Geophysical Survey Report

of

Castle Hill Flood Alleviation Scheme – Cropmark Investigation

For

JBAB

On Behalf Of

The Environment Agency

Magnitude Surveys Ref: MSTA819B

December 2020

Unit 17, Commerce Court

Challenge Way

Bradford

BD4 8NW

01274 926020

info@magnitudesurveys.co.uk

Report By:

Liz Topping BSc MSc

Lydia Jones BA MSc

Report Approved By:

Dr Kayt Armstrong MCIfA

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Abstract

Magnitude Surveys was commissioned to assess the subsurface archaeological potential of a c.10.36ha area of land at Bransholme. Due to waterlogging and heavy ploughing c.1.5ha was unsurveyable. A fluxgate gradiometer survey was successfully completed across the remaining survey area. The geophysical survey has primarily detected amorphous natural variations likely related to undulations in the underlying glacial till, alluvial deposits and high groundwater. No anomalies indicative of archaeology have been detected. Anomalies of an agricultural origin have been detected in the form of modern ploughing trends and drainage features. The impact of modern activity on the results in generally limited to an area of debris in the north, a service along the eastern boundary and overhead cables in the south west.

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1. Introduction

1.1. Magnitude Surveys Ltd (MS) was commissioned by JBAB on behalf of The Environment Agency to undertake a geophysical survey on a c.10.36ha area of land near to Bransholme, Kingston upon Hull, East Riding of Yorkshire, TA 12422 35085.

1.2. The geophysical survey comprised hand-carried GNSS-positioned fluxgate gradiometer survey.

1.3. The survey was conducted in line with the current best practice guidelines produced by Historic England (David et al., 2008), the Chartered Institute for Archaeologists (CIfA, 2014) and the European Archaeological Council (Schmidt et al., 2015).

1.4. The survey commenced on 07/12/2020 and took two days to complete.

2. Quality Assurance

2.1. Magnitude Surveys is a Registered Organisation of the Chartered Institute for Archaeologists (CIfA), the chartered UK body for archaeologists, and a corporate member of ISAP (International Society of Archaeological Prospection).

2.2. The directors of MS are involved in cutting edge research and the development of guidance/policy. Specifically, Dr Chrys Harris has a PhD in archaeological geophysics from the University of Bradford, is a Member of CIfA and is the Vice-Chair of the International Society for Archaeological Prospection (ISAP); Finnegan Pope-Carter has an MSc in archaeological geophysics and is a Fellow of the London Geological Society, as well as a member of GeoSIG (CIfA Geophysics Special Interest Group); Dr Kayt Armstrong has a PhD in archaeological geophysics from Bournemouth University, is a Member of CIfA, the Editor of ISAP News, and is the UK Management Committee representative for the COST Action SAGA; Dr Paul Johnson has a PhD in archaeology from the University of Southampton, has been a member of the ISAP Management Committee since 2015, and is currently the nominated representative for the EAA Archaeological Prospection Community to the board of the European Archaeological Association.

2.3. All MS managers have degree qualifications relevant to archaeology or geophysics. All MS field and office staff have relevant archaeology or geophysics degrees and/or field experience.

3. Objectives

3.1. The objective of this geophysical survey was to assess the subsurface archaeological potential of the survey area in advance of groundworks associated with the development of a flood storage area.

4. Geographic Background

4.1. The survey area was located c.540m east of Bransholme (Figure 1). Survey was undertaken across one field under fallow. The survey area was bounded by Castlehill Road to the north, Holderness Drain to the east, a small drain and Carr House Farm to the south and a drain and housing estate to the west (Figure 2). 1.5ha of the survey area was unsurveyable due to waterlogging and heavy plough.

4.2. Survey considerations:

Survey Area	Ground Conditions	Further Notes
1	Flat fallow field	Bounded by an embankment to the north, an embankment and public footpath to the east, hedgerow and a ditch drain to the south and a ditch drain to the west. Telegraph poles and overhead cables were located within the survey area running from the south-eastern corner across the field top the west. Sections of the survey area in the north and south were unsurveyable due to waterlogging and heavy ploughing respectively.

4.1. The underlying geology comprises chalk of the Flamborough Formation. Superficial deposits within the survey area comprise alluvium consisting of clay, silt, sand and gravel (British Geological Survey, 2020).

4.2. The soils consist of loamy and clayey soils of coastal flats with naturally high groundwater (Soilscapes, 2020).

4.3. Previous test pits excavated within the survey area in 2019 identified a peat layer underneath the alluvium (Toop, 2019).

5. Archaeological Background

5.1. The following is a summary of an Archaeological Watching Brief and Geoarchaeological Recording produced by FAS Heritage (Toop, 2019), and an archaeological background within a Written Scheme of Investigation produced by JBA Bentley (Amy, 2020).

5.2. Previous geophysical surveys have been completed by MS in 2018 and 2020 immediately to the east and north east of the survey area. The 2018 survey identified soil changes related to fluvial landforms and some possible archaeological anomalies, although later test pits did not identify any anthropogenic features, and instead suggested these anomalies related to undulations in the underlying superficial geology. The 2020 survey identified natural variations in the soil, agricultural and drainage features and several anomalies with an undetermined origin which may be archaeological in origin (Langston, 2020).

5.3. A Bronze Age barrow is recorded c.327m to the north east of the survey area. Geophysical surveys in 2017 identified rectilinear anomalies to the north of the survey area which were identified as potentially prehistoric in date. Previous test pits excavated within both the survey area and the wider area indicated a buried land surface with peat deposits up to 1.55m in depth. Scientific dating produced a calibrated late Neolithic to Early Bronze Age date for the buried surface, however no artefactual dating evidence was found and macrofossil preservation was poor.

5.4. Iron Age to Romano-British activity has been identified via cropmarks that have been interpreted as a possible trackway and double-ditch which are now underneath Bransholme housing estate c.400m to the west of the survey area. Two hoards of Romano-British coins were recorded in the surrounding area, as well as 3rd century pottery and a lead spindle whorl.

5.5. The scheduled monument of Castle Hill, the site of a medieval castle, is located c.80m to the north of the survey area. It is thought to date from 1200AD and is represented by a single motte with surrounding ditch.

5.6. Modern activity has been identified in the form of the Hull to Hornsea railway which runs immediately to the north of the survey area and was constructed in 1864, as well as various nearby drains and farmsteads.

6. Methodology

6.1. Magnetometer surveys are generally the most cost effective and suitable geophysical technique for the detection of archaeology in England. Therefore, a magnetometer survey should be the preferred geophysical technique unless its use is precluded by any specific survey objectives or the site environment. For this site, no factors precluded the recommendation of a standard magnetometer survey. Geophysical survey therefore comprised the magnetic method as described in the following section.

6.2. Data Collection

6.2.1. Geophysical prospection comprised the magnetic method as described in the following table.

6.2.2. Table of survey strategies:

Method	Instrument	Traverse Interval	Sample Interval
Magnetic	Bartington Instruments Grad-13 Digital Three-Axis Gradiometer	1m	200Hz reprojected to 0.125m

6.2.3. The magnetic data were collected using MS' bespoke hand-carried GNSS-positioned system.

6.2.3.1. MS' hand-carried system was comprised of Bartington Instruments Grad 13 Digital Three-Axis Gradiometers. Positional referencing was through a multi-channel, multi-constellation GNSS Smart Antenna RTK GPS outputting in NMEA mode to ensure high positional accuracy of collected measurements. The RTK GPS is accurate to 0.008m + 1ppm in the horizontal and 0.015m + 1ppm in the vertical.

6.2.3.2. Magnetic and GPS data were stored on an SD card within MS' bespoke datalogger. The datalogger was continuously synced, via an in-field Wi-Fi unit, to servers within MS' offices. This allowed for data collection, processing and visualisation to be monitored in real-time as fieldwork was ongoing.

6.2.3.3. A navigation system was integrated with the RTK GPS, which was used to guide the surveyor. Data were collected by traversing the survey area along the longest possible lines, ensuring efficient collection and processing.

6.3. Data Processing

6.3.1. Magnetic data were processed in bespoke in-house software produced by MS. Processing steps conform to Historic England's standards for "raw or minimally processed data" (see Section 4.2 in David *et al.,* 2008: 11).

Sensor Calibration – The sensors were calibrated using a bespoke in-house algorithm, which conforms to Olsen *et al*. (2003).

Zero Median Traverse – The median of each sensor traverse is calculated within a specified range and subtracted from the collected data. This removes striping effects caused by small variations in sensor electronics.

Projection to a Regular Grid – Data collected using RTK GPS positioning requires a uniform grid projection to visualise data. Data are rotated to best fit an orthogonal grid projection and are resampled onto the grid using an inverse distance-weighting algorithm.

Interpolation to Square Pixels – Data are interpolated using a bicubic algorithm to increase the pixel density between sensor traverses. This produces images with square pixels for ease of visualisation.

6.4. Data Visualisation and Interpretation

6.4.1. This report presents the gradient of the sensors' total field data as greyscale images, as well as the total field data from the lower sensors. The gradient of the sensors minimises external interferences and reduces the blown-out responses from ferrous and other high contrast material. However, the contrast of weak or ephemeral anomalies can be reduced through the process of calculating the gradient. Consequently, some features can be clearer in the respective gradient or total field datasets. Multiple greyscale images of the gradient and total field at different plotting ranges have been used for data interpretation. Greyscale images should be viewed alongside the XY trace plot (Figure 7). XY trace plots visualise the magnitude and form of the geophysical response, aiding in anomaly interpretation.

6.4.2. Geophysical results have been interpreted using greyscale images and XY traces in a layered environment, overlaid against open street maps, satellite imagery, historic maps, LiDAR data, and soil and geology maps. Google Earth (2020) was consulted as well, to compare the results with recent land usages.

6.4.3. Geodetic position of results - All vector and raster data have been projected into OSGB36 (ESPG27700) and can be provided upon request in ESRI Shapefile (.SHP) and Geotiff (.TIF) respectively. Figures are provided with raster and vector data projected against OS Open Data.

7. Results

7.1. Qualification

7.1.1. Geophysical results are not a map of the ground and are instead a direct measurement of subsurface properties. Detecting and mapping features requires that said features have properties that can be measured by the chosen technique(s) and that these properties have sufficient contrast with the background to be identifiable. The interpretation of any identified anomalies is inherently subjective. While the scrutiny of the results is undertaken by qualified, experienced individuals and rigorously checked for quality and consistency, it is often not possible to classify all anomaly sources. Where possible, an anomaly source will be identified along with the certainty of the interpretation. The only way to improve the interpretation of results is through a process of comparing excavated results with the geophysical reports. MS actively seek feedback on their reports, as well as reports from further work, in order to constantly improve our knowledge and service.

7.2. Discussion

7.2.1. The geophysical results are presented in consideration with satellite imagery and historic maps (Figure 6).

7.2.2. A fluxgate gradiometer survey was successfully undertaken across the survey area. The survey has primarily identified anomalies related to natural processes, cultivation and drainage of the land. Modern interference was identified in the form of magnetic disturbance along the edges of the survey area, mainly along the eastern boundary caused by an underground service and across the south western corner of the survey area caused by overhead cables.

7.2.3. No anomalies suggestive of archaeological features were identified.

7.2.4. Natural variations within the underlying geology have been identified across the survey area as sinuous bands of positive anomalies and an enhanced slightly mottled background. These are considered to be reflective of variations in the underlying alluvium deposits caused by naturally high groundwater and undulating glacial till as identified in trial trenching conducted in a field to the east of the survey area (Reeves, 2020).

7.2.5. Parallel narrowly spaced linear trends have been detected across the survey area in two directions (Figure 4) which are characteristic of modern ploughing and are visible in satellite imagery (Figure 6).

7.2.6. Drainage features have been detected across the survey area on various orientations (Figure 5). These have been identified as clay drains, and some potential ditch drains. In the wider area several drains are visible on mapping (Figures 1 and 2), two running along the eastern and southern boundaries of the survey area. Given the high groundwater, underlying deposits of coastal soils and surrounding drains, drainage is a key activity in this area.

7.2.7. A spread of dipolar signals have been detected in the north of the survey area (Figure 4) and are considered to be related to the non-extant railway and/or field boundary.

7.3. Interpretation

7.3.1. General Statements

7.3.1.1. Geophysical anomalies will be discussed broadly as classification types across the survey area. Only anomalies that are distinctive or unusual will be discussed individually.

7.3.1.2. **Magnetic Disturbance** – The strong anomalies produced by extant metallic structures along the edges of the field have been classified as 'Magnetic Disturbance'. These magnetic 'haloes' will obscure the response of any weaker underlying features, should they be present, often over a greater footprint than the structure they are being caused by.

7.3.1.3. **Ferrous (Spike)** – Discrete dipolar anomalies are likely to be the result of isolated pieces of modern ferrous debris on or near the ground surface.

7.3.1.4. **Ferrous/Debris (Spread)** – A ferrous/debris spread refers to a concentration of multiple discrete, dipolar anomalies usually resulting from highly magnetic material such as rubble containing ceramic building materials and ferrous rubbish.

7.3.1.5. **Overhead Cables** – Used to indicate weak magnetic disturbance often appearing as speckled interference caused specifically by overhead cables. While additional anomalies may be visible within this, there is generally slightly reduced clarity.

7.3.2. Magnetic Results - Specific Anomalies

7.3.2.1. **Agricultural (Trend)** – Two agricultural regimes, perpendicular to each other have been identified (Figure 5). These have been detected as narrowly spaced weakly positive linear anomalies running north west to south east and west south west to east north east. These respectively follow the current ploughing regime of the survey area and a previous modern ploughing regime, identified on satellite imagery.

7.3.2.2. **Drainage Feature** – Numerous linear anomalies following different orientations have been identified throughout the survey area. These anomalies exhibit a series of dipolar magnetic signals which are indicative of ceramic field drains. Various other linear anomalies have been detected which exhibit a weak positive magnetic signal and follow various orientations. Some of these anomalies are oriented north west to south east, following the current ploughing regime of the survey area, and are therefore more difficult to distinguish from the anomalies caused by ploughing activity. They have been interpreted as drainage features as they have a slightly stronger signal than the surrounding ploughing trends. They may be the remnants of ploughed out clay drains, and / or ditch drains.

7.3.2.3. **Ferrous (Spread)** – A spread of discrete, strongly magnetic anomalies are located on the northern edge of the survey area. On historic mapping a railway line is recorded running along the northern boundary of the site, and a field boundary is recorded running north to south, through the location of this group of anomalies (Figure 6). It is therefore likely that these anomalies are reflective of debris associated with either or both of these removed features.

7.3.2.4. **Natural (Strong/Weak/Spread)** – Natural variations in the survey area have been detected as bands of strong positive anomalies, weak amorphous positive anomalies and zones of enhanced magnetic background (Figure 4). The sinuous shape and arrangement of these anomalies are characteristic of alluvial deposits (Section 4.3). This interpretation is further supported by test pitting which has been conducted in the immediate surroundings (Reeves, 2020.; Toop, 2019). The 2020 report identified that a previous geophysical survey conducted in 2018 had detected natural variations rather than archaeological anomalies. The natural anomalies detected in this survey are considered to be caused by the recorded irregular and undulating surface of the underlying glacial till, and the alluvium which overlies this. The alluvium was recorded as being progressively drier as it neared the surface and Holderness Drain (Reeves, 2020), although the area has a high groundwater level. While a natural origin is considered likely for all these anomalies, it should be noted that due to known archaeological activity and features within close proximity to the survey area (see section 5), an archaeological origin cannot be fully discounted; discrete archaeological features such as pits can be very difficult to distinguish from natural anomalies in these circumstances.

7.3.2.5. **Service** – A strong dipolar linear anomaly along the northeast boundary of the survey area has been identified and interpretated as a service. It should be noted that the strength of the anomaly could obscure weaker anomalies in the immediate vicinity.

8. Conclusions

8.1. A fluxgate gradiometer survey has successfully been undertaken across the survey area, with c.1.5ha unsurveyable due to ploughing and waterlogging. The geophysical survey has detected a range of different types of anomalies of natural, agricultural and modern origin. No anomalies suggestive of an archaeological origin have been identified. The impact of modern interference is mainly limited to the survey edges including a service running along the eastern boundary.

8.2. Strong natural variations have been detected across the survey area related to the undulating glacial till, deposits of alluvium and high groundwater. This interpretation has been supported by the previous programmes of test pitting conducted in the survey area and immediate surroundings.

8.3. Agricultural and drainage activity has been detected across the survey area in the form of modern ploughing trends, and clay and possible ditch field drains.

9. Archiving

9.1. MS maintains an in-house digital archive, which is based on Schmidt and Ernenwein (2013). This stores the collected measurements, minimally processed data, georeferenced and un-georeferenced images, XY traces and a copy of the final report.

9.2. MS contributes reports to the ADS Grey Literature Library upon permission from the client, subject to any dictated time embargoes.

10. Copyright

10.1. Copyright and intellectual property pertaining to all reports, figures and datasets produced by Magnitude Services Ltd is retained by MS. The client is given full licence to use such material for their own purposes. Permission must be sought by any third party wishing to use or reproduce any IP owned by MS.

11. References

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12. Project Metadata

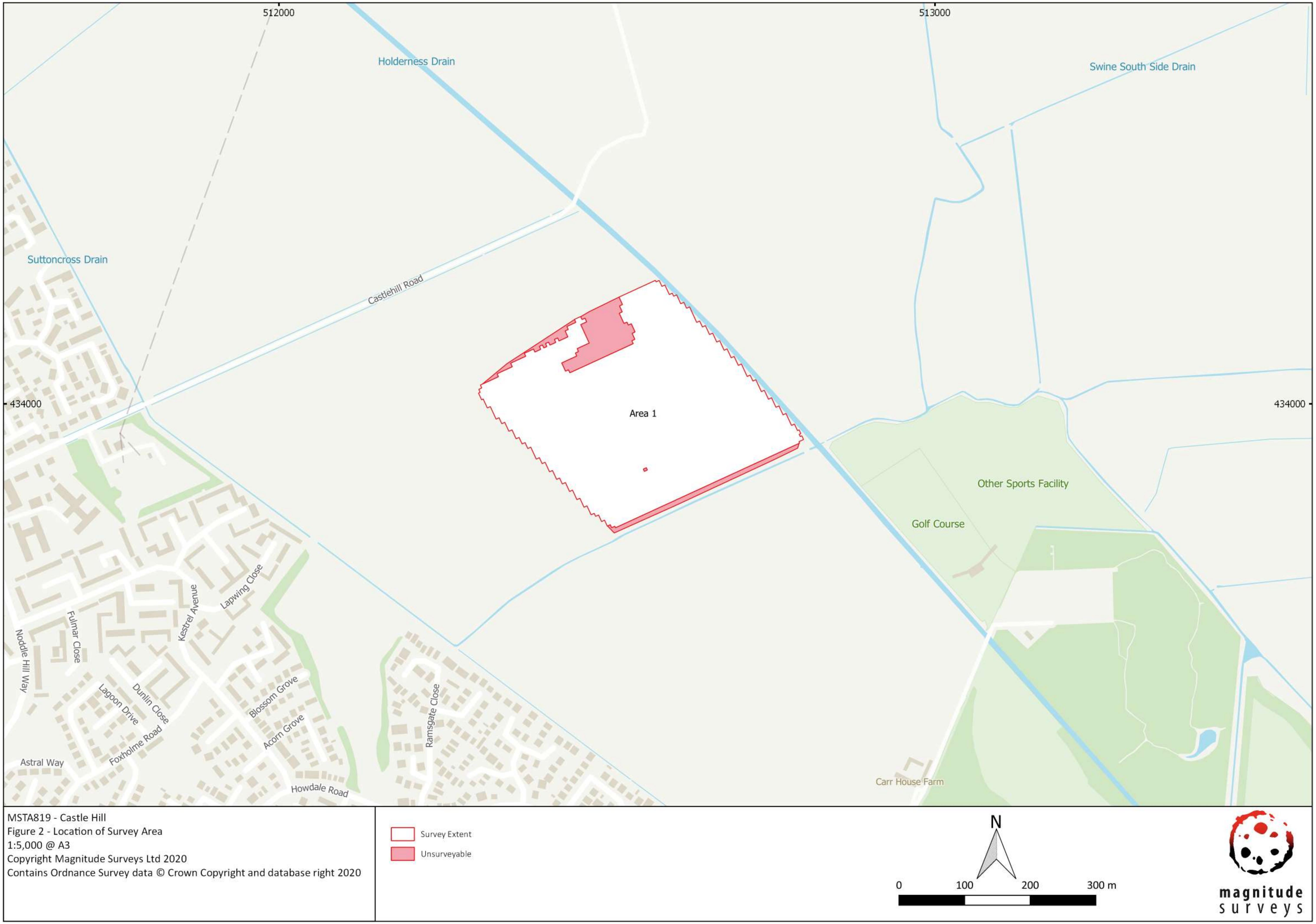
MS Job Code	MSTA819B
Project Name	Castle Hill Flood Alleviation Scheme – Cropmark Investigation
Client	JBAB
Grid Reference	TA 12422 35085
Survey Techniques	Magnetometry
Survey Size (ha)	8.86ha
Survey Dates	2020-12-07 to 2020-12-08
Project Lead	Christian Adams BA MSc
Project Officer	Christian Adams BA MSc
HER Event No	N/A
OASIS No	N/A
S42 Licence No	N/A
Report Version	0.2

13. Document History

Version	Comments	Author	Checked By	Date
0.1	Initial draft for Project Lead to Review	LJ and LT	CA	15 December 2020
0.2	Draft for Director Approval	LJ and LT	KA	15 December 2020

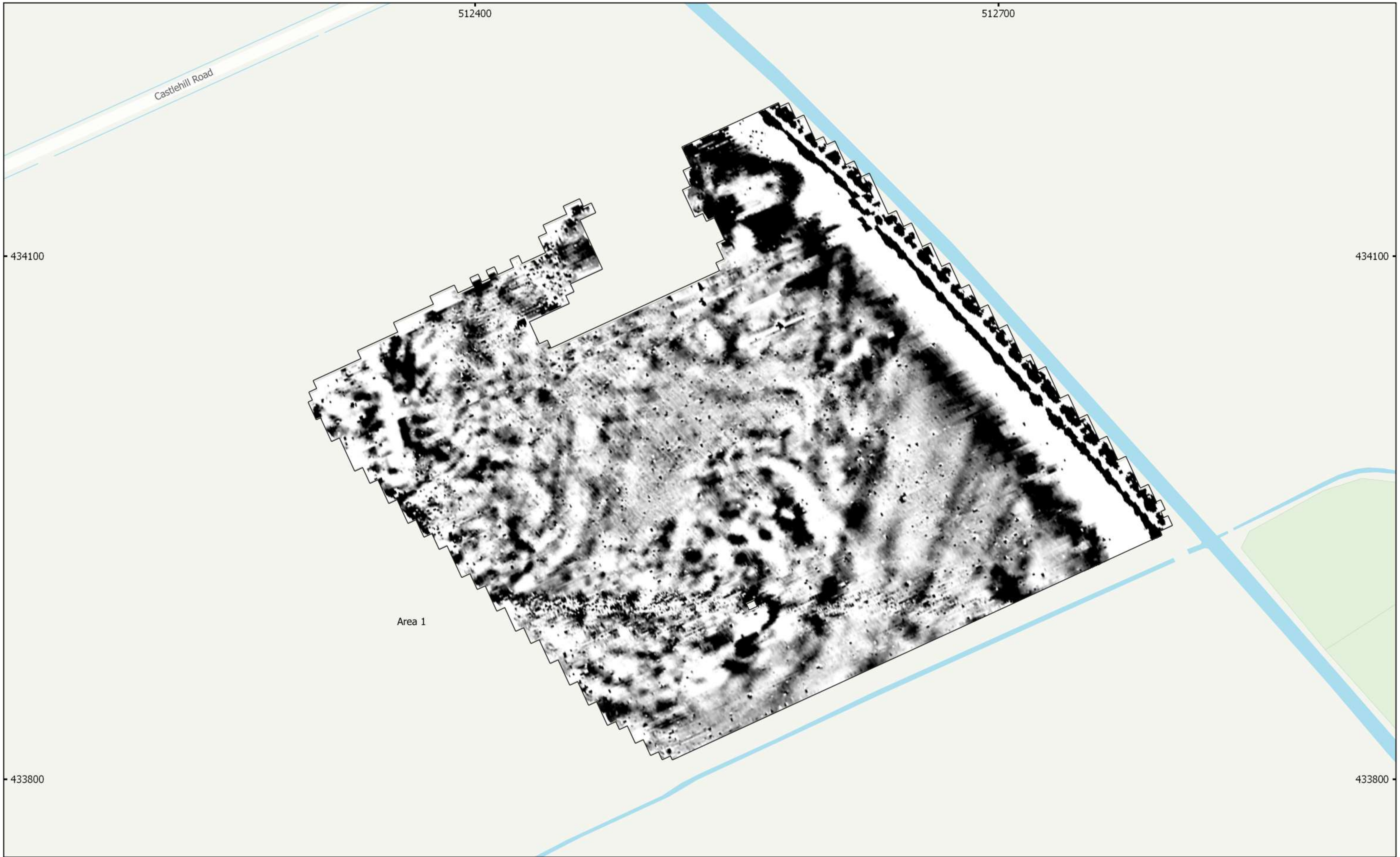
MSTA819 - Castle Hill
Figure 1 - Site Location
1:25,000 @ A4

magnitude surveys



MSTA819 - Castle Hill
Figure 2 - Location of Survey Area
1:5,000 @ A3

magnitude surveys



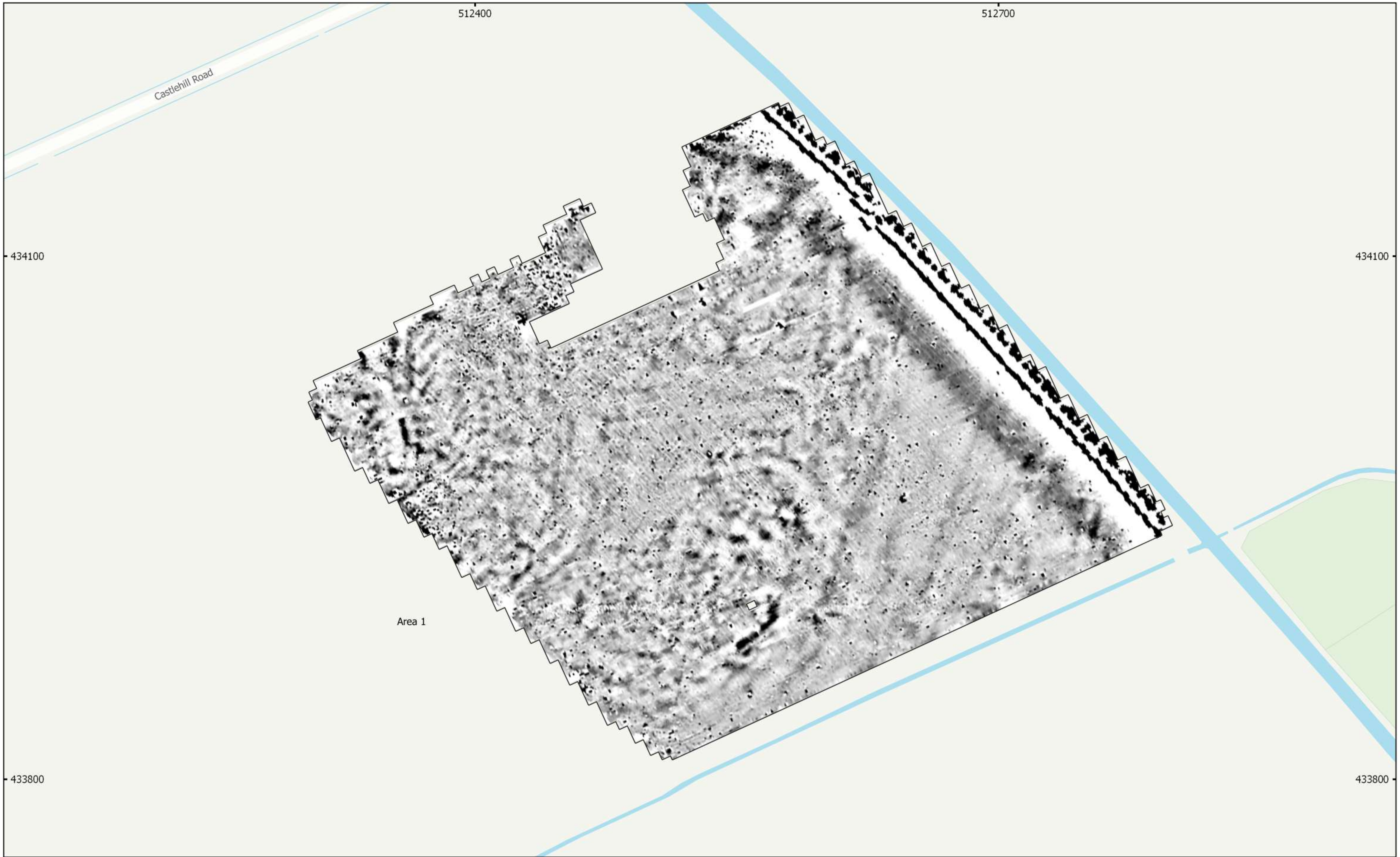
MSTA819 - Castle Hill
Figure 3 - Magnetic Total Field (Lower Sensor)
1:2,000 @ A3

48,997 nT 49,005

N

0 50 100 150 m

magnitude surveys



MSTA819 - Castle Hill
Figure 4 - Magnetic Gradient
1:2,000 @ A3

-1 nT 2

N

0 50 100 150 m

magnitude surveys

MSTA819 - Castle Hill
Figure 5 - Magnetic Interpretation
1:2,000 @ A3

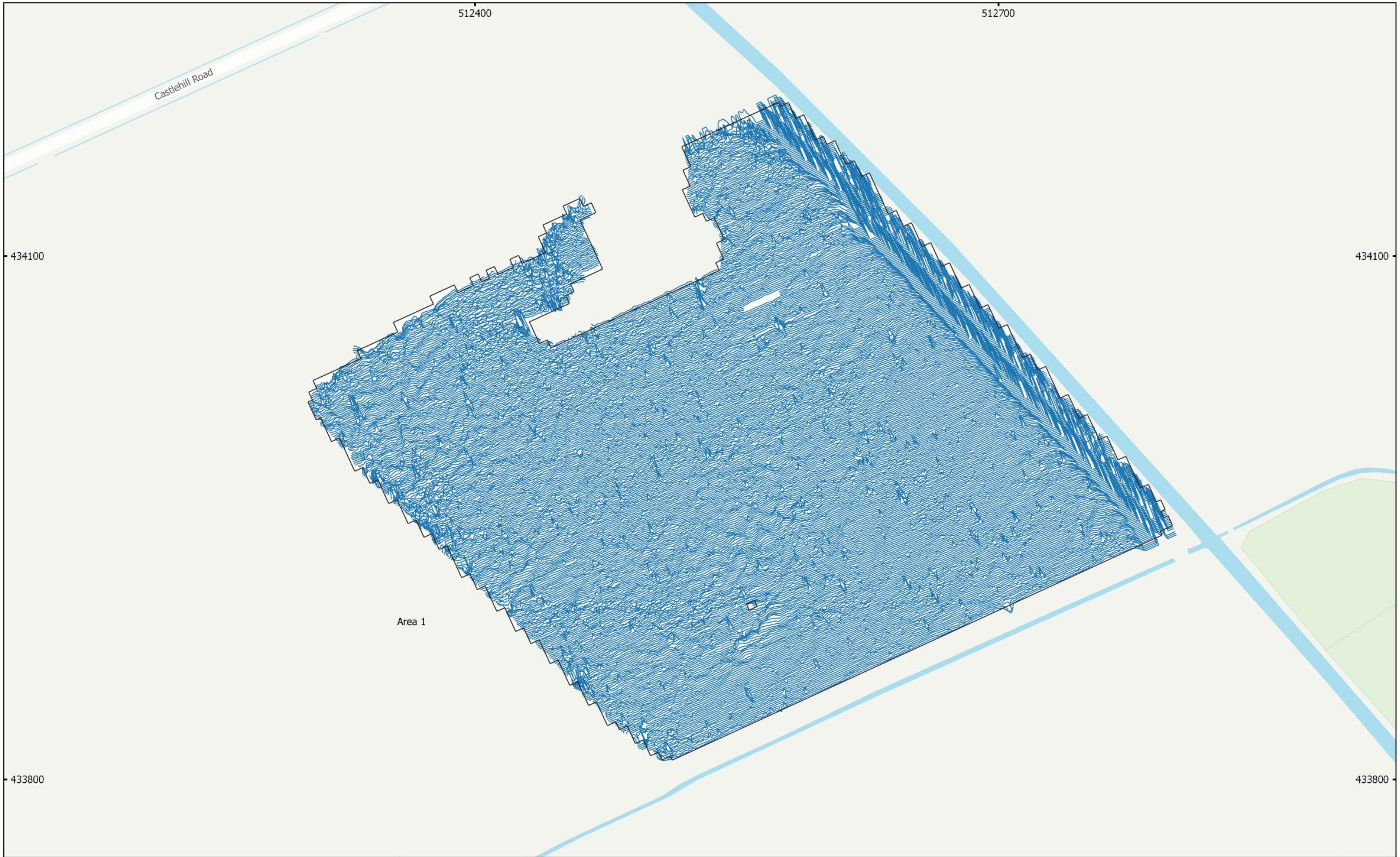
MSTA819 - Castle Hill
Figure 6 - Magnetic Interpretation Over Historical Maps and Satellite Imagery
1:3,000 @ A3

Natural (Strong)
Natural (Weak)
Natural (Zone)
Magnetic Disturbance
Ferrous Debris/Spread
Agricultural (Trend)
Overhead Cable
Service
Drainage Feature
Ferrous (Spike)

N

0 100 200 300 m

magnitude surveys



MSTA819 - Castle Hill
Figure 7 - XY Trace Plot
40nT/cm at 1:2,000 @ A3

N

0 50 100 150 m

magnitude surveys