

GEOPHYSICAL SURVEY REPORT

Cainhoe Castle, Clophill, Bedfordshire

Client

Albion Archaeology

For

The Greensand Trust

Survey Report

10520

OASIS Ref. No.

sumogeop1-511887

Ancient Monuments Case No.

SL00234396

Date

20 December 2022



Survey Report 10520: Cainhoe Castle, Clophill, Bedfordshire

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3 SURVEY TECHNIQUE

- 3.1 Detailed magnetic survey (magnetometry) was chosen as the most efficient and effective method of locating the type of archaeological anomalies which might be expected at this site. All survey techniques followed the guidance set out by CIFA (2014, updated 2020), Historic England (2008), and the European Archaeology Council (EAC) (2016).

Bartington Grad 601-2 Traverse Interval 1.0m Sample Interval 0.25m

The only processes performed on data are the following unless specifically stated otherwise:

Zero Mean Traverse	This process sets the background mean of each traverse within each grid to zero. The operation removes instrument striping effects and edge discontinuities over the whole of the data set.
Step Correction (De-stagger)	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise. These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors.

4 SUMMARY OF RESULTS

- 4.1 A magnetometer survey of 10.5 hectares of land spread across four Sites at Cainhoe Castle and the surrounding area has recorded numerous magnetic responses that have been interpreted as being of archaeological interest. Within the Cainhoe Castle scheduled monument (1009248) ditch-like responses, pit-like anomalies and areas of increased response have been detected. The location of a possible building has also been marked.
- 4.2 In Area 3 responses of probable and possible interest appear to correspond with the location of an enclosure that is visible as cropmarks (HER 14642). Linear responses in Area 4 appear to mark the routes of medieval field boundaries while pit-like anomalies and areas of increased response are likely to be products of localised industrial activity.
- 4.3 Uncertain responses have been recorded at most of the sites which are likely to be due to underlying natural and agricultural processes. However, archaeological origins cannot be entirely discounted for some of the responses. Ridge and furrow ploughing has also been recorded in Site 1.

5 INTRODUCTION

- 5.1 **SUMO Geophysics Ltd** were commissioned to undertake a geophysical survey which forms part of an archaeological investigation being undertaken by **Albion Archaeology** on behalf of **The Greensand Trust**.

5.2 Site Details

NGR / Postcode	Site 1	TL 09668 37377 / SG17 5PJ
	Site 2	TL 09541 37526 / SG17 5PJ
	Site 3	TL 09287 37497 / SG17 5PJ
	Site 4	TL 09087 38005 / MK45 4BE

Location The sites are located 5.5 km east of Ampthill and 5.5km west of Shefford. Areas 1, 2 and 3 are bounded to the south by the A507 and to the north by a disused quarry. Area 4 is bounded to the south by the River Flint and to the north by houses off High Street.

HER Bedfordshire HER

SM No.	1009248
OASIS Ref. No.	sumogeop1-511887
District	Central Bedfordshire
Parish	Clophill Civil Parish
Topography	Areas 1 and 4 are undulating while Areas 2 and 3 are generally flat
Land Use	Pasture / Arable agriculture
Geology (BGS 2022)	Bedrock: Woburn Sands Formation - Sandstone Superficial: Oadby Member - Diamicton Head - Clay, silt, sand and gravel Peat - Peat River Terrace Deposits, 1 - Sand and gravel Alluvium - Clay, silt, sand and gravel
Soils (CU 2022)	Soilscape 6: Freely draining slightly acid loamy soils Soilscape 9: Lime-rich loamy and clayey soils with impeded drainage Soilscape 10: Freely draining slightly acid sandy soils Soilscape 20: Loamy and clayey floodplain soils with naturally high groundwater
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	Site 1 – 4.4 ha Site 2 – 0.5 ha Site 3 – 2 ha Site 4 – 3.6 ha

5.3 **Archaeological Background (AA 2022)**

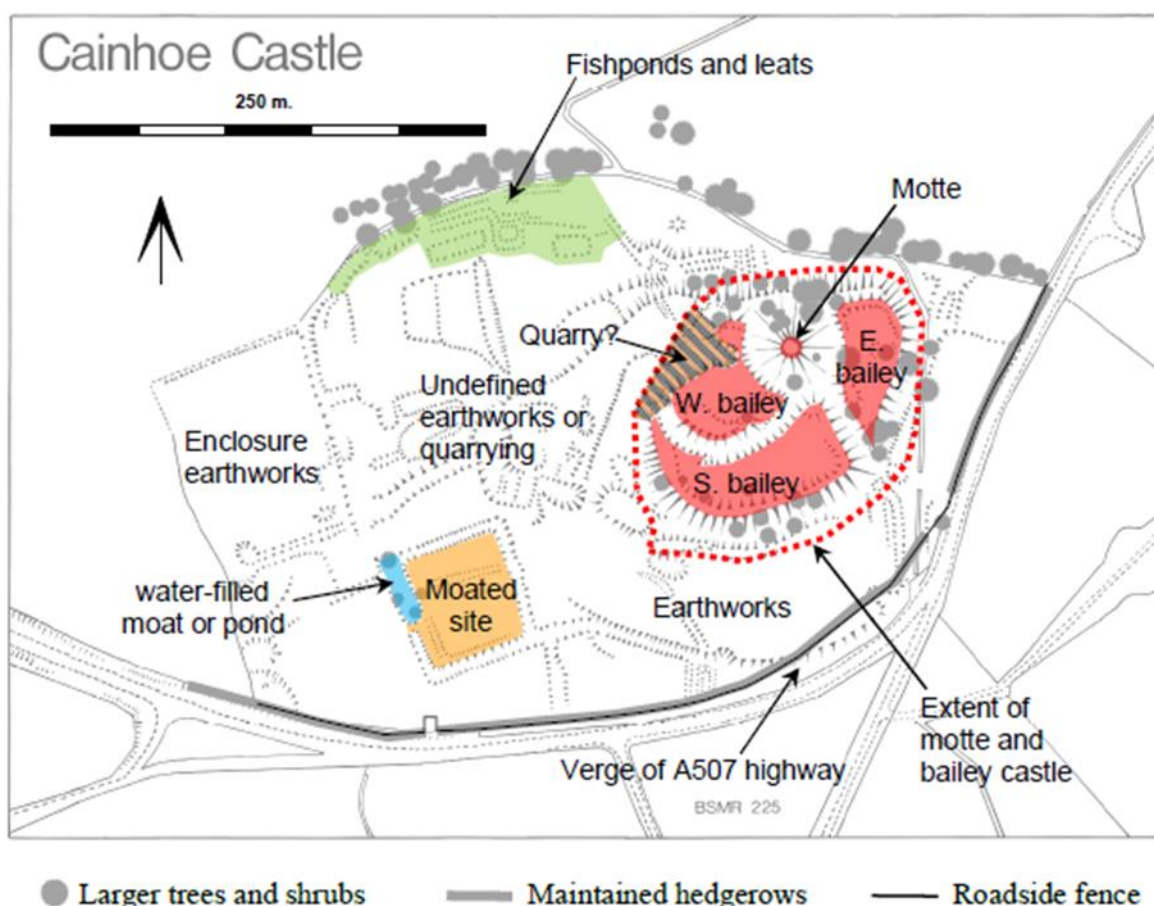
5.3.1 Site 1 is located within Cainhoe Castle Scheduled Monument (1009248). The monument includes the following visible components:

- Motte and bailey
- Moated manor house
- A system of fishponds
- A series of closes used variously as house plots, livestock enclosures, gardens or small fields.
- Old trackways.
- Quarries.

5.3.2 Cainhoe Castle comprises a motte surrounded by three separate baileys. To the west and south-west of the motte and baileys are remains of a probable medieval manorial site which is thought to have succeeded the early castle. The square enclosure highlighted in orange is c.80m across externally and may have been a water filled moat surrounding the manor building. However, it may have just been a simple enclosure, possibly for stock, or a garden and that it was never occupied; the ditch may be too slight for a moat and there appears to be a lack of interior features.

5.3.3 Another distinctive group of features lies close to the northern edge of the monument and comprises a series of dried-up fishponds. The scheduling description assumed that the ponds were fed by a stream whose course ran around the north edge of the monument.

5.3.4 A series of closes (probably associated with the moated manor) can be seen on the ground as a series of slight linear hollows and mounds plus level areas. These are likely to be the remains of enclosures associated with the medieval manorial site.



- 5.3.5 A probable holloway is present at the south-east corner of the site heading towards the gap between the south and east bailey (possibly one of the castle entrances). This is where metallised road surfaces were recorded during an excavation in 1973, though not necessarily contemporary with the use of the castle itself.
- 5.3.6 An area of 170m by 140m maximum extent in the centre of the site has also been altered by quarrying. This is apparent as an area of undulating earthworks north-west of the castle and a large hollow cutting into the west bailey. It is not known how old they are, but they were present in the late 19th century and are clearly shown on 1883 Ordnance Survey mapping.
- 5.3.7 Linear cropmarks which extend north-west and north-east of Cainhoe Castle (HER 14642) lie in Areas 2 and 3. Some were still visible as earthworks before the land was quarried and the current extent of their survival is partial and unknown. The HER tentatively dates them to the post-medieval period, but they might well be earlier. Some appeared to extend the pattern of enclosures observed within the scheduled area and they might, therefore, have been associated with Cainhoe Castle – perhaps indicating the former extent of the settlement.
- 5.3.8 Site 4 is due south of the historic core of Clophill village (HER 16998) which certainly existed in 1765 when it was mapped by Jefferies. Evidence from recent excavations at 118b High Street due north-east of the site, suggests a medieval tannery or related industry beside the existing public footpath. Butchery of high-status animal (horses) was also uncovered which may relate to the castle.

5.4 **Aims and Objectives**

- 5.4.1 **Site 1. Cainhoe Castle scheduled monument, motte and bailey castle, manorial earthworks and fishponds** - To magnetically map the site and compare the results with the earthworks.
- 5.4.2 **Sites 2 and 3. Part of crop-mark sites on land north and north-west of the Cainhoe Castle scheduled monument (1990s quarrying not subjected to archaeological monitoring)** - To confirm extent of archaeological survival/impact of 1990s quarrying and identify any archaeological remains that might equate with the cropmarks
- 5.4.3 **Site 4. Paddocks south of High Street and north of River Flit, within Nature Reserve** - The open land south of High Street and north of River Flit has no known archaeological remains and is not so closely connected with the scheduled monument but is within Nature Reserve and might shed light on medieval settlement on Clophill (e.g. any evidence to support the early origin of the village in its present location).

6 **RESULTS**

6.1 *The survey has been divided into four survey locations (Sites 1-4) and specific anomalies have been given numerical labels [1] [2] which appear in the text below, as well as on the Interpretation Figure(s).*

6.2 **Site 1**

6.2.1 **Probable / Possible Archaeology**

- 6.2.1.1 Numerous magnetic responses have been recorded in Site 1 which are of archaeological interest, though it has been difficult to interpret the responses in respect of whether they are castle or manorial in date. However, several well-defined and sinuous ditch-like responses [1] have been detected in Site 1. These could be associated with the motte and bailey castle as they generally follow the earthworks of the main monument.
- 6.2.1.2 With regards to the moated manorial site, the broad ditch-like response [2] and trends [3] appear to correspond with the surrounding earthworks. However, only weak linear trends [4] have been recorded in the in the centre suggesting the absence of a substantial building. In fact the 'internal' responses appear more akin to ridge and furrow cultivation rather than ditches.
- 6.2.1.3 Several magnetically stronger pit-like responses and ditch-like anomalies [5] have been detected which appear to form a rectangular feature which measures some 20m by 30m with further pit-like responses 'inside'. It is tempting to interpret the complex as a possible building, perhaps comprising of post-holes and timber slots; though, it is not possible to say whether these mark the location of a manorial structure.
- 6.2.1.4 Numerous other trends, ditches and pits have been recorded in Site 1 which have been interpreted as being of *Probable* and *Possible Archaeological* interest dependant on their magnetic strengths and morphology.

6.2.2 **Uncertain**

- 6.2.2.1 A couple of weak linear and curvilinear trends have been detected which have been assigned to the category of *Uncertain*. They are generally weak and lack the defined morphology of anomalies of archaeological interest, they could be due to natural processes. However, given their proximity to archaeological remains and the surrounding context, archaeological origins cannot be entirely discounted.

6.2.3 ***Agricultural – Ridge and Furrow***

6.2.3.1 Broad and parallel linear anomalies are visible in the south-west of the data in Site 1 which are due to historic ridge and furrow cultivation. The ploughing is visible in the LiDAR data plot (see Figure 15).

6.3 **Site 2**

6.3.1 ***Uncertain***

6.3.1.1 Linear trends, pit like responses and a circular area of increased response have been detected in Site 2 and have been assigned to the category of *Uncertain*. They generally lack the defined morphology of anomalies that would ordinarily be interpreted as being of archaeological interest. However, a series of cropmarks have been recorded within Area 2 (see 5.3.8); consequently, archaeological origins for the responses cannot be entirely discounted.

6.4 **Site 3**

6.4.1 ***Probable / Possible Archaeology***

6.4.1.1 A number of ditch-like anomalies, linear trends and broad curvilinear responses have been detected in Site 3 which appear to mark the eastern and southern extend of a large enclosure which is visible as cropmarks on aerial imagery (see Figure 15) and that are recorded in the HER (14642). A linear trend [6] and a ditch-like anomaly [7] to the south-east could be an extension of the enclosure as they appear be on the same alignment.

6.4.2 ***Uncertain***

6.4.2.1 Bands of increased magnetic response are visible which appear to form a rectilinear pattern [8] which could indicate an enclosure; however, the responses very weak. They could be due to natural processes.

6.4.2.2 Other linear and curvilinear trends plus weak pit-like responses have been detected in Site 3 which have also been assigned to the category of *Uncertain*. They generally lack the defined morphology of anomalies that would ordinarily be interpreted as being of archaeological interest. They are likely to be due to underlying natural or agricultural processes. However, archaeological origins cannot be entirely discounted given they are located within a large enclosure.

6.5 **Site 4**

6.5.1 ***Probable / Possible Archaeology***

6.5.1.1 A series of linear anomalies [9] have been detected in Site 4 which have been assigned to the category *Probable* and *Possible Archaeology* dependant on their magnetic strengths. They are likely to be former field boundaries, possibly dating to the Medieval period as they are not visible on available historic mapping. These parcels back onto the Medieval village core of Clophill. They are also visible in the LiDAR data plot (see Figure 16).

6.5.1.2 Three magnetically enhance responses [10] could be thermoremanent in nature (see Figure 23); they could possibly be associated with kilns or similar small scale industrial activity. North-east of Site 4 a medieval tannery was uncovered during excavations; the responses could be an extension of such activity. There are numerous strong anomalies in the immediate area which could indicate wasters or perhaps metalworking slags; however, see paragraph 6.5.4.1 below.

6.5.1.3 A possible irregular shaped enclosure [11] is visible in the south-east of Site 4, it measures 15m by 20m. It has been difficult to interpret giving the increased levels of background noise in the vicinity. At the centre of [11] is a large pit-like response [12], however, it could be a chance alignment.

6.5.1.4 The entire south half of Site 4 contains a plethora of strong magnetic anomalies which could be associated with the Medieval activity mentioned above (6.5.1.2), however, it is possible that dredging of, or past flooding and alluvial deposits from, the adjacent River Flint has contributed to the observed responses.

6.6 ***Ferrous / Magnetic Disturbance***

6.6.1 Numerous ferrous responses have been recorded throughout all four sites. Ferrous responses close to boundaries are due to adjacent fences and gates. Three strong ferrous responses [13] in Site 4 are due to telegraph posts. Smaller scale ferrous anomalies ("iron spikes") are present throughout the data and are characteristic of small pieces of ferrous debris (or brick / tile) in the topsoil; they are commonly assigned a modern origin. Only the most prominent of these are highlighted on the interpretation diagram.

7 **DATA APPRAISAL & CONFIDENCE ASSESSMENT**

7.1 Historic England guidelines (EH 2008) Table 4 states that the typical magnetic response on the local soils / geology is generally good. The results from this survey indicate the presence of ditches, pits, enclosures and responses of possible thermoremanent origin; as a consequence, the survey is deemed to have worked well. However, in places it has been difficult to interpret the responses due to the density of magnetic anomalies.

8 **CONCLUSION**

8.1 In Site 1 the survey has detected a large range of archaeological responses; strong and sinuous ditch-like anomalies appear to be associated with the earlier motte and bailey while weaker rectilinear responses could relate to later phases of activity. No responses, other than ditches, have been recorded which relate to the conjectural manorial site, perhaps suggesting that the feature may have been a simple enclosure, possibly for stock, or a garden and that it was never occupied. Some 40m north of this location magnetic anomalies may indicate the presence of a building; perhaps comprising timber slots and post-holes, although this interpretation is tentative.

8.2 At Site 2 there are no anomalies of definite archaeological interest; however, a number of responses of uncertain origin are present. The results confirm that the quarrying recorded north of the site does not extent as far south as Site 2 as no ground disturbance is visible in the data.

8.3 A number of weak responses of archaeological interest are visible In Site 3 which correspond with cropmarks that are recorded in the HER. The survey has also confirmed quarrying debris does not extend into this area.

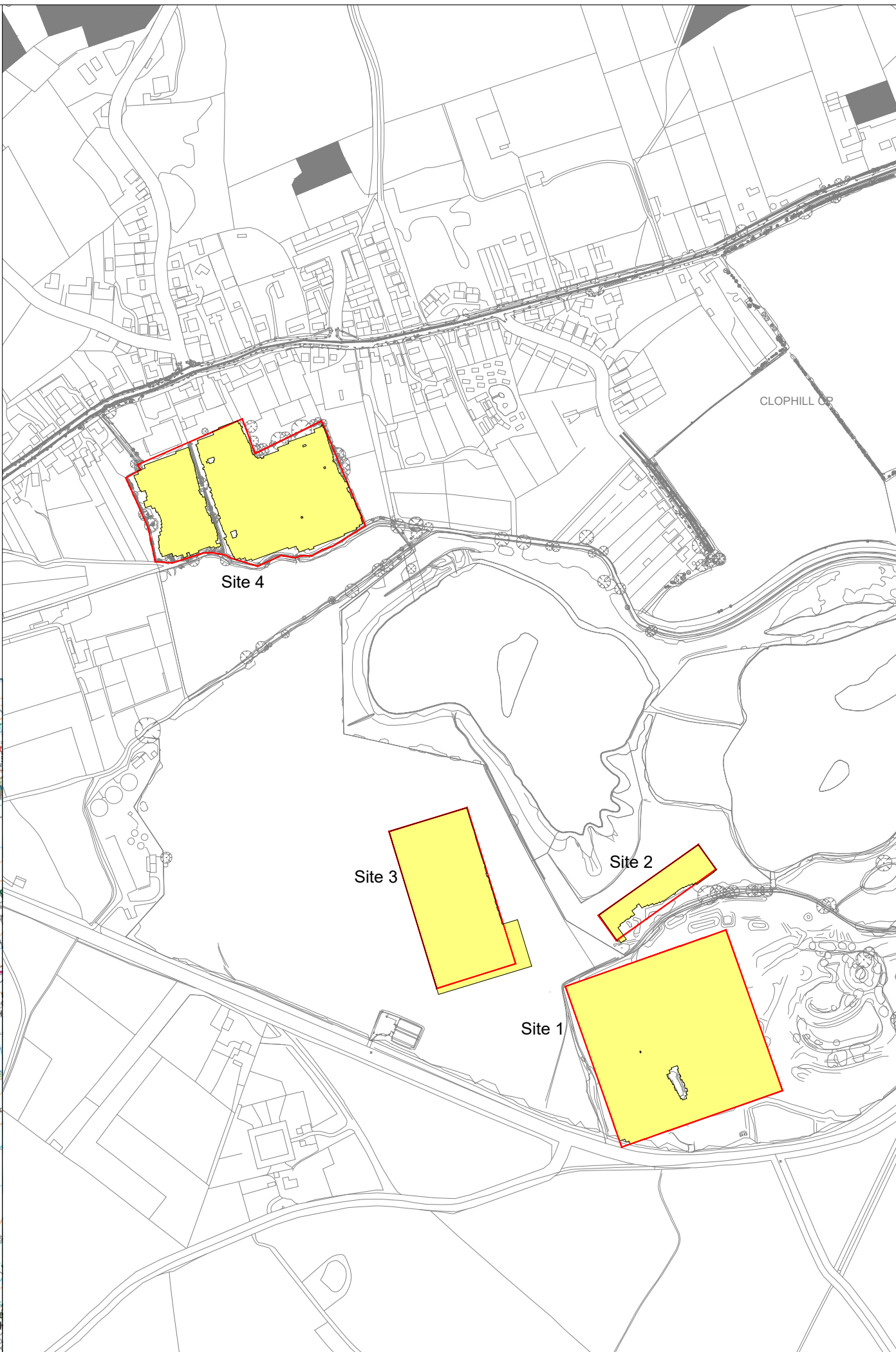
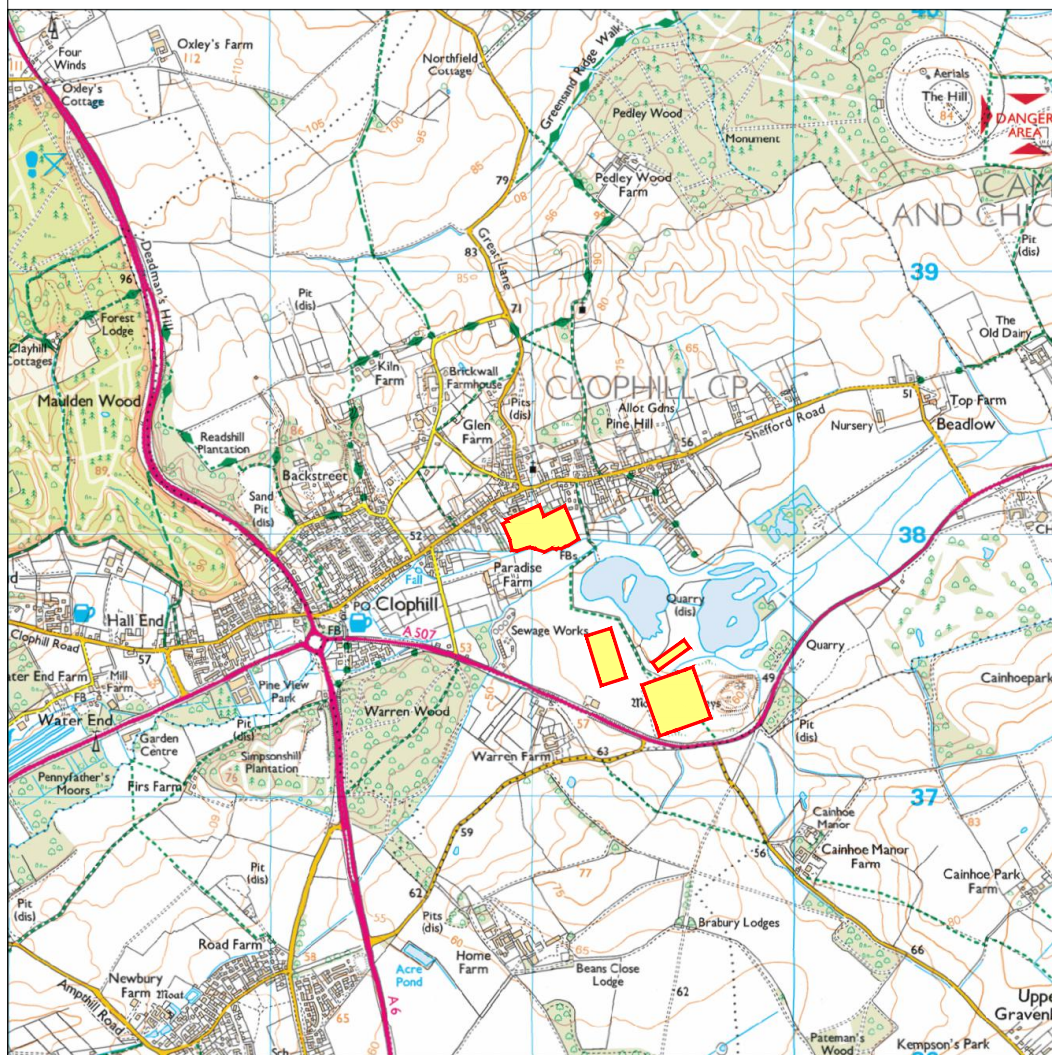
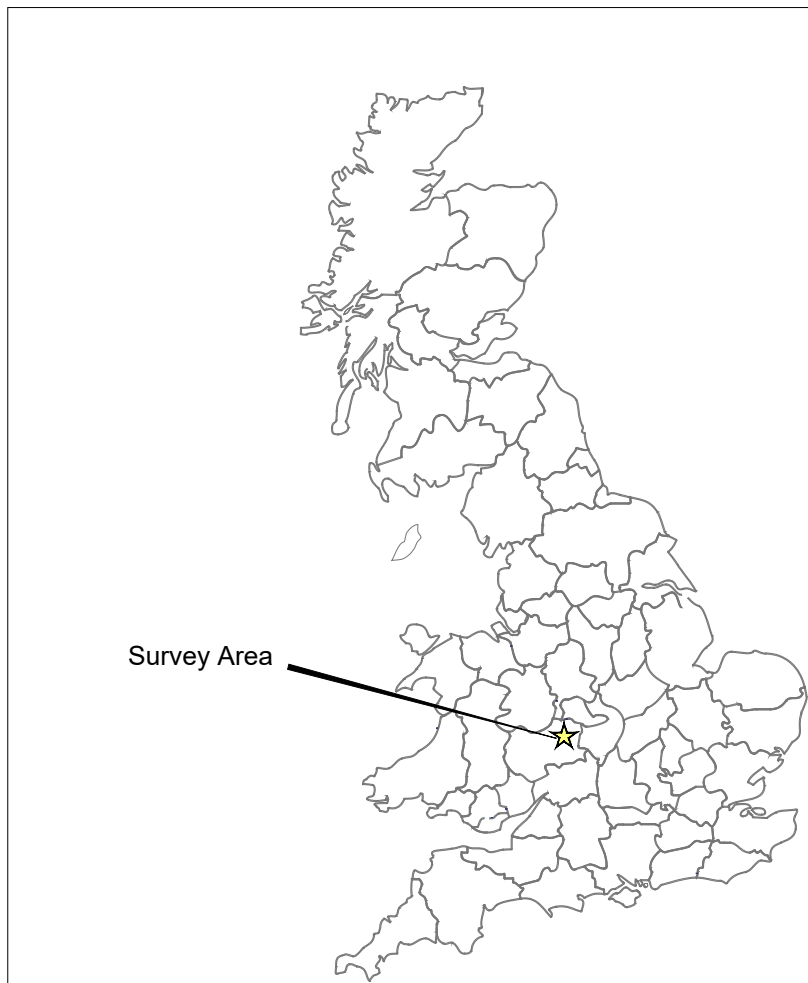
8.4 Numerous magnetic responses of probable and possible archaeological interest have been detected in Site 4. While no archaeological remains are recorded in the HER in this location, it appears that the survey has detected medieval land parcels and possibly associated industrial activity. However, some of the responses could also be due to dredging of the adjacent river.

9 REFERENCES


- AA 2022 *Cainhoe Castle, Clophill, Bedfordshire Monument Management Plan*. Albion Archaeology, Bedford
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Amended 2020 https://www.archaeologists.net/sites/default/files/ClfAS%26GGeophysics_3.pdf
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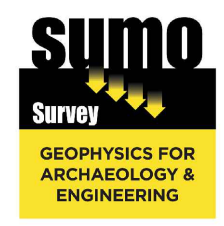
10 ARCHIVE

- 10.1 The minimally processed data, data images, XY traces and a copy of this report are stored in **SUMO Geophysics Ltd.'s** digital archive, on an internal RAID configured NAS drive in the Midlands Office. These data are also backed up to the Cloud for off-site storage.
- 10.2 The Grey Literature will be archived with OASIS and the relevant HER within a period of 12 months.

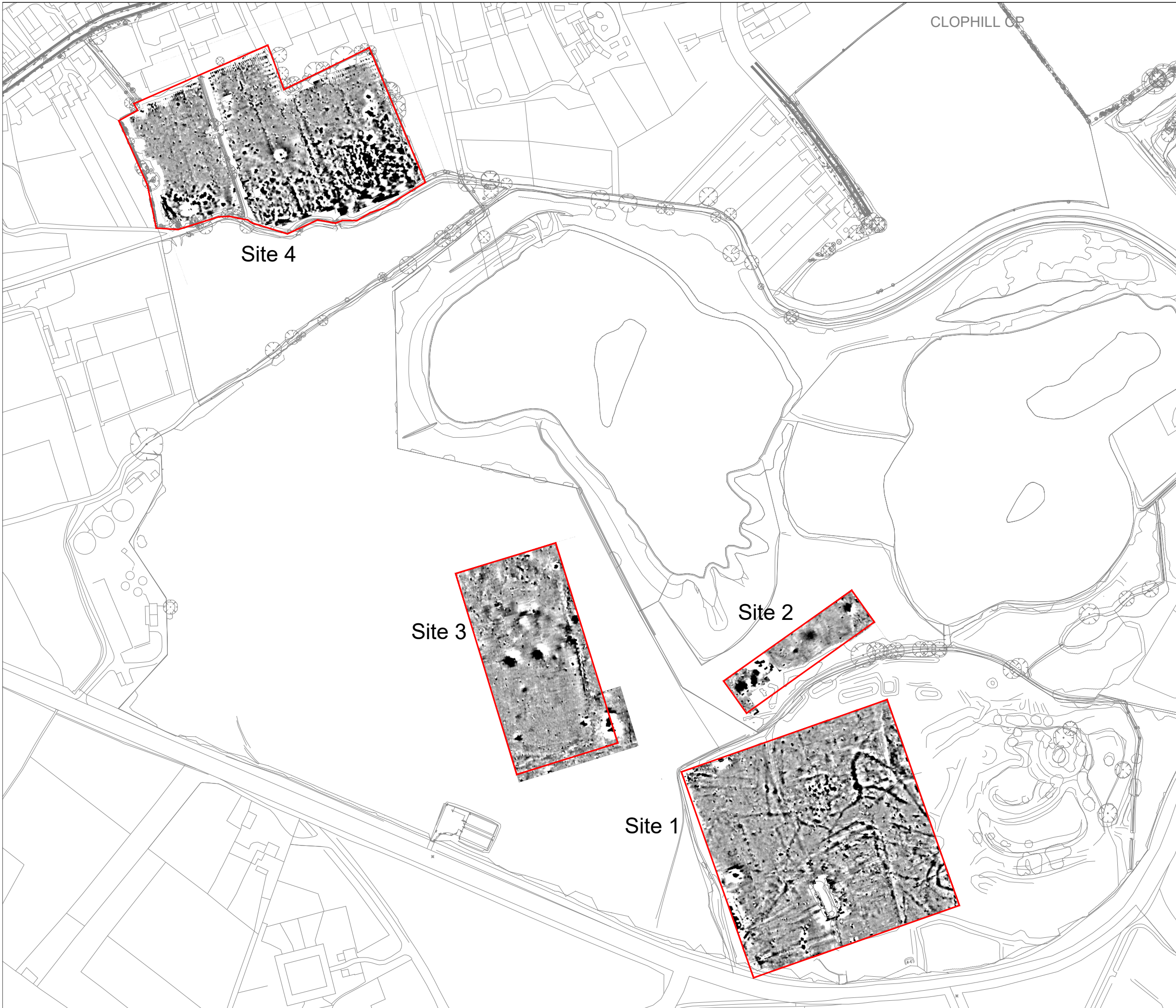


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	Survey Areas	
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Title:	Site Location	
Client:	Albion Archaeology	
Project:	10520 - Cainhoe Castle, Clophill, Bedfordshire	
Scale:	NOT TO SCALE	Fig No: 01



CLOPHILL CP

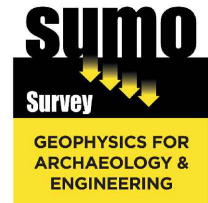
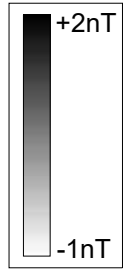


Site 4

Site 3

Site 2

Site 1



Title: Magnetometer Survey - Greyscale Plots (Overview 2nT to -1nT)

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

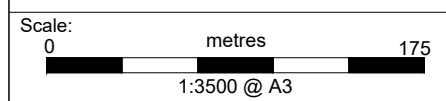


Fig No: 02



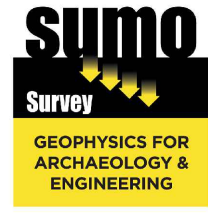
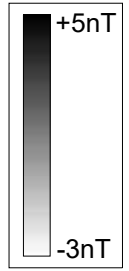
CLOPHILL CP

Site 4

Site 3

Site 2

Site 1



Title: Magnetometer Survey - Greyscale Plots
(Overview - 5nT to -3nT)

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

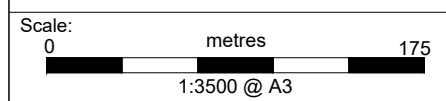
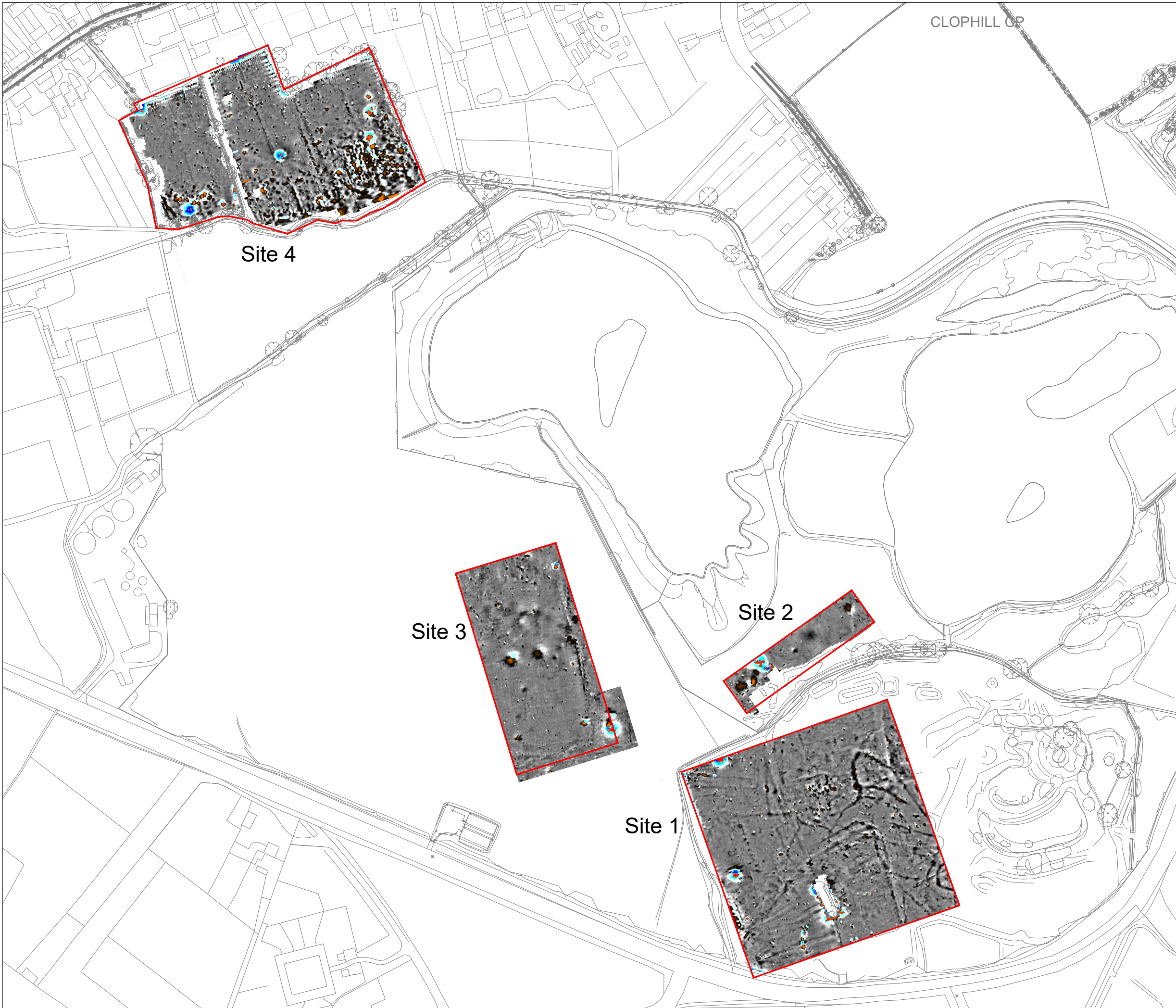


Fig No: 03



CLOPHILL CP

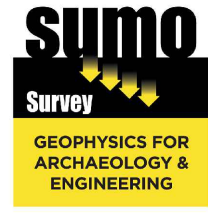
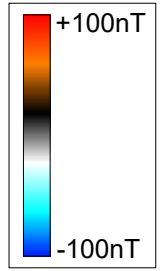


Site 4

Site 3

Site 2

Site 1



Title: Magnetometer Survey - Colour Plots (Overview)

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

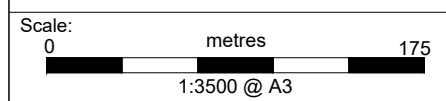


Fig No: 04

CLOPHILL CP



Site 4

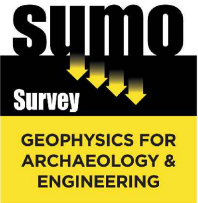
Site 3

Site 2

Site 1

KEY

	Probable archaeology (discrete anomaly / trend / increased response)
	Possible archaeology (discrete anomaly / trend / increased response)
	Uncertain Origin (discrete anomaly / trend / increased response)
	Agriculture (ridge and furrow)
	Ferrous



Title: Magnetometer Survey - Interpretations (Overview)

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

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1:3500 @ A3

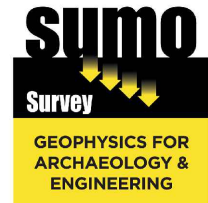
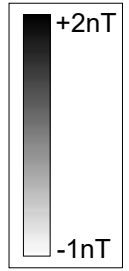
Fig No: 05



Site 3

Site 2

Site 1



Title: Magnetometer Survey - Greyscale Plots (Site 1, 2 & 3 - 2nT to -1nT)

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

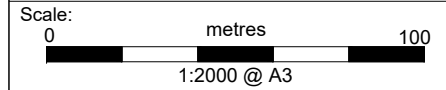
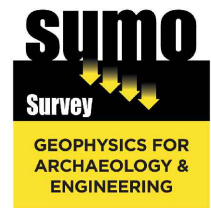
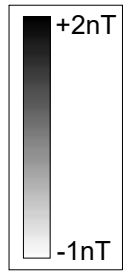


Fig No: 06



Title: Magnetometer Survey - Greyscale Plots
(Site 1, 2 & 3 - 5nT to -3nT)

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

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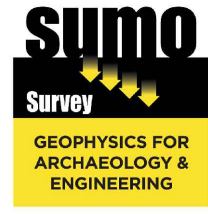
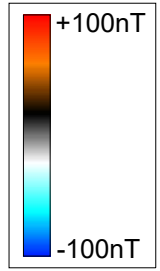
Fig No: 07



Site 3

Site 2

Site 1



Title: Magnetometer Survey - Colour Plots (Site 1, 2 & 3)

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

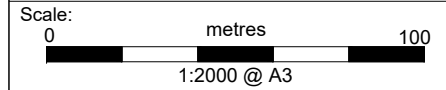


Fig No: 08



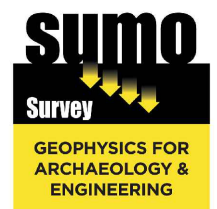
Site 3

Site 2

Site 1

KEY

	Probable archaeology (discrete anomaly / trend / increased response)
	Possible archaeology (discrete anomaly / trend / increased response)
	Uncertain Origin (discrete anomaly / trend / increased response)
	Agriculture (ridge and furrow)
	Ferrous



Title: Magnetometer Survey - Interpretation (Site 1, 2 & 3)

Client: Albion Archaeology

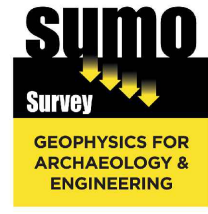
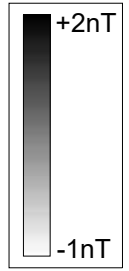
Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale: 0 metres 100
1:2000 @ A3

Fig No: 09



Site 4



Title: Magnetometer Survey - Grayscale Plots
(Site 4 - 2nT to -1nT)

Client: Albion Archaeology

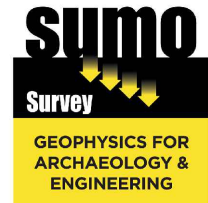
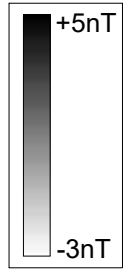
Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale: 0 metres 50
1:1000 @ A3

Fig No: 10



Site 4



Title: Magnetometer Survey - Greyscale Plots
(Site 4 - 5nT to -3nT)

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

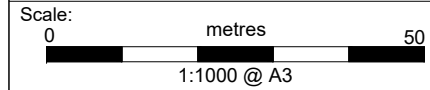
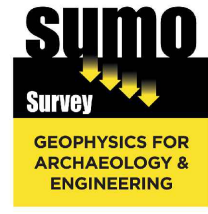
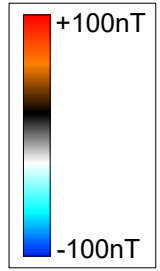


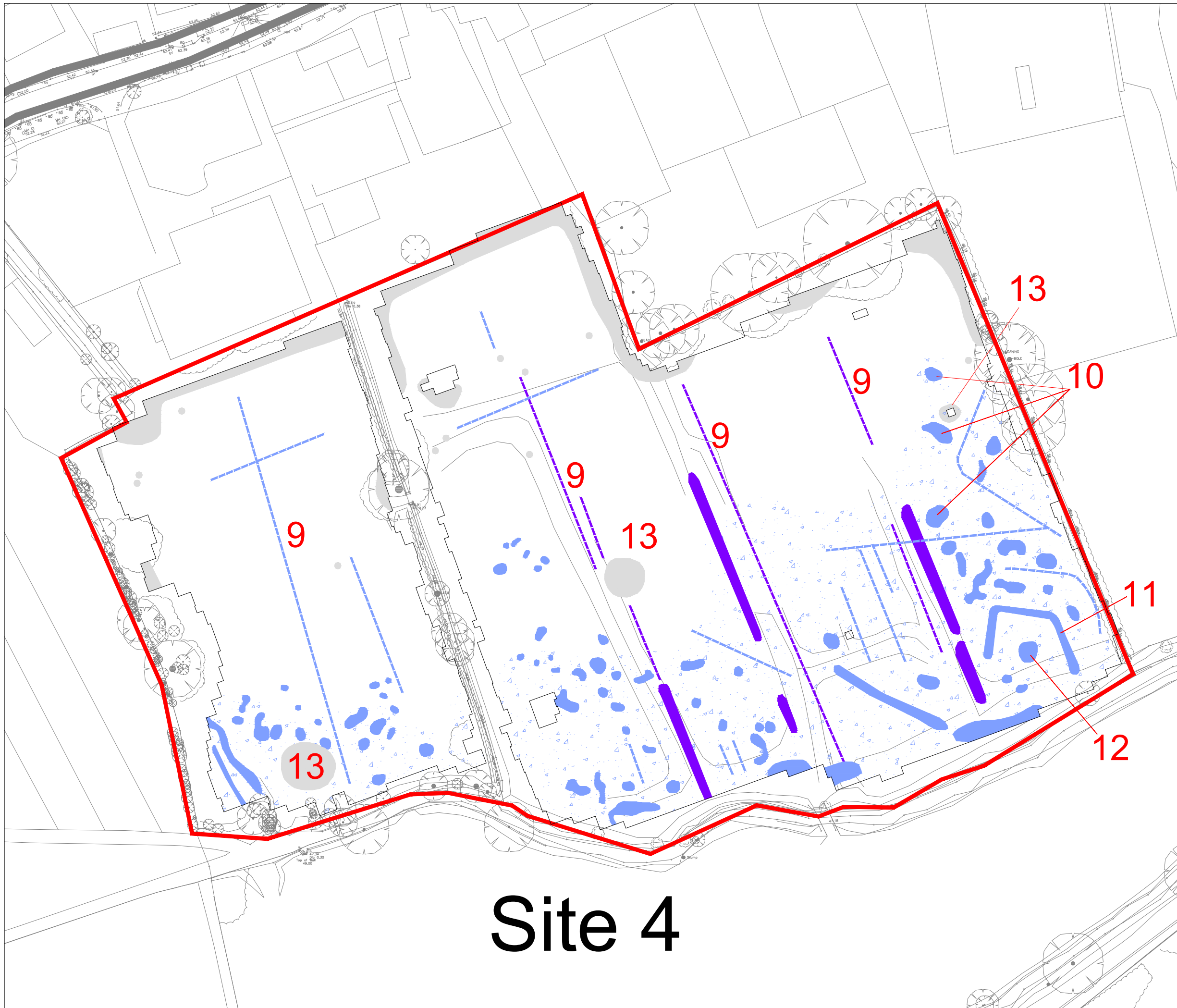
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Site 4

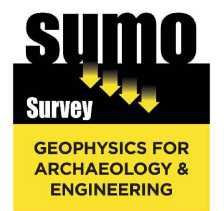


Title: Magnetometer Survey - Colour Plots (Site 4)	
Client: Albion Archaeology	
Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire	
Scale: 0 metres 50 1:1000 @ A3	Fig No: 12



KEY

	Probable archaeology (discrete anomaly / trend / increased response)
	Possible archaeology (discrete anomaly / trend / increased response)
	Uncertain Origin (discrete anomaly / trend / increased response)
	Agriculture (ridge and furrow)
	Ferrous



Title: Magnetometer Survey - Interpretation (Site 4)

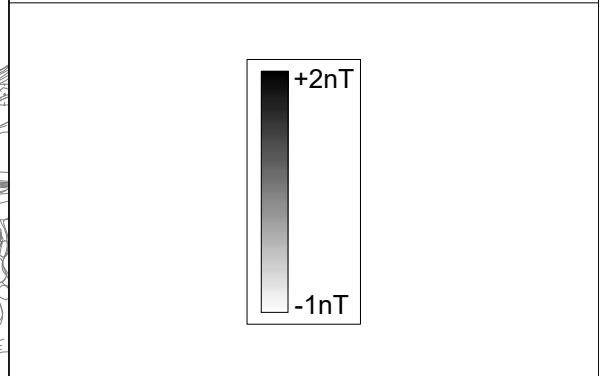
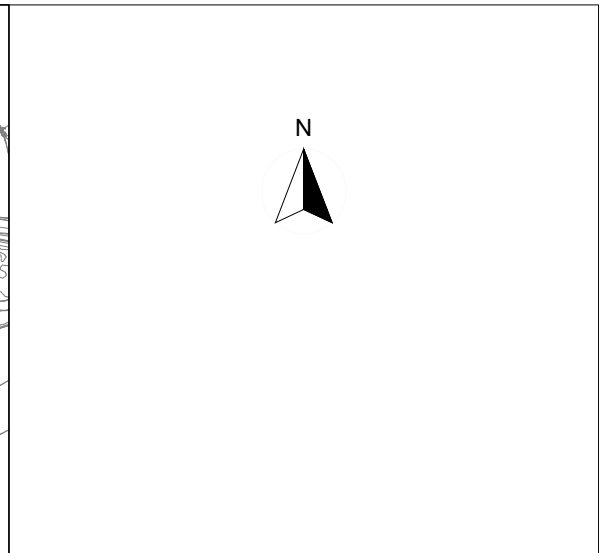
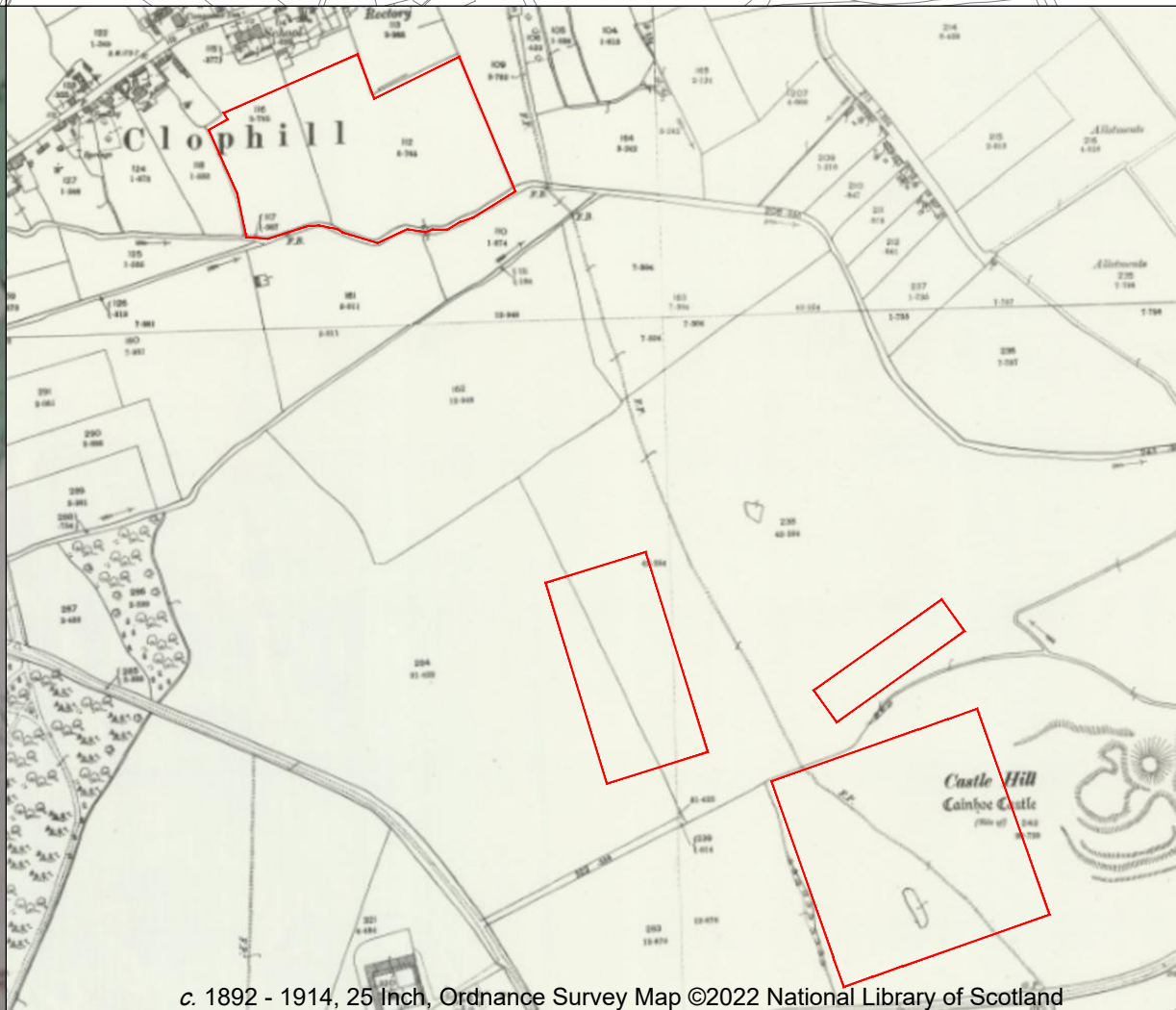
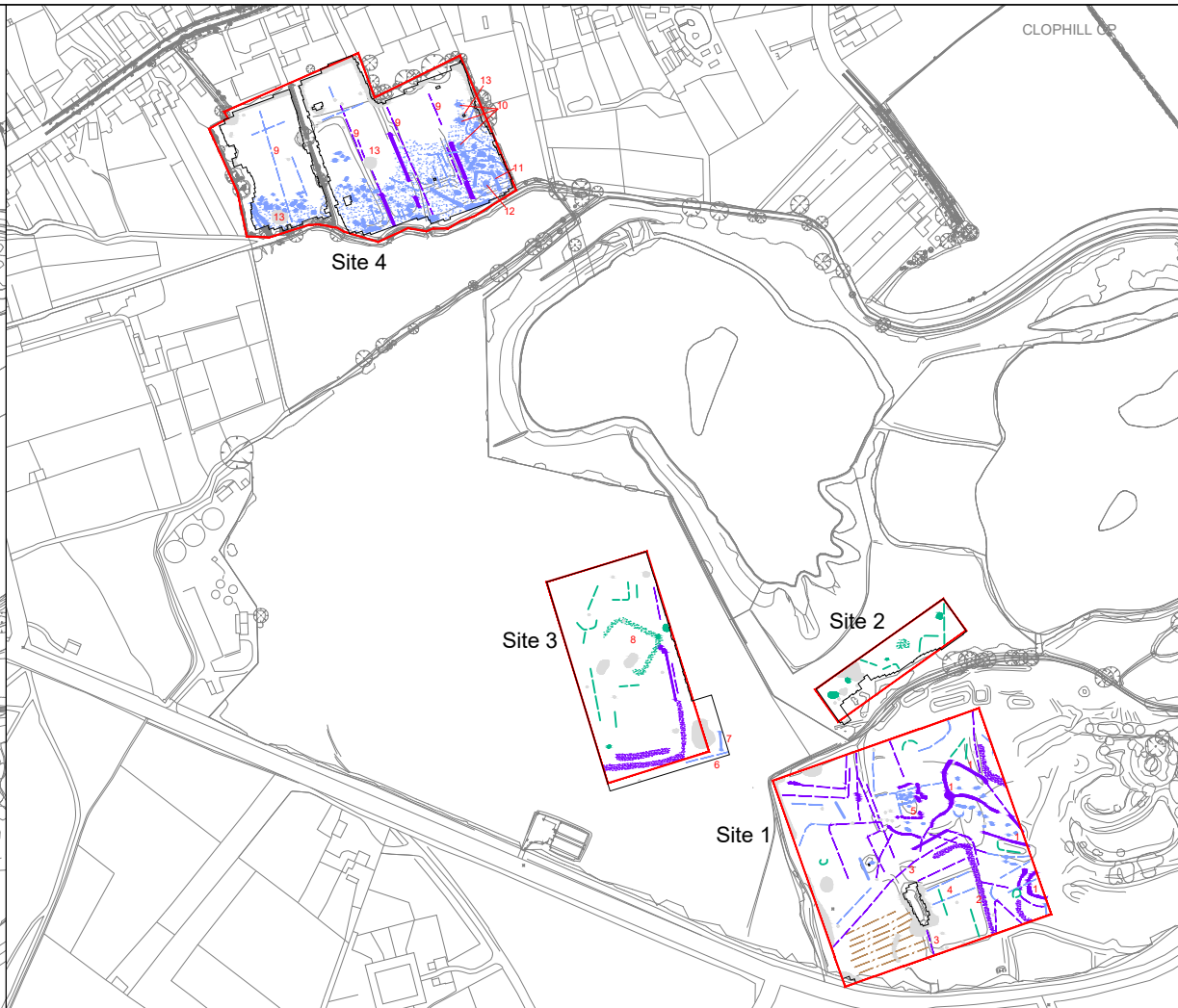
Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale: 0 metres 50
1:1000 @ A3

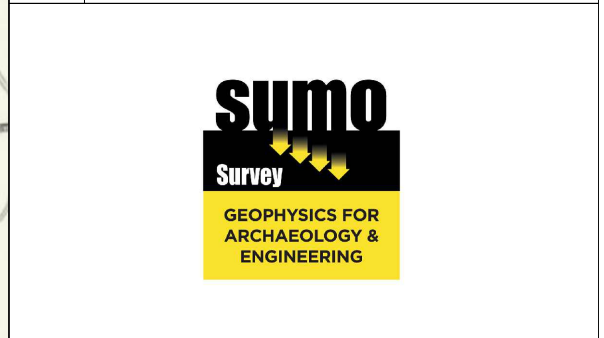
Fig No: 13

Site 4



KEY

	Probable archaeology (discrete anomaly / trend / increased response)
	Possible archaeology (discrete anomaly / trend / increased response)
	Uncertain Origin (discrete anomaly / trend / increased response)
	Agriculture (ridge and furrow)
	Ferrous



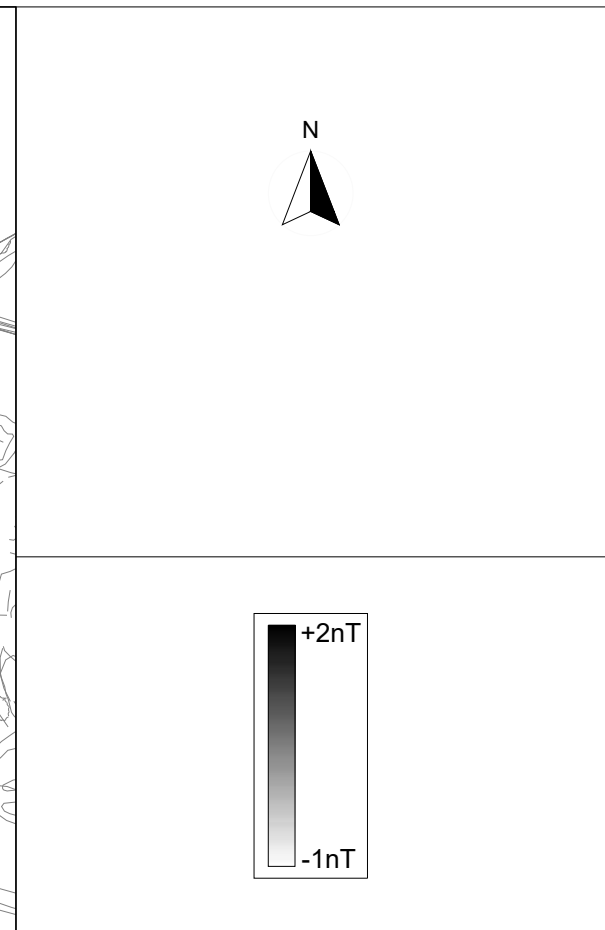
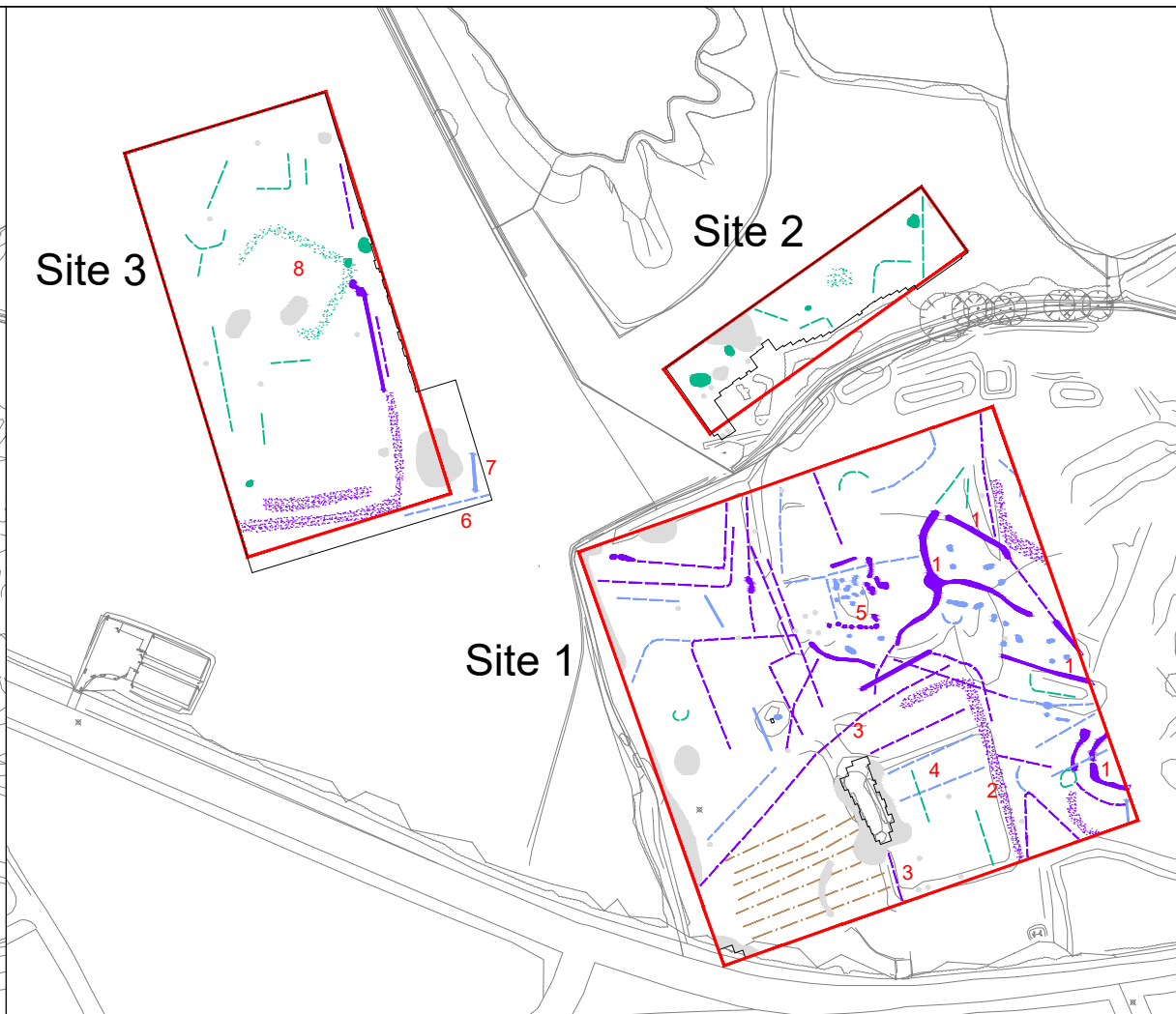
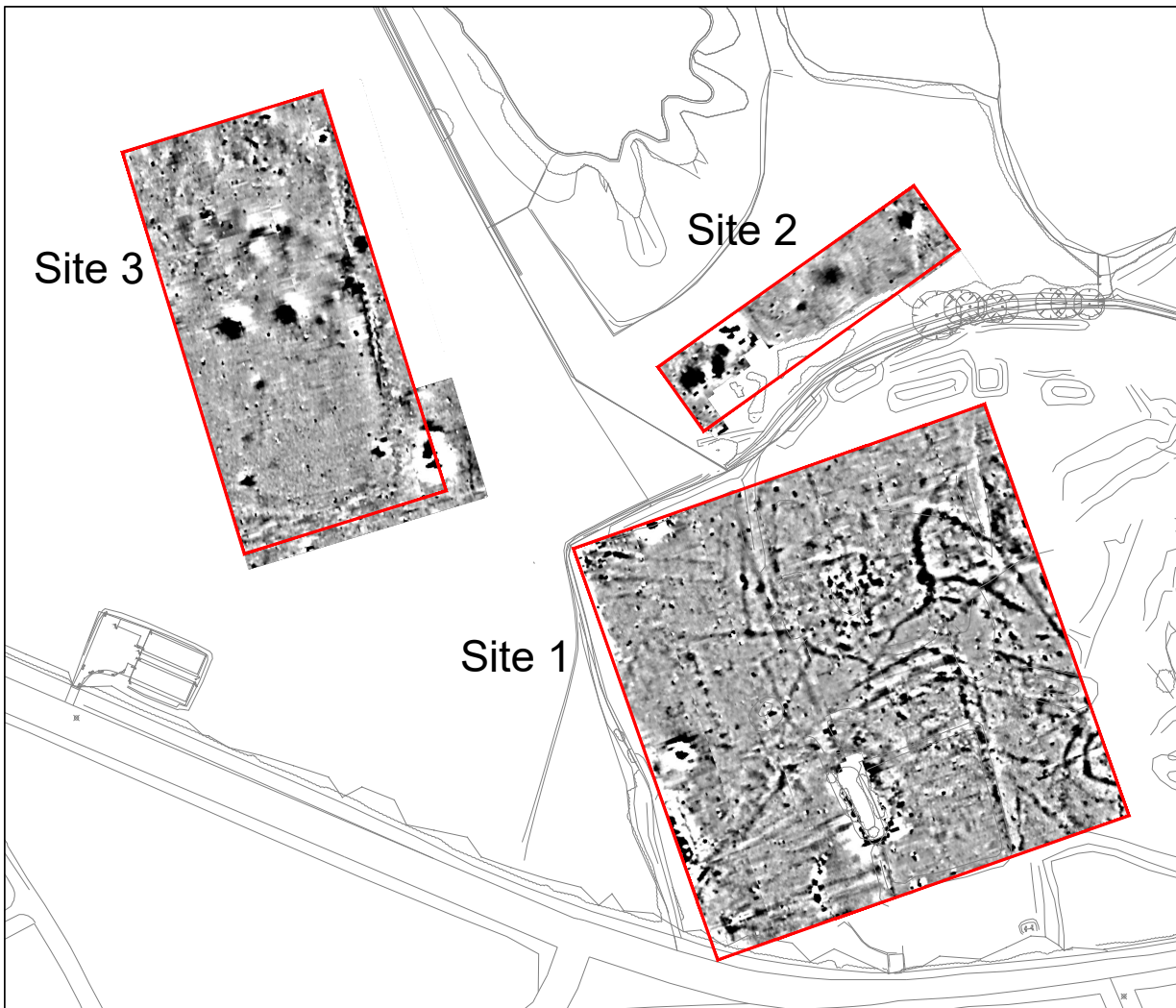
Title: Greyscale Plots / Interpretation / 1826 Pre-Enclosure MAP (2022) / 1892-1914 Ordnance Survey Map

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

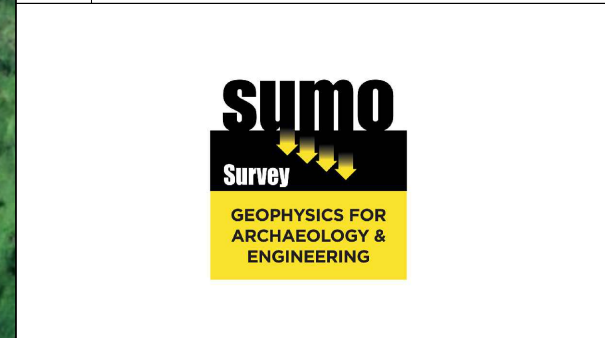
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Fig No: 14



KEY

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	Possible archaeology (discrete anomaly / trend / increased response)
	Uncertain Origin (discrete anomaly / trend / increased response)
	Agriculture (ridge and furrow)
	Ferrous



Title: Greyscale Plots / Interpretation / LiDAR Data Plot / 2002 Aerial Image

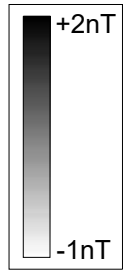
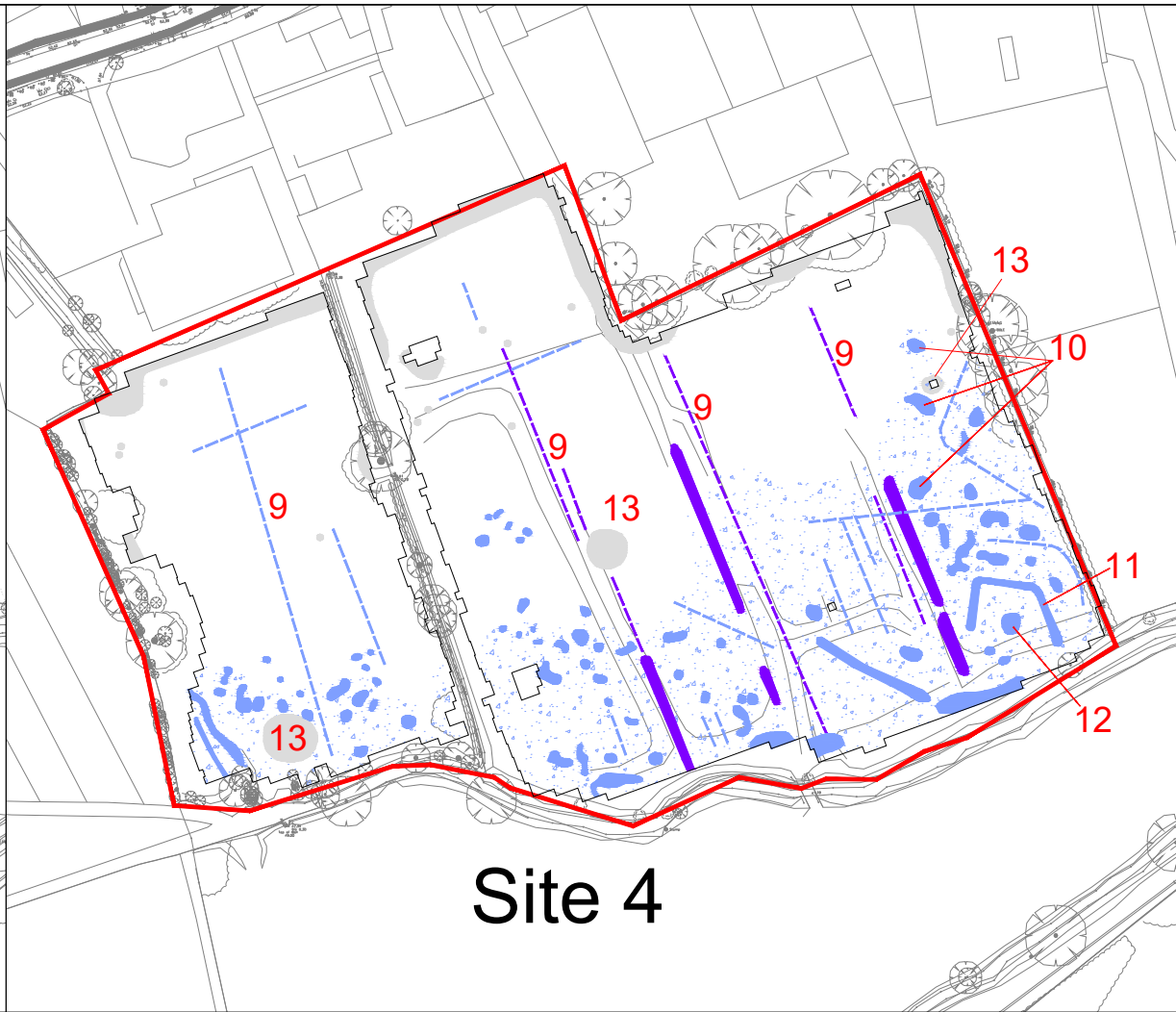
Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale: NOT TO SCALE Fig No: 15

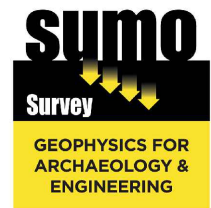
1m DSM data © lidar map

©2022 Google Earth



KEY

	Probable archaeology (discrete anomaly / trend / increased response)
	Possible archaeology (discrete anomaly / trend / increased response)
	Uncertain Origin (discrete anomaly / trend / increased response)
	Agriculture (ridge and furrow)
	Ferrous



Title: Greyscale Plots / Interpretation / LiDAR Data Plot / 2003 Aerial Image

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale: NOT TO SCALE

Fig No: 16



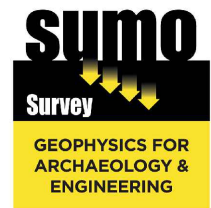
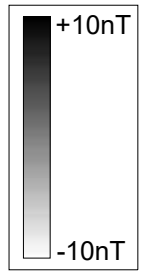
CLOPHILL CP

Site 4

Site 3

Site 2

Site 1



Title: Minimally Processed Data - Greyscale Plots

Client: Albion Archaeology

Project: 10520 - Cainhoe Castle, Clophill, Bedfordshire

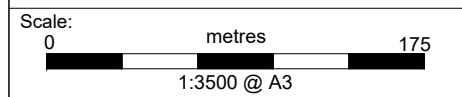


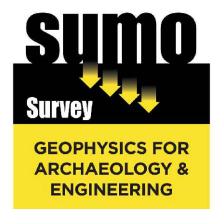
Fig No: 17



Site 3

Site 2

Site 1



Title:
Site 1, 2 & 3 - XY Trace Plots (clipped at +/-15nT)

Client:
Albion Archaeology

Project:
10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale:
0 metres 100
1:2000 @ A3

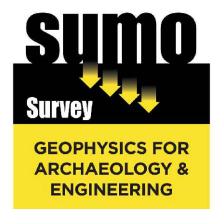
Fig No:
18



Site 3

Site 2

Site 1



Title:
Site 1, 2 & 3 - XY Trace Plots (clipped at +/-50nT)

Client:
Albion Archaeology

Project:
10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale:
0 metres 100
1:2000 @ A3

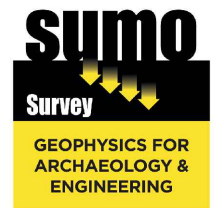
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19



Site 3

Site 2

Site 1



Title:
Site 1, 2 & 3 - XY Trace Plots (clipped at +/-100nT)

Client:
Albion Archaeology

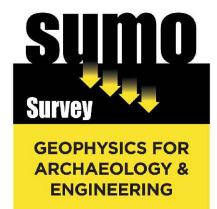
Project:
10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale:
0 metres 100
1:2000 @ A3

Fig No:
20



Site 4



Title:
Site 4 - XY Trace Plots (clipped at +/-15nT)

Client:
Albion Archaeology

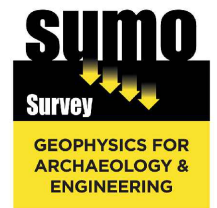
Project:
10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale:
0 metres 50
1:1000 @ A3

Fig No:
21



Site 4



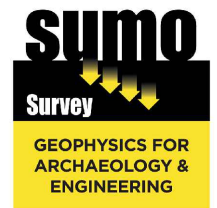
Title:
Site 4 - XY Trace Plots (clipped at +/-50nT)

Client:
Albion Archaeology

Project:
10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale:
0 metres 50
1:1000 @ A3

Fig No:
22



Title:
Site 4 - XY Trace Plots (clipped at +/-100nT)

Client:
Albion Archaeology

Project:
10520 - Cainhoe Castle, Clophill, Bedfordshire

Scale:
0 metres 50
1:1000 @ A3

Fig No:
23

Site 4

Appendix A - Technical Information: Magnetometer Survey Method

Grid Positioning

For hand held gradiometers the location of the survey grids has been plotted together with the referencing information. Grids were set out using a Trimble R8 Real Time Kinematic (RTK) VRS Now GNSS GPS system.

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. This results in an accuracy of around 0.01m.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	Bartington Grad 601-2	1.0m	0.25m
Magnetometer	Bartington Cart System	1.0m	0.125m

Instrumentation:

Bartington instruments operate in a gradiometer configuration which comprises fluxgate sensors mounted horizontally, set 1.0m apart. The fluxgate gradiometer suppresses any diurnal or regional effects. The instruments are carried, or cart mounted, with the bottom sensor approximately 0.1-0.3m from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is measured in nanoTesla (nT). The sensitivity of the instrument can be adjusted; for most archaeological surveys the most sensitive range (0.1nT) is used. Generally, features up to 1m deep may be detected by this method, though strongly magnetic objects may be visible at greater depths.

Bartington Grad 601-2

Hand-Held: Data will be collected using a Bartington Grad 601-2. The instrument consists of two paired sensors and readings are logged at 0.25m centres along traverses 1.0m apart across 30m grids. The collection of data at 0.25m centres provides an appropriate methodology balancing cost and time with resolution as per Historic England guidelines

Bartington Cart System

Data will be collected using a cart carrying four paired Bartington magnetic sensors. Each data point is geographically referenced using an on-board Trimble RTK survey grade GPS system. Readings will be taken at 0.125m centres along traverses 1.0m apart.

Data Processing

Zero Mean	This process sets the background mean of each traverse within each grid to zero.
Traverse	The operation removes striping effects and edge discontinuities over the whole of the data set.
Step Correction (De-stagger)	When gradiometer data are collected in 'zig-zag' fashion, stepping errors can sometimes arise. These occur because of a slight difference in the speed of walking on the forward and reverse traverses. The result is a staggered effect in the data, which is particularly noticeable on linear anomalies. This process corrects these errors.

Display

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

In certain circumstances (usually when there is corroborative evidence from desk-based or excavation data) very specific interpretations can be assigned to magnetic anomalies (for example, *Roman Road, Wall, etc.*) and where appropriate, such interpretations will be applied. The list below outlines the generic categories commonly used in the interpretation of the results.

<i>Archaeology / Probable Archaeology</i>	This term is used when the form, nature and pattern of the responses are clearly or very probably archaeological and /or if corroborative evidence is available. These anomalies, whilst considered anthropogenic, could be of any age.
<i>Possible Archaeology</i>	These anomalies exhibit either weak signal strength and / or poor definition, or form incomplete archaeological patterns, thereby reducing the level of confidence in the interpretation. Although the archaeological interpretation is favoured, they may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.
<i>Industrial / Burnt-Fired</i>	Strong magnetic anomalies that, due to their shape and form or the context in which they are found, suggest the presence of kilns, ovens, corn dryers, metal-working areas or hearths. It should be noted that in many instances modern ferrous material can produce similar magnetic anomalies.
<i>Former Field Boundary (probable & possible)</i>	Anomalies that correspond to former boundaries indicated on historic mapping, or which are clearly a continuation of existing land divisions. Possible denotes less confidence where the anomaly may not be shown on historic mapping but nevertheless the anomaly displays all the characteristics of a field boundary.
<i>Ridge & Furrow</i>	Parallel linear anomalies whose broad spacing suggests ridge and furrow cultivation. In some cases, the response may be the result of more recent agricultural activity.
<i>Agriculture (ploughing)</i>	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
<i>Land Drain</i>	Weakly magnetic linear anomalies, quite often appearing in series forming parallel and herringbone patterns. Smaller drains may lead and empty into larger diameter pipes, which in turn usually lead to local streams and ponds. These are indicative of clay fired land drains.
<i>Natural</i>	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions.
<i>Magnetic Disturbance</i>	Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present.
<i>Service</i>	Magnetically strong anomalies, usually forming linear features are indicative of ferrous pipes/cables. Sometimes other materials (e.g. pvc) or the fill of the trench can cause weaker magnetic responses which can be identified from their uniform linearity.
<i>Ferrous</i>	This type of response is associated with ferrous material and may result from small items in the topsoil, larger buried objects such as pipes, or above ground features such as fence lines or pylons. Ferrous responses are usually regarded as modern. Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.
<i>Uncertain Origin</i>	Anomalies which stand out from the background magnetic variation, yet whose form and lack of patterning gives little clue as to their origin. Often the characteristics and distribution of the responses straddle the categories of <i>Possible Archaeology / Natural</i> or (in the case of linear responses) <i>Possible Archaeology / Agriculture</i> ; occasionally they are simply of an unusual form.

Where appropriate some anomalies will be further classified according to their form (positive or negative) and relative strength and coherence (trend: weak and poorly defined).

Appendix B - Technical Information: Magnetic Theory

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock. Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.1 nanoTeslas (nT) in an overall field strength of 48,000 (nT), can be accurately detected.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremanent* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremanence is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremanent archaeological features can include hearths and kilns; material such as brick and tile may be magnetised through the same process.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried feature. The difference between the two sensors will relate to the strength of a magnetic field created by this feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity and disturbance from modern services.

Summary for sumogeop1-511887

OASIS ID (UID)	sumogeop1-511887
Project Name	Geophysical Survey, Magnetometry Survey at Cainhoe Castle, Clophill, Bedfordshire
Sitename	Cainhoe Castle, Clophill, Bedfordshire
Activity type	Geophysical Survey, Magnetometry Survey, MAGNETOMETRY SURVEY
Project Identifier(s)	10520
Planning Id	
Reason For Investigation	Heritage management
Organisation Responsible for work	SUMO Geophysics Ltd.
Project Dates	08-Dec-2022 - 09-Dec-2022
Location	<p>Cainhoe Castle, Clophill, Bedfordshire</p> <p>NGR : TL 09293 37518 LL : 52.0253178302237, -0.408485673861585 12 Fig : 509293,237518</p> <p>NGR : TL 09546 37524 LL : 52.0253288928859, -0.404800937233851 12 Fig : 509546,237524</p> <p>NGR : TL 09038 38013 LL : 52.0298170558875, -0.412050142301191 12 Fig : 509038,238013</p> <p>NGR : TL 09567 37344 LL : 52.0237072643699, -0.404558205480475 12 Fig : 509567,237344</p>
Administrative Areas	<p>Country : England</p> <p>County : Bedfordshire</p> <p>District : Central Bedfordshire</p> <p>Parish : Clophill</p>
Project Methodology	<p>A temporary grid system was established over the site and marked out using canes. The location of the grid was set out using an RTK GPS system theoretically accurate to some 0.01m and referenced to OS co-ordinates. Data was collected using a cart carrying four paired Bartington magnetic sensors. Four sensors mounted 1m horizontally apart and very accurately aligned to nullify the effects of the earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. Each data point is geographically referenced using an on-board Trimble RTK survey grade GPS system. Readings were taken at 0.125m centres along traverses 1.0m apart. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background.</p>

Project Results	<p>In Site 1 the survey has detected a large range of archaeological responses; strong and sinuous ditch-like anomalies appear to be associated with the earlier motte and bailey while weaker rectilinear responses could relate to later phases of activity. No responses, other than ditches, have been recorded which relate to the conjectural manorial site, perhaps suggesting that the feature may have been a simple enclosure, possibly for stock, or a garden and that it was never occupied. Some 40m north of this location magnetic anomalies may indicate the presence of a building; perhaps comprising timber slots and post-holes, although this interpretation is tentative. At Site 2 there are no anomalies of definite archaeological interest; however, a number of responses of uncertain origin are present. The results confirm that the quarrying recorded north of the site does not extent as far south as Site 2 as no ground disturbance is visible in the data. A number of weak responses of archaeological interest are visible In Site 3 which correspond with cropmarks that are recorded in the HER. The survey has also confirmed quarrying debris does not extend into this area. Numerous magnetic responses of probable and possible archaeological interest have been detected in Site 4. While no archaeological remains are recorded in the HER in this location, it appears that the survey has detected medieval land parcels and possibly associated industrial activity. However, some of the responses could also be due to dredging of the adjacent river.</p>
Keywords	<p>Ditch - MEDIEVAL - FISH Thesaurus of Monument Types Pit - MEDIEVAL - FISH Thesaurus of Monument Types Enclosure - MEDIEVAL - FISH Thesaurus of Monument Types Post Hole - MEDIEVAL - FISH Thesaurus of Monument Types Ditched Enclosure - UNCERTAIN - FISH Thesaurus of Monument Types Field Boundary - MEDIEVAL - FISH Thesaurus of Monument Types Kiln - MEDIEVAL - FISH Thesaurus of Monument Types Subrectangular Enclosure - UNCERTAIN - FISH Thesaurus of Monument Types</p>
Funder	
HER	<p>Central Bedfordshire HER - unRev - STANDARD Historic England review - unRev - STANDARD Scheduled Monument Casework - unRev - STANDARD</p>
Person Responsible for work	Thomas, Cockcroft
HER Identifiers	
Archives	

Ms Fiona Sidley
Sumo Geophysics
Vineyard House
Upton Upon Severn
Worcestershire
WR8 0SA

Direct Dial: 01223 582725

Our ref: AA/040700/

Dear Ms Sidley

Ancient Monuments and Archaeological Areas Act 1979 (as amended) section 42 - licence to carry out a geophysical survey

CAINHOE CASTLE: A MOTTE AND BAILEY WITH ASSOCIATED MOATED SITE, FISHPONDS AND FIELD SYSTEM

Case No:SL00234396

Monument no: 1009248

I refer to your application dated 9 November 2022, to carry out a geophysical survey at the above site.

Historic England is empowered to grant licences for such activity and I can confirm that we are prepared to do so as set out below.

By virtue of powers contained in section 42 of the 1979 Ancient Monuments and Archaeological Areas Act (as amended by the National Heritage Act 1983) Historic England hereby grants permission for geophysical survey of CAINHOE CASTLE: A MOTTE AND BAILEY WITH ASSOCIATED MOATED SITE, for the areas shown on the map that accompanied your application (copy attached). This permission is subject to the following conditions.

1. The permission shall only be exercised by Fiona Sidley, and/or her nominated representatives and by no other person. It is not transferable to another individual.
2. The permission shall commence on 5th December 2022 and shall cease to have effect on 16th December 2022.
3. A full report summarising the results of the geophysical survey and their interpretation shall be sent in hard copy to Tom Goodman (Brooklands, 24 Brooklands Avenue, Cambridge, CB2 8BU) and electronic (pdf) format to slawek.ustrata@historicengland.org.uk, copied to Paul.Linford@HistoricEngland.org.uk; no later than 2 months after the completion of the survey.
4. The enclosed questionnaire shall be completed and appended to the survey report. For convenience an electronic version of this questionnaire can be downloaded from <http://HistoricEngland.org.uk/advice/technical-advice/archaeological-science/geophysics>.
5. A copy of the report shall also be sent (in their preferred format) to the local Historic Environment Record (HER). The local HER's contact details can be found at <http://www.heritagegateway.org.uk/gateway/chr/default.aspx>.

6. A record signposting your investigation shall be made with the Archaeology Data Service using their online OASIS Data Collection form no later than 2 months after completion of the survey. Please see <http://oasis.ac.uk/> for details or contact oasis@HistoricEngland.org.uk for information and training.

This letter does not carry any consent or approval required under any enactment, bye-law, order or regulation other than section 42 of the 1979 Act (as amended).

You are advised that the person nominated under this licence to carry out the activity should keep a copy of this licence in their possession in case they should be challenged whilst on site.

Yours sincerely

Slawek Utrata

Inspector of Ancient Monuments

E-mail: slawek.utrata@historicengland.org.uk

cc. Hannah Firth (Central Bedfordshire Council Archaeologist)

Historic England Geophysical Survey Summary Questionnaire

Survey Details

Name of Site: CAINHOE CASTLE: A MOTTE AND BAILEY WITH ASSOCIATED MOATED SITE, FISHPONDS AND FIELD SYSTEM

County: Bedfordshire

NGR Grid Reference (Centre of survey to nearest 100m): TL 09667 37355

Start Date: 8 December 2022 **End Date:** 9 December 2022

Geology at site (Drift and Solid):

Bedrock: Woburn Sands Formation - Sandstone.

Superficial: Oadby Member – Diamicton / Head - Clay, silt, sand and gravel

Known archaeological Sites/Monuments covered by the survey

(Scheduled Monument No. or National Archaeological Record No. if known)

Case No:SL00234396

Monument no: 1009248

Archaeological Sites/Monument types detected by survey

(Type and Period if known. "?" where any doubt).

Numerous magnetic responses have been recorded in the SM which are of archaeological interest, though it has been difficult to interpret the responses in respect of whether they are castle or manorial in date. However, several well-defined and sinuous ditch-like responses have been detected. These could be associated with the motte and bailey castle as they generally follow the earthworks of the main monument. With regards to the moated manorial site, the broad ditch-like response and trends appear to correspond with the surrounding earthworks. However, only weak linear trends have been recorded in the in the centre suggesting the absence of a substantial building. In fact, the 'internal' responses appear more akin to ridge and furrow cultivation rather than ditches. Several magnetically stronger pit-like responses and ditch-like anomalies have been detected which appear to form a rectangular feature which measures some 20m by 30m with further pit-like responses 'inside'. It is tempting to interpret the complex as a possible building, perhaps comprising of post-holes and timber slots; though, it is not possible to say whether these mark the location of a manorial structure. Numerous other trends, ditches and pits have been recorded in Site 1 which have been interpreted as being of Probable and Possible Archaeological interest dependant on their magnetic strengths and morphology.



Historic England

Surveyor (Organisation, if applicable, otherwise individual responsible for the survey):
SUMO Geophysics Ltd

Name of Client, if any: The Greensand Trust

Purpose of Survey:

To identify any anomalies of interest within the monument

Location of:

a) Primary archive, i.e. raw data, electronic archive etc:

C:\Users\Tom\Documents\06 Confirmed Projects\SUMO-10520 Clophill\10520-Final report\Data

b) Full Report: C:\Users\Tom\Documents\06 Confirmed Projects\SUMO-10520 Clophill\10520-Final report



Technical Details

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

Type of Survey (Use term from attached list or specify other): Detailed magnetic survey (magnetometry)

Area Surveyed, if applicable (In hectares to one decimal place): 4.4 ha

Traverse Separation, if regular: 1m
Reading/Sample Interval: 0.25m

Type, Make and model of Instrumentation: Bartington Grad 601-2

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



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

List of terms for Survey Type

Magnetometer (includes gradiometer)

Resistivity

Resistivity Profile

Magnetic Susceptibility

Electro-Magnetic Survey

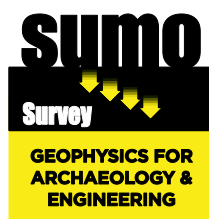
Ground Penetrating Radar

Other (please specify)



List of terms for Land Use:

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



- Archaeological
- Geophysical
- Laser Scanning
- Measured Building
- Topographic
- Utility Mapping

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