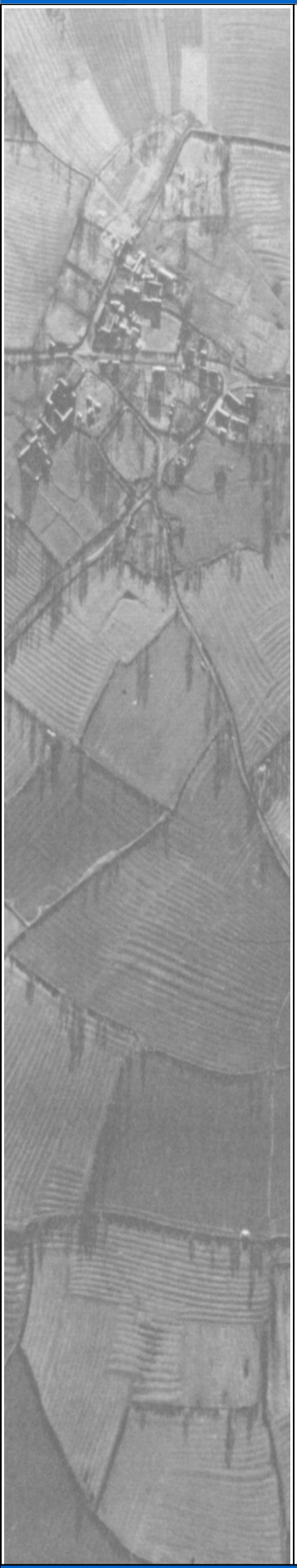

Thornbury Castle
South Gloucestershire

MAGNETOMETER SURVEY REPORT

for

Cotswold Archaeology

Kerry Donaldson & David Sabin

February 2016

Ref. no. 645

ARCHAEOLOGICAL SURVEYS LTD

Thornbury Castle
South Gloucestershire

Magnetometer Survey Report

for

Cotswold Archaeology

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

Survey dates – 27th January 2016
Ordnance Survey Grid Reference – **ST 63310 90765**

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CONTENTS

SUMMARY....1

1 INTRODUCTION....1

1.1 Survey background....1

1.2 Survey objectives and techniques....2

1.3 Site location, description and survey conditions....3

1.4 Site history and archaeological potential....4

1.5 Geology and soils....5

2 METHODOLOGY....5

2.1 Technical synopsis....5

2.2 Equipment configuration, data collection and survey detail....6

2.3 Data processing and presentation....6

3 RESULTS....7

3.1 General assessment of survey results....7

3.2 Statement of data quality....8

3.3 Data interpretation....8

3.4 List of anomalies - Area 1....9

3.5 List of anomalies - Area 2....9

3.6 List of anomalies - Area 4....10

4 CONCLUSION....11

5 REFERENCES....12

Appendix A – basic principles of magnetic survey....13

Appendix B – data processing notes....14

Appendix C – survey and data information....15

Appendix D – digital archive.....16

Appendix E – copyright and intellectual property.....17

LIST OF FIGURES

Figure 01 Map of survey area (1:25 000)

Figure 02 Referencing information (1:1500)

Figure 03 Greyscale plot of minimally processed magnetometer data (1:1000)

Figure 04 Greyscale plot of filtered magnetometer data (1:1000)

Figure 05 Abstraction and interpretation of magnetic anomalies (1:1000)

LIST OF TABLES

Table 1: List and description of interpretation categories.....9

SUMMARY

A detailed magnetometer survey was carried out by Archaeological Surveys Ltd at Thornbury Castle in South Gloucestershire. The survey was requested within four areas, the West and East Court garden (Areas 1 & 2), the kitchen court and car park (Area 3) and the field to the north of the castle (Area 4). The East Court garden (Area 2) is part of the scheduled area which contains the buried remains of the demolished east wing of the 16th century castle and privy gardens. Area 3 contained numerous ferrous objects with associated high levels of magnetic disturbance precluding recorded survey. The results within Area 4, to the north of the castle, demonstrate the presence of a number of positive linear, rectilinear and discrete anomalies that appear to relate to ditch-like and pit-like features. Areas 1 and 2 in the West and East Court gardens contain widespread and very strongly magnetic disturbance from numerous buried services. A small number of very short positive and negative linear anomalies have been located within Areas 1 and 2, with some negative responses in the scheduled area. However the very limited size of these anomalies, coupled with the presence of such widespread magnetic disturbance and debris, means that while they may be associated with buried archaeological remains, they are incoherent and cannot be confidently interpreted.

1 INTRODUCTION

1.1 Survey background

1.1.1 Archaeological Surveys Ltd was commissioned by Cotswold Archaeology, to undertake a magnetometer survey of several areas at Thornbury Castle in South Gloucestershire. The castle is currently used as a hotel and part of the site has been outlined for a proposed development of new hotel buildings. The survey forms part of an archaeological assessment of the site.

1.1.2 Thornbury Castle comprises several Grade I and Grade II listed buildings with the grounds part of a registered park and garden. It also includes the scheduled buried remains of the medieval fortified house and the 16th century privy garden.

1.1.3 The geophysical survey was carried out in accordance with a Written Scheme of Investigation (WSI) produced by Archaeological Surveys (2016) and approved by David Haigh and Rebecca Bennett of South Gloucestershire Council prior to commencing the survey. The WSI considers the requirements of a Brief for geophysical survey issued by Paul Driscoll, Archaeology & HER Officer for South Gloucestershire Council (Driscoll, 2015).

1.1.4 The brief indicates that there are four areas outlined for geophysical survey: the West Court garden (Area 1), The East Court garden (Area 2), which contains the scheduled buried remains of the east wing and privy gardens, the Kitchen Court and existing car park (Area 3) and the field north of the north castle walls (Area 4).

The geophysical survey has been requested as part of a suite of archaeological works and will be used to inform further investigations.

1.1.5 Only a small part of the survey area is within the scheduled monument. It consists of approximately 0.15ha of open lawn available in the eastern part of the site (East Court garden) which is part of *The buried remains of the medieval fortified house and the C16 privy garden at Thornbury Castle* (Historic England List Entry No: 1410041). A licence under Section 42 of the 1979 Ancient Monuments and Archaeological Areas Act (as amended by the National Heritage Act 1983) was granted to Archaeological Surveys Ltd, by Historic England South West office, prior to commencing the fieldwork within the scheduled area.

1.1.6 The original aim of the survey was to use magnetometry to assess the archaeological potential of the site. If this technique located potential structural remains, then a small area of targeted earth resistance survey was to be considered. However, the results of the magnetometry demonstrate that there is widespread and very strongly magnetic disturbance within the castle area. This, coupled with hardstanding, obstacles, trees, ground disturbance, potential currents from cabling and the saturated ground conditions, meant that earth resistance survey would be restricted in area and with likely very poor results.

1.2 Survey objectives and techniques

1.2.1 The objectives of the survey were to use non-intrusive geophysical techniques to identify the nature, character, date and extent of archaeology within the proposed development area and in adjacent areas in order to characterise the archaeology and to identify archaeology that may be impacted by consolidation works to standing structures as well as landscaping, infrastructure works, utilities etc. The methodology is considered an efficient and effective approach to archaeological prospection; however, magnetometry can be greatly affected by strongly magnetic material and this may obscure weaker anomalies.

1.2.2 The survey was conducted within the West Court gardens (Area 1) and the East Court gardens (Area 2). Due to the presence of steel containers, vehicles, hardstanding, services, fencing and dumped material the area of the carpark (Area 3) was scanned with the magnetometer to confirm the expected high level of magnetic disturbance from the obstructions. Recorded survey within Area 3 was considered pointless due to the level of disturbance encountered. Area 4, a field to the north of the castle walls, was open and accessible for survey.

1.2.3 The survey and report generally follow the recommendations set out by: English Heritage (2008) *Geophysical survey in archaeological field evaluation;* and Institute for Archaeologists (2002) *The use of Geophysical Techniques in Archaeological Evaluations*. The work has been carried out to the Chartered Institute for Archaeologists (2014) *Standard and Guidance for Archaeological*

Geophysical Survey.

1.3 Site location, description and survey conditions

1.3.1 The site is located within and to the north of Thornbury Castle, on the north western edge of Thornbury in South Gloucestershire. It is centred on Ordnance Survey National Grid Reference (OS NGR) ST 63310 90765, see Figures 01 and 02.

1.3.2 The geophysical survey covers approximately 2.2ha, with 0.5ha covered in Areas 1 & 2, within the confines of the castle, and 1.7ha covered in Area 4, the field to the north of the castle.

Plate 1: Area 2 looking west

1.3.3 The ground conditions within Areas 1 and 2 were mainly lawn, but with hardstanding, paths, roads and obstacles within. The road and paths were surveyed to maximise the coverage. Area 3 was very restricted in area due to the presence of steel containers, dumped debris and vehicles. Open areas were scanned in Area 3 (see 1.2.2), but the majority was affected by disturbance. Area 4 was open and accessible for survey. The weather conditions during the survey were heavy rain and strong winds.

Plate 2: Area 4 looking south

1.4 Site history and archaeological potential

1.4.1 The history of the site has been taken from the List Entry (No: 1410041) (Historic England, 2015). The principal part of Thornbury Castle was built between 1511 and 1521 for Edward Stafford, 3rd Duke of Buckingham. It is recognised as being one of the finest examples of Tudor domestic architecture in the country. It underwent extensive 19th century restoration and alteration by Anthony Salvin, and more recent alterations have been made as a result of the building's conversion to a hotel, including an addition in 1997 to the north range of the inner court by Niall Phillips Architects. Thornbury Castle contains at least six Grade I and Grade II listed buildings, as well as the listed park and gardens, and the scheduled buried remains of the medieval house and 16th century privy garden in the eastern part of the site.

1.4.2 Documentary sources and early 14th century and 15th century financial accounts provide evidence for an extensive complex in which an inner court, entered through a central gate, gave access to a hall, orientated north to south, with kitchen offices to the west and a chapel, begun in 1340 and completed in 1435, to the east of the hall. Accounts also record an outer courtyard containing a range of service buildings. By 1510 Edward Stafford had been granted licence to crenellate, with the hall and chapel of the existing manor house forming the east range of an inner courtyard. He set about building an elaborate palace-castle, apparently modelled on Richmond Palace. Buckingham was executed for treason in 1521, his lavish building programme having exacerbated the suspicion with which he was viewed. The estate was confiscated and remained in crown ownership until 1554, when it was then returned to the Staffords. The upkeep of the buildings proved too expensive for subsequent generations and many fell into ruin, with later demolition of the east wing, medieval hall and chapel before 1732. In 1982 excavations confirmed the survival of a tiled floor and the remains of a wall on the east side of the inner court, with a second tiled floor observed during a watching brief in 1988

within the privy garden. These are likely to be late 15th or early 16th century, relating to the inner court's east range which was demolished in the early 18th century. Geophysical surveys of the castle grounds and a trial excavation of the privy garden in 1992 by Bath Archaeological Trust, provided further evidence of the buried foundations of an east range to the inner court as well as the buried remains of the 16th century privy garden.

1.4.3 The scheduled area (see Fig 02) consists of the remains of the demolished east range which includes the earlier medieval remains of the previous manor house within and to the east of the inner court, and the archaeological remains of the 16th century privy garden within the bounds of the walled garden. Excavations have identified floor tiles, and a resistivity survey revealed the L-shaped range, extending to the east, which corresponds with the 1583 inventory of the castle. The plan has been postulated to include a buttery, porch, old hall, and chapel. The demolished east range is shown to have continued into the walled garden with the tiled remains of a room postulated to have been the lodging of the Duke of Bedford.

1.4.4 A Ground Penetrating Radar (GPR) survey has been carried out within the kitchen court area, on the north eastern side of the castle (Stratascan, 2016). The results of this survey indicate the presence of a number of linear anomalies of an uncertain origin, but may indicate archaeological features, which are parallel with the existing castle walls. A number of services, modern surfaces and widespread ground disturbance was also encountered. Ordnance Survey mapping from the early 20th century shows that this area once contained trees, shrubs and edging.

1.5 Geology and soils

1.5.1 The underlying solid geology across the site is from the Mercia Mudstone Group (Dolomitic Conglomerate) (BGS, 2016).

1.5.2 The overlying soil across the survey area is from the Brockhurst 2 association and is a typical stagnogley. It consists of a slowly permeable, seasonally waterlogged, clayey soil (Soil Survey of England and Wales, 1983).

1.5.3 Magnetometry survey carried out across similar soils has produced variable results. There can be low magnetic susceptibility; however, where there is long term occupation there can be sufficient magnetic contrast for anomalies to be present. The underlying geology and soils are therefore 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 are factors associated with the formation of localised fields. Additional details are set out below and within Appendix A.

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

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

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

2.2 Equipment configuration, data collection and survey detail

2.2.1 The detailed magnetic survey was carried out using a SENSYS MAGNETO®MXPDA 5 channel cart-based system. The instrument has 5 fluxgate gradiometers spaced 0.5m apart with readings recorded at 20Hz. The gradiometers have a range of recording data between 0.1nT and 10,000nT. The sensors are not zeroed in the field, as the vertical axis alignment is fixed using a tension band system. In order to produce visible, useful greyscale images a zero median traverse process is undertaken in TerraSurveyor. The system is linked to a Leica GS10 RTK GPS with data recorded by SENSYS MAGNETO®MXPDA software on a rugged computer.

2.2.2 Data are collected along a series of parallel survey tracks wherever possible. The length of each track is variable and relates to the size of the survey area and other factors including ground conditions. A visual display aids accurate placing of tracks and their separation.

2.2.3 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).

2.3 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. Survey tracks are analysed and georeferenced raw data (UTM Z30N) are then exported in ASCII format for further analysis and display using TerraSurveyor.

2.3.2 The data are collected between limits of ±10000nT and clipped for display at ±20nT for Areas 1 & 2 and ±3nT for Area 4. Data are interpolated to a resolution of effectively 0.5m between tracks and 0.12m along each survey track. A zero median traverse function is required in order to remove fixed offset values present within the sensors which do not undergo a zeroing procedure in the field. The approach ensures that the gradiometer sensors are very accurately aligned and fixed to the vertical magnetic field and are not influenced by localised magnetic fields or disturbed by vibration. 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 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 any processes, such as clipping, carried out on the data. A filtered image is also displayed in Fig 04 where a high pass filter is applied to smooth data and remove slight variations along survey tracks caused by strongly magnetic disturbance.

2.3.4 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.

2.3.5 The raster images are combined with base mapping using ProgeCAD Professional 2016, creating DWG (2010) 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 GPS, resection method, etc.

2.3.6 An abstraction and interpretation is also 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.

2.3.7 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.

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

3 RESULTS

3.1 General assessment of survey results

3.1.1 The detailed magnetic survey was carried out over a total of three survey areas covering approximately 2.2ha.

3.1.2 Magnetic anomalies located can be generally classified as positive and negative linear anomalies of an uncertain origin, linear anomalies of an agricultural 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. Anomalies located within each survey area have been numbered in 3.4 below.

3.2 Statement of data quality

3.2.1 Data are considered representative of the magnetic anomalies present within the site. Magnetic disturbance, related to modern services/cables and steel above surface objects, is widespread and has the potential to obscure weak anomalies of archaeological potential. High pass filtering was carried out across the data in order to remove some of the effects of the disturbance and improve the level of confidence associated with abstraction and interpretation. Both filtered and unfiltered greyscale representations of the magnetic data are shown within this report.

3.3 Data interpretation

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

Report sub-heading CAD layer names and plot colour	**Description and origin of anomalies**
Anomalies with an uncertain origin AS-ABST MAG POS LINEAR UNCERTAIN AS-ABST MAG NEG LINEAR UNCERTAIN AS-ABST MAG POS DISCRETE UNCERTAIN AS-ABST MAG POS UNCERTAIN	The category applies to a range of anomalies where there is not enough evidence to confidently suggest an origin. Anomalies in this category may well be related to archaeologically significant features, but equally relatively modern features, geological/pedological features and agricultural features should be considered. Positive anomalies are indicative of magnetically enhanced soils that may form the fill of 'cut' features or may be produced by accumulation within layers or 'earthwork' features; soils subject to burning may also produce positive anomalies. Negative anomalies are produced by material of comparatively low magnetic susceptibility such as stone and subsoil.
Anomalies with an agricultural origin AS-ABST MAG AGRICULTURAL	The anomalies are often linear and form a series of parallel responses or are parallel to extant land boundaries. Where the response is broad, former ridge and furrow is likely; narrow response is often related to modern ploughing.
Anomalies associated with magnetic debris AS-ABST MAG DEBRIS AS-ABST MAG STRONG DIPOLAR	Magnetic debris often appears as areas containing many small dipolar anomalies that may range from weak to very strong in magnitude. It often occurs where there has been dumping or ground make-up and is related to magnetically thermoremnant materials such as brick or tile or other small fragments of ferrous material. This type of response is occasionally associated with

	kilns, furnace structures, or hearths and may therefore be archaeologically significant. Strong discrete dipolar anomalies are responses to ferrous objects within the topsoil.
Anomalies with a modern origin AS-ABST MAG DISTURBANCE AS-ABST MAG SERVICE	The magnetic response is often strong and dipolar indicative of ferrous material and may be associated with extant above surface features such as wire fencing, cables, pylons etc.. Often a significant area around such features has a strong magnetic flux which may create magnetic disturbance; such disturbance can effectively obscure low magnitude anomalies if they are present. Fluxgate sensors may respond erratically and with hysteresis adjacent to strong magnetic sources. Buried services may produce characteristic multiple dipolar anomalies dependant upon their construction.

Table 1: List and description of interpretation categories

3.4 List of anomalies - Area 1

Area centred on OS NGR 363340 190685, see Figures 04 & 05.

Anomalies with an uncertain origin

(1) - A small number of weakly positive linear anomalies are located in the survey area. They are short, indistinct and lack a coherent morphology.

Anomalies with a modern origin

(2) - A number of strong, multiple dipolar, linear anomalies are a response to buried cables or services.

3.5 List of anomalies - Area 2

Area centred on OS NGR 363412 190715, see Figures 04 & 05.

Anomalies with an uncertain origin

(3) - Negative linear anomalies have been located in the eastern part of the survey area. They are short and indistinct and their origin cannot be confidently determined considering the level of adjacent magnetic disturbance. Given the location of the anomalies within the scheduled area, it is possible that they relate to structural remains, but later garden features cannot be ruled out.

(4) - Short positive linear anomalies and discrete positive responses are located close to anomalies (3) with others on the western side of the survey area. Due to their lack of coherent morphology, restricted area and widespread magnetic disturbance and debris it is not possible to determine if they relate to magnetically enhanced anomalies associated with former archaeological features.

Anomalies associated with magnetic debris

(5) - Zones of magnetic debris can be seen in the eastern part of the survey area. The strong dipolar responses indicate that much of the material has a ferrous content but it cannot be determined if this relates to any buried features associated with the scheduled remains, or if it relates to later land use or ground make up.

Anomalies with a modern origin

(6) - As with Area 1, Area 2 contains a number of buried service/cables and these have resulted in widespread magnetic disturbance

3.6 List of anomalies - Area 4

Area centred on OS NGR 363285 190790, see Figures 03 - 05.

Anomalies with an uncertain origin

(7 & 8) - A positive linear anomaly (2-3nT) extends across the eastern part of the survey area and is oriented north west to south east (7). This appears to relate to a linear ditch and may form a rectilinear feature with anomaly (8) to the south.

(9) - Located in the western part of the survey area is a positive linear anomaly. It is oriented north north west to south south east, and also appears to relate to a cut linear feature.

(10) - A number of positive linear, or possible curvilinear/rectilinear anomalies are located in the central part of the survey area. They are fragmented and indistinct and while they may relate to cut, ditch-like features of anthropogenic origin, naturally formed features should also be considered.

(11 & 12) - Extending across the northern half of the survey area are three parallel linear anomalies. These appear to have been truncated by agricultural anomalies (18). Two of them extend eastwards beyond anomaly (7), possibly then forming a curvilinear response (12).

(13) - The survey area contains a number of weakly positive linear and possible rectilinear anomalies. While they may relate to cut, ditch-like features, they lack a coherent morphology preventing confident interpretation.

(14) - In the northern part of the survey area are a cluster of discrete positive responses (4-9nT). They appear to relate to magnetically enhanced features, possibly indicating pits or areas of burning. It is not possible to determine if these are recent, such as modern dumping or burning, or from antiquity and an association with (19) is possible.

(15 & 16) - A weakly positive broadly linear response is located in the south western part of the survey area (15). The response is generally 1nT, and it appears to split or diverge to the west of anomaly (9). Other similar anomalies can be seen immediately to the north and also in the north eastern part of the site (16). It is not possible to determine if they have an anthropogenic or natural origin.

(17) - The survey area contains a number of discrete positive responses. Although some are clustered and appear pit-like, it is not possible to determine their origin.

Anomalies with an agricultural origin

(18) - The survey area contains a series of parallel linear anomalies relating to agricultural activity. Some of these appear to have truncated earlier anomalies (10 & 11). Not all of the anomalies have been abstracted.

Anomalies associated with magnetic debris

(19) - A patch of magnetic debris is located close to the north eastern corner of the survey area. This may relate to dumped magnetically thermoremnant material or burning and an association with (14) cannot be discounted.

(20) - The survey area contains numerous and widespread strong, discrete, dipolar anomalies which relate to ferrous and other magnetically thermoremnant objects within the topsoil.

Anomalies with a modern origin

(21) - A negative linear anomaly in the eastern part of the survey area extends between two inspection chambers and relates to a buried service (sewer).

4 CONCLUSION

4.1.1 The magnetometer survey was carried out within accessible and suitable areas for this technique. These were Areas 1 and 2, the West Court and East Court gardens and Area 4, the field to the north of the castle walls. Area 3 contained cars, steel containers, hardstanding, dumped material and other obstructions which prevented survey in this area. A magnetic scan of the only open areas confirmed widespread magnetic disturbance.

4.1.2 Within Areas 1 and 2, the results demonstrate that there are a large number of buried services and/or cables with resulting widespread magnetic disturbance encountered. A small number of negative linear and positive responses were located within the scheduled area, and while it is possible that they relate to archaeological remains, they are so small and incoherent that their origin cannot be determined. The presence of services and other ground disturbances within this area indicates that targeted earth resistance is likely

to be highly restricted and may be of limited use.

4.1.3 Within Area 4 to the north of the castle a number of positive linear, possible rectilinear and discrete responses were located. They appear to relate to ditch-like and possible pit-like features, but they lack a clear and coherent morphology preventing confident interpretation.

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Appendix A – basic principles of magnetic survey

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

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

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

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

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

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

Magnetic survey or magnetometry can be carried out using a fluxgate gradiometer and may be referred to as gradiometry. The SENSYS gradiometer is a passive instrument consisting of two fluxgate sensors mounted vertically 65cm apart. The instrument is carried about 10-20cm above the ground surface and the upper sensor measures the Earth's magnetic field as does the lower sensor but this is influenced to a greater degree by any localised buried field. The difference between the two sensors will relate to the strength the magnetic field created by the buried feature.

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

Appendix B – data processing notes

Clipping

Minimum and maximum values are set and replace data outside of the range with those values. Extreme values are removed improving colour or greyscale contrast associated with data values that may be archaeologically significant. It has been found that clipping data to ranges between ±5nT and ±3nT often improves the appearance of features associated with archaeology. Different ranges are applied to data in order to determine the most suitable for anomaly abstraction and display.

Zero (destripe) Median/Mean Traverse

The median (or mean) of 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 baseline value of gradiometer sensors.

High Pass Filtering

A mathematical process used to remove low frequency anomalies relating to survey tracks and modern agricultural features.

Appendix C – survey and data information

Area 1 minimally processed magnetometer data

Path: C:\Business\Jobs\J645 Thornbury Castle\Data\Area 1\comps\
Filename: J645-mag-Area1-proc.xcp
Description: Imported as Composite from: J645-mag-Area1.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 363310.397199402, 190750.550327679 m
Southeast corner: 363447.197199402, 190648.910327679 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 144700
Dimensions
Composite Size (readings): 1140 x 847
Survey Size (meters): 137 m x 102 m
Grid Size: 137 m x 102 m
X Interval: 0.12 m
Y Interval: 0.12 m
Stats
Max: 20.00
Min: -20.00
Std Dev: 11.88
Mean: -0.16
Median: 0.02
Composite Area: 1.3904 ha
Surveyed Area: 0.46967 ha
Processes: 2
1 Base Layer
2 Clip from -20.00 to 20.00 nT
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -20.00 to 20.00 nT

Area 1 filtered magnetometer data

Filename: J645-mag-Area1-proc-HPF.xcp
Description: Imported as Composite from: J645-mag-Area1.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 363310.397199402, 190750.550327679 m
Southeast corner: 363447.197199402, 190648.910327679 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 144700
Dimensions
Composite Size (readings): 1140 x 847
Survey Size (meters): 137 m x 102 m
Grid Size: 137 m x 102 m
X Interval: 0.12 m
Y Interval: 0.12 m
Stats
Max: 20.00
Min: -20.00
Std Dev: 11.43
Mean: -0.06
Median: 0.16
Composite Area: 1.3904 ha
Surveyed Area: 0.46967 ha
Processes: 2
1 Base Layer
2 Clip from -20.00 to 20.00 nT
GPS based Proce5
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 High pass Uniform (median) filter: Window dia: 300
5 Clip from -20.00 to 20.00 nT

Area 4 minimally processed magnetometer data

Path: C:\Business\Jobs\J645 Thornbury Castle\Data\Area 4\comps\
Filename: J645-mag-Area4-proc.xcp
Description: Imported as Composite from: J645-mag-Area4.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 363189.437984239, 190899.592496464 m
Southeast corner: 363371.357984239, 190721.512496464 m
Collection Method: Randomised
Sensors: 1
Dummy Value: 32702
Source GPS Points: 496200
Dimensions
Composite Size (readings): 1516 x 1484
Survey Size (meters): 182 m x 178 m
Grid Size: 182 m x 178 m
X Interval: 0.12 m
Y Interval: 0.12 m
Stats
Max: 3.00
Min: -3.00
Std Dev: 1.21
Mean: 0.03
Median: 0.01
Composite Area: 3.2396 ha
Surveyed Area: 1.666 ha
Processes: 2
1 Base Layer
2 Clip from -3.00 to 3.00 nT
GPS based Proce4
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 Clip from -3.00 to 3.00 nT

Area 4 filtered magnetometer data

Filename: J645-mag-Area4-proc-hpf.xcp
Description: Imported as Composite from: J645-mag-Area4.asc
Instrument Type: Sensys DLMGPS
Units: nT
UTM Zone: 30U
Survey corner coordinates (X/Y):OSGB36
Northwest corner: 363189.437984239, 190899.592496464 m
Southeast corner: 363371.357984239, 190721.512496464 m
Collection Method: Randomised
Sensors: 5
Dummy Value: 32702
Source GPS Points: 496200
Dimensions
Composite Size (readings): 1516 x 1484
Survey Size (meters): 182 m x 178 m
Grid Size: 182 m x 178 m
X Interval: 0.12 m
Y Interval: 0.12 m
Stats
Max: 3.00
Min: -3.00
Std Dev: 1.15
Mean: 0.02
Median: 0.00
Composite Area: 3.2396 ha
Surveyed Area: 1.666 ha
Processes: 2
1 Base Layer
2 Clip from -3.00 to 3.00 nT
GPS based Proce5
1 Base Layer.
2 Unit Conversion Layer (Lat/Long to OSGB36).
3 DeStripe Median Traverse:
4 High pass Uniform (median) filter: Window dia: 400
5 Clip from -3.00 to 3.00 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 PDF copy will be supplied to the South Gloucestershire Historic Environment Record together with the raw data as a CSV. Greyscale plots will be supplied as TIFs and the abstraction layers supplied in DXF format. The report will also be uploaded to the Online AccesS to the Index of archaeological investigationS (OASIS).

Copies of the report will also be sent to the Historic England South West Team at the Bristol Office and a PDF copy to the Geophysics Team Manager in Fort Cumberland.

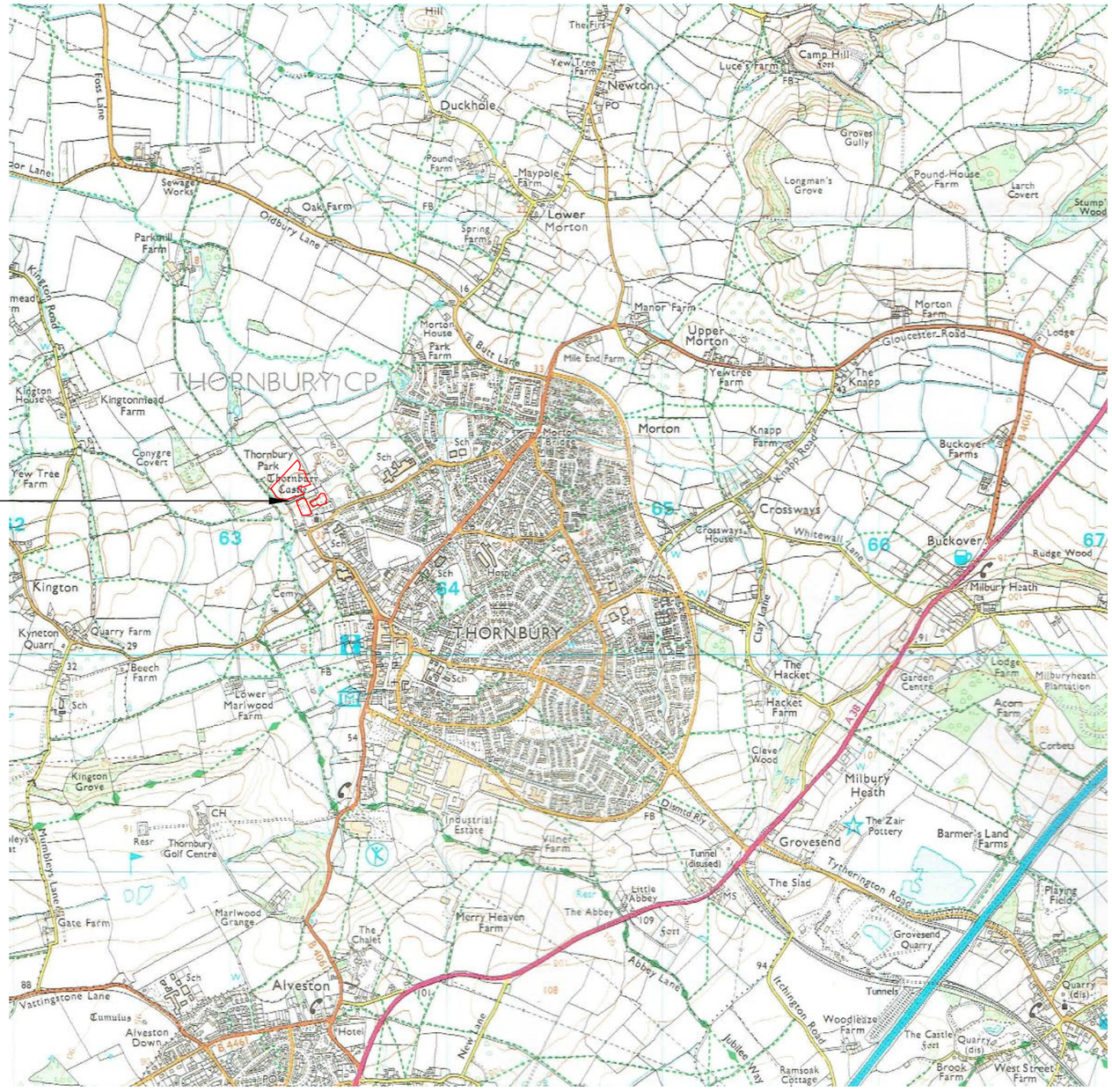
Archive contents:

Geophysical data Areas 1 & 2 - path: J645 Thornbury Castle\Data				
Path and Filename	**Software**	**Description**	**Date**	**Creator**
thornby1\MX\ .prm .dgb .disp	Sensys MXPDA	Proprietary data formats representing magnetometer survey traverses logged to a PDA.	27/01/16	D.J.Sabin
thornby1\MX\J645-mag-Area1.asc	Sensys DLMGPS	ASCII CSV (tab) file representing survey Areas 1 & 2 in eastings, northings (UTM Z30N), magnetic measurement, traverse file and sensor number.	28/01/16	D.J.Sabin
Area1\comps\J645mag-Area1.xcp	TerraSurveyor 3.0.23.0	Composite data file derived from ASCII CSV.	28/01/16	D.J.Sabin
Area1\comps\J645-mag-Area1-proc.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt and clipping to ±20nT).	28/01/16	D.J.Sabin
Area1\comps\J645-mag-Area1-proc-hpf.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt, high pass filter and clipping to ±20nT).	12/02/16	K.T. Donaldson
Geophysical data Area 4 - path: J645 Thornbury Castle\Data				
thornby4\MX\ .prm .dgb .disp	Sensys MXPDA	Proprietary data formats representing magnetometer survey traverses logged to a PDA at.	27/01/16	D.J.Sabin
thornby4\MX\J645-mag-Area4.asc	Sensys DLMGPS	ASCII CSV (tab) file representing survey Area 4 in eastings, northings (UTM Z30N), magnetic measurement, traverse file and sensor number.	28/01/16	D.J.Sabin
Area4\comps\J645-mag-Area4.xcp	TerraSurveyor 3.0.23.0	Composite data file derived from ASCII CSV.	28/01/16	D.J.Sabin
Area4\comps\J645-mag-Area4-proc.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt and clipping to ±3nT).	21/01/16	D.J.Sabin
Area4\comps\J645-mag-Area4-proc-hpf.xcp	TerraSurveyor 3.0.23.0	Processed composite data file (zmt, high pass filter and clipping to ±3nT).	01/02/16	D.J.Sabin
Graphic data - path: J645 Thornbury Castle\Data				
Area1\graphics\ J645mag-proc.tif	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±20nT.	28/01/16	K.T.Donaldson
Area1\graphics\ J645-mag-proc.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.	28/01/16	K.T.Donaldson
Area1\graphics\ J645-mag-proc-hpf.tif	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±3nT.	12/02/16	K.T.Donaldson
Area1\graphics\ J645-mag-proc-hpf.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.	12/02/16	K.T.Donaldson
Area4\graphics\	TerraSurveyor	TIF file showing a minimally processed greyscale plot	28/01/16	K.T.Donaldson

J645-mag-proc.tif	3.0.23.0	clipped to ±3nT.		
Area4\graphics\ J645-mag-proc.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.	28/01/16	K.T.Donaldson
Area4\graphics\ J645-mag-proc-hpf.tif	TerraSurveyor 3.0.23.0	TIF file showing a minimally processed greyscale plot clipped to ±3nT.	01/02/16	K.T.Donaldson
Area4\graphics\ J645-mag-proc-hpf.tfw	TerraSurveyor 3.0.23.0	World file for georeferencing TIF to OSGB36.	01/02/16	K.T.Donaldson
CAD data - path: J645 Thornbury Castle\CAD				
J645version 1.dwg	ProgeCAD 2016	CAD file for creating plots of greyscales, abstraction, interpretation and mapping. Grid coordinates as OSGB. AutoCAD 2010 format.	18/01/16	K.T.Donaldson
Text data - path: J645 Thornbury Castle\Documentation				
J645 report.odt	OpenOffice.org 3.0.1 Writer	Report text as an Open Office document.	08/02/16	K.T.Donaldson

Appendix E – copyright and intellectual property

Survey location



Archaeological Surveys Ltd

Geophysical Survey
Thornbury Castle
South Gloucestershire

Map of survey area

● Survey location

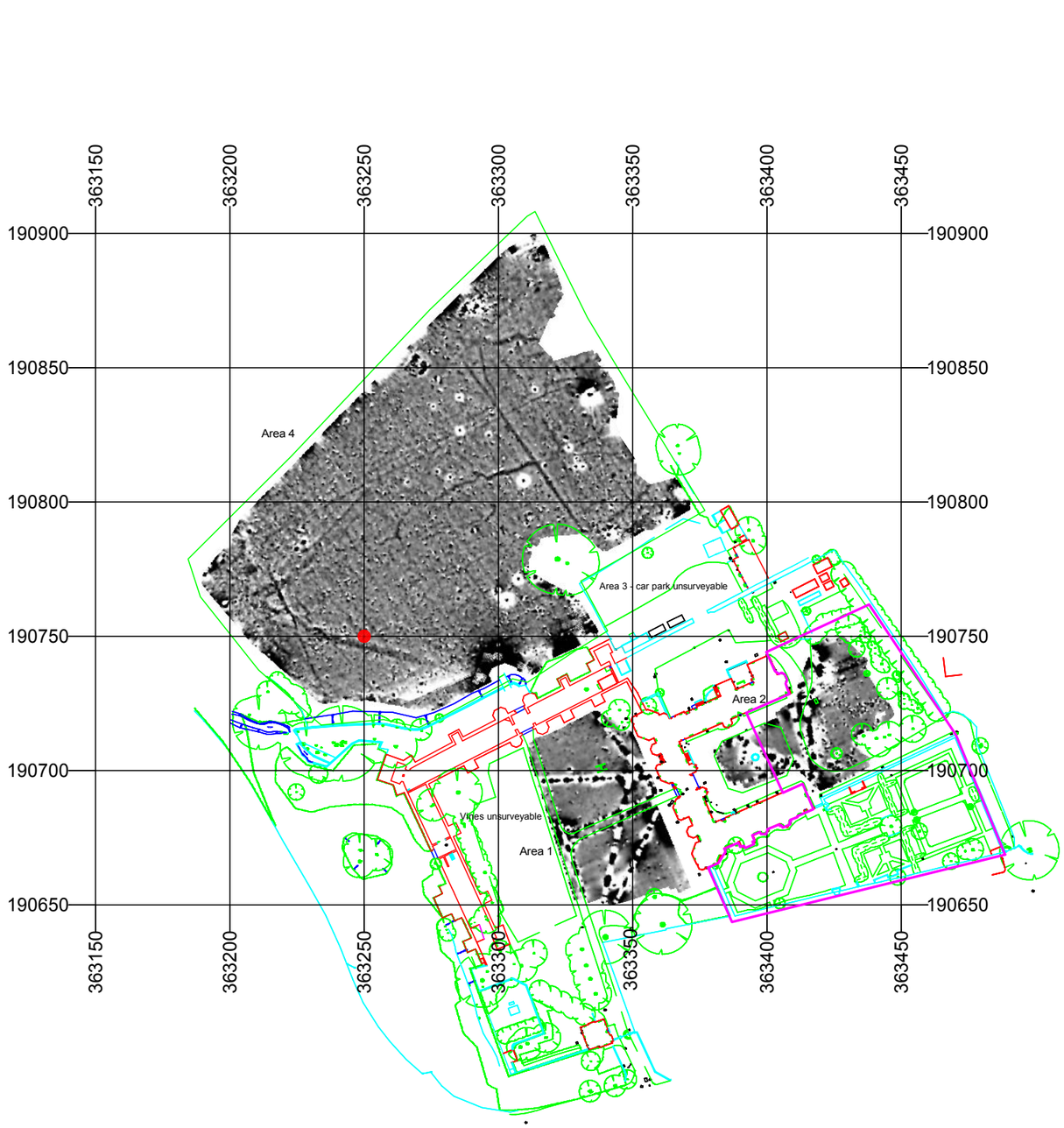
Site centred on OS NGR
ST 63310 90765

SCALE 1:25 000

0m 500m 1000m

SCALE TRUE AT A3

FIG 01



Archaeological Surveys Ltd

Geophysical Survey
Thornbury Castle
South Gloucestershire

Referencing information

Referencing grid to OSGB36 datum at 50m intervals

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

- 363250 190750
- Scheduled area

SCALE 1:1500

0m 10 20 30 40 50m

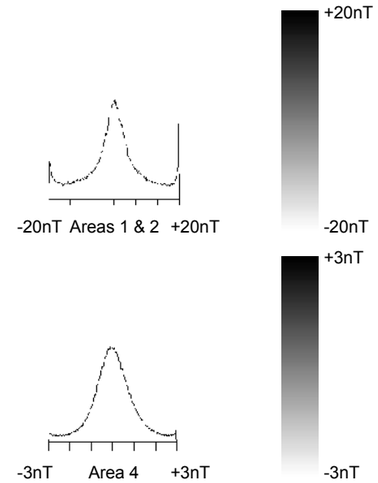
SCALE TRUE AT A3

FIG 02

Archaeological Surveys Ltd

Geophysical Survey
Thornbury Castle
South Gloucestershire

Greyscale plot of minimally processed magnetometer data



Area 4

Area 3 - car park unsurveyable

Area 2

Vines unsurveyable

Area 1

N

SCALE 1:1000

0m 10 20 30 40 50m

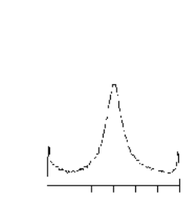
SCALE TRUE AT A3

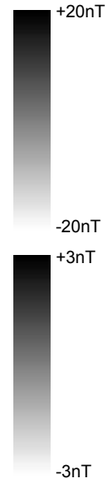
FIG 03

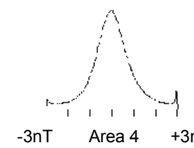
Archaeological Surveys Ltd

Geophysical Survey
Thornbury Castle
South Gloucestershire

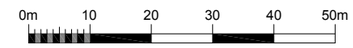
Greyscale plot of filtered data







SCALE 1:1000

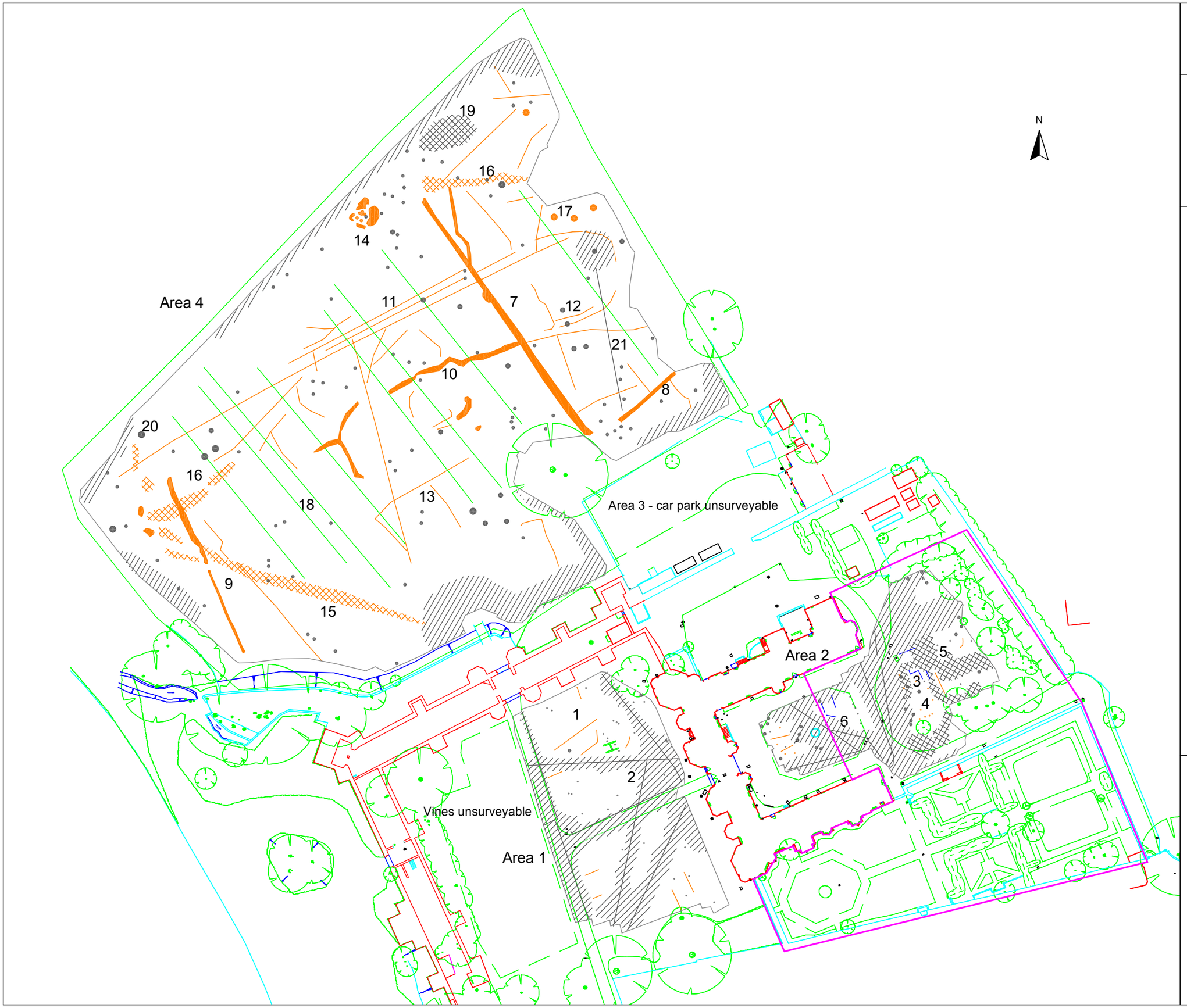


SCALE TRUE AT A3

FIG 04

Archaeological Surveys Ltd

Geophysical Survey
Thornbury Castle
South Gloucestershire



Abstraction and interpretation of magnetometer anomalies

- Positive linear anomaly - ditch-like feature
- Linear anomaly - of agricultural origin
- Negative linear anomaly - material of low magnetic susceptibility
- Discrete positive response - possible pit-like feature
- Positive anomaly - magnetically enhanced material
- 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 1:1000

0m 10 20 30 40 50m

SCALE TRUE AT A3

FIG 05