GEOPHYSICAL SURVEY REPORT G1383

Greta Bridge
Roman Fort and Vicus
County Durham

Client:

NAA
Heritage Consultants

On behalf of:

ARCHITECTURAL AND ARCHAEOLOGICAL SOCIETY
OF DURHAM AND NORTHUMBERLAND

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Survey
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GSB Survey Report No. G1383
Greta Bridge Roman Fort

Contents

List of Figures (Printed and on CD)

List of Archive Figures (on CD only)

Survey Personnel

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Dates

Fieldwork: 10 - 13 December 2013
Report: 31 January 2014

Report Approved: Dr John Gater MIfA FSA

Background Project Details

NGR	NZ 084 131
Location	The site lies in the hamlet of Greta Bridge, to the south of the A66, approximately 5km south east of Barnard Castle. The research area runs from The Morritt Arms Hotel across the field immediately to the south, bound to the west and east by Brignall Lane and the River Greta, respectively.
HER/SMR	Durham County Council
District	County Durham
Parish	Brignall
Topography	In general the survey area sloped gently down towards the north, with a steep scarp drops along the eastern side of the fort to a level river terrace adjacent to the River Greta.
Current Land Use	Pasture
Soils	Wick1 (541r): deep well-drained coarse loamy and sandy soils, locally over gravel (SSEW 1983).
Geology	Alluvium and river terrace deposits of sand, silt and gravel give way to Devensian till on the higher ground; this overlies a sandstone bedrock of the Alston formation (BGS 2014).
Archaeology	Greta Bridge Roman fort (Scheduled Monument no. 19926) is believed to have been occupied from the early 2nd century to late 4th century AD. It lies on the Roman road which is largely followed by the present-day A66. Little is known of the interior layout or extent of the *vicus*; limited excavation around The Morritt Arms Hotel, especially on its north side, has revealed evidence of stone structures (P Johnson, NAA, *pers. comm.* & EH 2014).
Survey Methods	Detailed magnetometer survey (fluxgate gradiometer) and earth resistance.
Study Area	~5ha

Aims

To locate and characterise any anomalies of possible archaeological interest associated with the Roman fort and *vicus* at Greta Bridge. The work forms part of a wider archaeological assessment being carried out by **Northern Archaeological Associates** on behalf of the **Architectural and Archaeological Society of Durham and Northumberland**.

Summary of Results

Evidence of stone buildings has been recorded across the fort, with magnetic enhancement suggesting some structures probably had hypocaust systems. Possible roadways crossing the interior of the fort have also been identified as well as some open spaces and a near-circular anomaly of uncertain antiquity. The complexity of the responses has precluded the creation of a definitive plan of the fort interior. Although speculative, a potential second phase to the fort's construction has been suggested with a squared-off layout.

There is no evidence for an extensive *vicus* south of the fort, in fact very little was found here other than a slight increase in noise immediately outside the southern defences. It could be that any settlement here was predominantly timber built. Strong anomalies at the foot of the scarp forming the fort's eastern defences are suspected to be a build-up of archaeologically enhanced deposits which have slipped down-slope since the fort went out of use. No clear evidence of defences other than the natural lie of the land could be found in the data from the east side.

Responses from ridge and furrow and a former golf course have been detected within the fort and on the ground immediately surrounding it. A small survey area to the north of The Morritt Arms Hotel revealed nothing that could be attributed an archaeological origin.

Method

Grid positioning for the Resistance survey was carried out using Trimble's GeoExplorer Real Time Kinematic (RTK) VRS Now GNSS equipment. The geophysical survey areas are georeferenced relative to the Ordnance Survey National Grid by tying in to local detail and corrected to the mapping data provided by the client. These tie-ins are presented in Figure T1. Please refer to this diagram when re-establishing the grid or positioning trenches.

All cart survey data points had their position recorded using Trimble R8 Real Time Kinematic (RTK) GNSS equipment. The geophysical survey area is thus georeferenced relative to the Ordnance Survey National Grid.

Technique	Instrument	Traverse Interval	Sample Interval
Magnetometer	CARTEASY^{N} cart system (Bartington Grad 601sensors)	0.75m	0.125m
Resistance	Geoscan Research RM85 (0.5m twin array)	1.0m	1.0m

All survey work is carried out in accordance with the current English Heritage guidelines (EH 2008).

Data Processing

Data processing was performed as appropriate using both in-house and commercial software packages (Geoplot and CARTEASY^{N}) as outlined below.

Magnetic Data
Zero mean traverse and gridding.

Resistance Data
Despike, grid edge match, high pass filter (where indicated) and interpolation (on both X & Y axes, where indicated).

Interpretation

When interpreting the results several factors are taken into consideration, including the nature of archaeological features being investigated and the local conditions at the site (geology, pedology, topography etc.). Anomalies are categorised by their potential origin. Where responses can be related to very specific known features documented in other sources, this is done (for example: *Abbey Wall*, *Roman Road*). For the generic categories levels of confidence are indicated, for example: *Archaeology* – *?Archaeology*. The former is used for a confident interpretation, based on anomaly definition and/or other corroborative data such as cropmarks. Poor anomaly definition, a lack of clear patterns to the responses and an absence of other supporting data reduces confidence, hence the classification *?Archaeology*. Details of the data plot formats and interpretation categories used are given in the Appendix: Technical Information at the end of the report.

General Considerations

The conditions for survey were very good with the vast majority of the site being under short pasture.

Resistance survey was confined to the fort interior and a 120m by 30m strip immediately south of the southern ramparts.

Steep slopes dropping down from the eastern side of the fort to the river were surveyed as far as possible with the cart but were too steep to traverse safely at the southern end of the site. Severe undulations associated with the southern ramparts of the fort were also surveyed as extensively as possible with the cart.

Area 2b is magnetic data from the central section of the fort, resurveyed with the traverses at right angles to the main survey (i.e. along the long axis of the fort rather than east-west). The data are included on the Archive CD for comparison – reassuringly, there is very little difference between the two datasets.

1 Survey Results

Bracketed numbers, letters and Roman numerals within the main body of the text refer to specific anomalies highlighted on the magnetic (Figure 5), resistance (Figure 7) and topographic (Figure 9) diagrams, respectively.

1.1 Magnetometer Survey

1.1.1. The results of the magnetic survey are the most informative of the techniques, both within and immediately surrounding the fort. The interior has a dense spread of anomalies with much better definition than the resistance data (see *Section 1.2*). Whilst it is possible to discount some features as having modern origins, there are many responses which would appear to define internal roadways, buildings and potential demolition spreads.

1.1.2. The topsoil from across the fort's interior is a very dark, particularly rich-looking material. It is thought that this may have been imported either to form gardens behind the hotel (which is built over the northern ramparts) or when a small golf course was developed in the early 20th century. Fortunately, aside from a small number of anomalies [**1**] associated with some surviving golf course earthworks, this possible importation of material has not adversely affected the magnetic results judging by the strength and density of responses.

1.1.3. Given that there are likely to be multiple phases of construction and rebuilding, trying to interpret every anomaly and attempting to assign the wealth of rectilinear responses to individual buildings, roads or other features is not possible. As such, the interpretation and text contained within this report singles out the clearest of the archaeological features and any unusual anomaly groups for discussion.

1.1.4. There are clearly identifiable rectangular negative responses [**2** – **6**] across the fort which would imply the presence of stone walls or foundations presumably associated with barrack blocks and other buildings. They are all 5m - 6m wide and range in length from 8m to 17m. The strength of the interior magnetic responses from buildings [**4**] and [**5**] might indicate a build-up of material within surviving walls, tiled floors or, alternatively, a phase of burning.

1.1.5. At the northern limits of survey over the fort, other potential structures have been identified [**7** – **8**]. Unfortunately, strong magnetic halos from the adjacent property boundary, and potentially anomalies relating to the construction of the hotel and its amenities, are affecting the clarity of results.

1.1.6. Towards the centre of the fort, a mass of intersecting strong negative and positive anomalies [**9**] has been recorded, suggesting the presence of a complex of stone buildings. At least one part of the buildings within this zone appears to have an apsidal end [**10**]. Adjacent to this complex is a large rectangular zone of magnetic enhancement [**11**], approximately 10m by 20m in size; whether it is a large building or perhaps an open space between buildings that became magnetically enhanced through a period of burning, remains unclear. Immediately north of the complex a broad and strong negative zone [**12**] stands out; the character would suggest a large spread of stone, either a large metalled area or foundation 'raft'.

1.1.7. The presence of a partial circular anomaly [**13**] is quite striking amongst the predominantly rectilinear dataset. The feature is 17m in diameter and whilst tempting to suggest it may pre-date the fort, the presence of garden and golf course features elsewhere within the data, tempers any interpretation or dating.

1.1.8. The ditches forming the southern defences of the fort have not produced particularly strong responses. However, there are positive anomalies associated with the inner bank, which have a distinct rectilinearity on the western side. In the break between the two southern banks, a strong negative anomaly [**14**] may be evidence of a metalled road surface and possibly footings for an entrance tower.

1.1.9. Running north from [**14**] is one of a number of strong, long negative linear anomalies tentatively interpreted as metalled interior roads. Unfortunately, interpretation is complicated by the wealth of intersecting anomalies and the size of the magnetic halos from some of the Roman buildings.

There are two potential caveats against the interpretation of the “roads” aligned with the long axis of the fort (southwest-northeast). The first is the presence of ridge and furrow (visible in the topographic model – see Section 1.3) which is on the same strike; it is possible that this has added to the linear anomalies running in this direction. There may also be stone-filled drains, either antiquated or dug during the construction of the golf course, which could produce similar results. A relatively ‘quiet’ (in magnetic terms) band runs across the fort, demarked by trends [**15**] could also be evidence of a break between barrack blocks and/or other buildings (although an alternative explanation for this band is proffered in *Paragraph 1.2.3*).

1.1.10. On the south side of the fort there is little direct evidence of an extensive *vicus.* There is a general increase in response flanking the ramparts (characterised by a mottled appearance) which could indicated the demolished remains of timber structures, tile debris, minor industry and/or small pits. That said, it could be a lens of up-cast material from the ditch, levelling out the exit from this side, as it stops at the break of slope (see Section 1.3). There is a hint of roadside ditches and a compacted road surface [**16**] extending south a short way outside of the fort (characterised by positive and negative responses, respectively). To the west, some linear responses heading back to the ditch potentially indicating drains, either simple ditches (positive response) or stone filled gullies (negative response), of uncertain antiquity.

1.1.11. The strongest responses in this southern survey area would seem to be a facet of the topography; the positive responses coincide with the main part of the slope through this field and thus may reflect variations in soil depth. There is also some evidence of ridge and furrow cultivation traversing this part of the field.

1.1.12. East of the fort, strong anomalies have been recorded along the top and bottom edge of the scarp running down to the river terrace. The responses at the top may be remnants of the inner rampart whilst the greatly increased response at the toe of the slope is thought to be an effect of magnetically enhanced material (possibly refuse deposits) slumping downhill since the fort went out of use. It is not entirely clear as to whether there were ever ditches or additional ramparts on this eastern side or whether the defences relied solely upon the natural lie of the land; the anomalies that remain on the flanks of the scarp show little definition.

1.1.13. Magnetic survey over the semi-circular lawn on the north side of the hotel has produced nothing that could be identified as having archaeological potential. The ferrous responses from the adjacent parking bays, services and railings have swamped the dataset.

1.1.14. Ferrous responses along the limits of the data in all survey areas can be attributed to boundary walls and fencing. Small-scale ferrous responses, most obvious as sharp 'spikes' in the XY trace plots (see Archive CD), are typically deemed to be iron-rich debris within the topsoil and most likely to be of modern origins. The most prominent of these have been highlighted on the interpretation diagram by way of example.

1.2 Resistance Survey

1.2.1. The resistance survey was undertaken by Northern Archaeological Associates with assistance from local volunteers. Unfortunately, due to ground conditions, the results are far from ‘clear-cut’ with the responses being relatively amorphous, albeit displaying hints of linearity aligned with, or perpendicular to, the fort’s ramparts. Some of the broader examples (e.g. [**B**]) are presumably related to either the interior road network or the limits of rubble spreads from some of the structures. There are some very narrow linear responses (e.g. [**C**]) running along the long axis of the fort which might be related to cultivation work during the golf course construction; they look too narrow to be archaeological.

1.2.2. This overall lack of clarity is thought to be further evidence for the presence of a layer of imported soil, with some of the resistance variation being attributable to changes within the topsoil and a somewhat ‘muted’ response being recorded from the Roman structures. For example, it is hard to say what is causing the increased resistance in the middle of the fort and at the northern edge, near the hotel grounds; their lack of definition or correlation with any magnetic responses means they remain of *Uncertain Origin.*

1.2.3. Across the northern half of the fort is a zone of increased resistance, running northwest-southeast. High-pass filtering, to enhance detail, reveals two bands [**D**] and [**E**], both with a break towards the centre of the fort. The southernmost of these [**D**] is coincident with a low earthwork (see Section1.3] on a similar strike in the topographic data. Given this correlation, and although somewhat speculative, it is possible that the anomalies demark the line of ramparts from another phase of the fort's use, forming a squarer enclosure. The alignment of the responses matches the southern ramparts, as do the dimensions: the overall width of [**D**] and [**E**], and the distance between them, is similar to their southern counterparts. However, there is very little in the magnetic data to corroborate this, although there is the zone of slightly diminished magnetic response [**15**], which aligns with band [**D**].

1.2.4. There are very few examples of direct correlation between the resistance and magnetic datasets and to compound the difficulty in interpretation, where the surveys do correspond the response type varies. For example, over buildings and stone structures it would be reasonable to assume a high resistance response but a sharply defined low resistance response [**F**] has been recorded over the building [**4**] (identified in the magnetic data); this could be because the remains of the structure are impeding the drainage of ground water. Conversely, the strong negative magnetic response [**14**] (also presumably a stone structure) has returned high resistance readings [**G**]. It may be coincidence, but the latter anomaly sits in the middle of what would be the northern ramparts, *if* the previously discussed 'shrunken phase' interpretation were to be correct.

1.2.5. South of the fort there is little evidence for an extensive *vicus*, or even the road leading south from the defences. It is possible to see the effects of the edge of the ramparts and the central break where the road would have exited but, beyond that, it is difficult to identify anything clearly of archaeological origin, aside what is presumed to be evidence of ridge and furrow. It is possible that any settlement on this side of the fort was predominantly timber-built and thus has left little to produce sufficient enough contrast to be detected by the resistance technique.

1.2.6. Over the small lawn on the northern side of The Morritt Arms hotel, very little was detected that would be interpreted as archaeological. This is despite the fact that excavation, during alterations to the hotel's frontage, revealed a substantial wall running diagonally into this area. The responses recorded in this instance appear to be relatively modern and / or related to the construction of this semi-circular promontory.

1.3 Topographic Survey

1.3.1. The topographic model is created by extracting elevations from the cart's GPS positional data and resampling it to a 1.0m by 1.0m grid. The accuracy of heights and positions will be compromised slightly over the more extreme earthworks, owing to the system 'leaning' away from vertical, however it is still a close approximation of the actual landscape.

1.3.2. The topographic data have allowed for direct comparison to be made between the earthworks and the geophysical data. Features relating to the former golf course [**i**] can be easily discounted and the dataset shows clearly the ridge and furrow within the fort [**ii**] and, to a lesser extent, similar agricultural practice to the south [**iii**]. A very low ridge [**iv**] crossing the fort interior correlates with the high resistance band [**D**] potentially supporting the "smaller fort" theory. That said, there is no apparent break in this earthwork to form a northern gate, which is one reason why this interpretation remains tentative. South of the fort, the modelled land surface indicates that the increased response in the magnetic survey stops at the toe of the slope [**v**].

1.3.3. There are some topographic features that do not have an equivalent geophysical response but which may still be of interest. Firstly, is the difference between the western [**vi**] and eastern [**vii**] inner ditches; the former appears to have been at least partially back-filled whilst the latter remains relatively well defined. Secondly, there is a trackway [**viii**] leading up the scarp on the eastern side of the fort. Whilst this is very unlikely to be contemporary with the fort's occupation, it may be that it has taken advantage of a 'slumped' section of rampart and ditch which would have completed the circuit of the inner defences [**vi / vii**].

2 Conclusions

2.1 Geophysical survey at Greta Bridge Roman fort has produced three datasets, all of which have added to the understanding of the site, albeit to differing extents.

2.2 The magnetic survey has been the most successful technique, producing clear evidence of stone buildings right across the fort, from simple rectangular structures to a more intricate complex of remains towards the centre of the enclosure. The strength of the magnetic enhancement within some of these buildings suggests not just the presence of tiled floors but also that there may well have been hypocaust systems installed. Possible roadways crossing the interior of the fort have been identified as well as an enigmatic near-circular anomaly, some 17m in diameter, of uncertain antiquity. The strength, complexity and sheer number of magnetic anomalies within the fort actually precludes the production of a definitive plan of the interior with, presumably, multiple phases of construction adding to the complications. From the resistance and topographic datasets, a potential second phase to the fort's layout has been tentatively suggested; that said there is little in the magnetic survey to corroborate this squared-off layout.

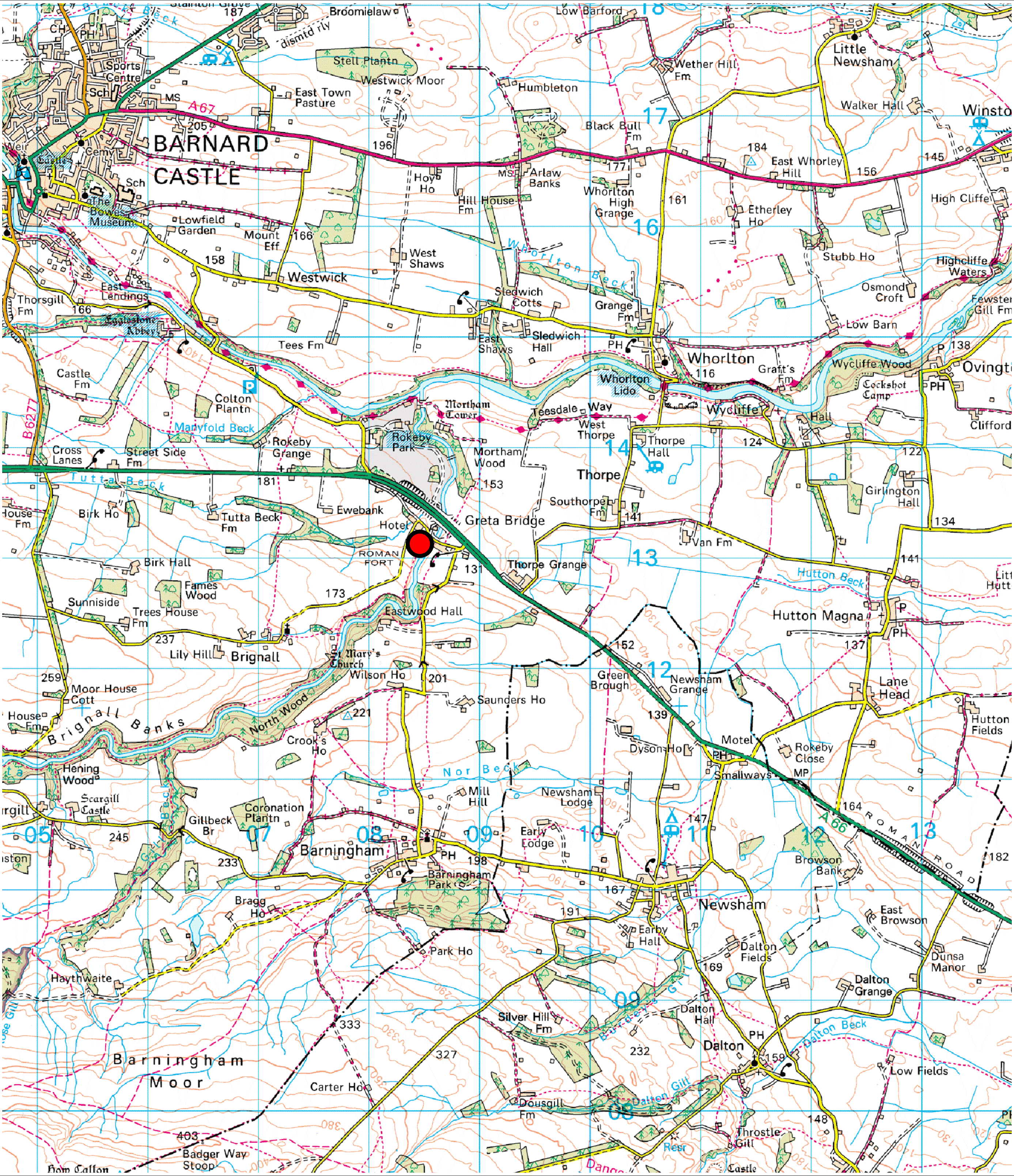
2.3 There is no evidence for an extensive *vicus* south of the fort, in fact very little was found here other than a slight increase in noise immediately outside the southern defences. It could be that any settlement here was predominantly timber built.

2.4 Strong anomalies at the foot of the scarp forming the fort's eastern defences are suspected to be a build-up of archaeologically enhanced deposits which have slipped down-slope since the fort went out of use. No clear evidence of defences other than the natural lie of the land could be found in the data.

2.5 Responses from ridge and furrow and a former golf course have been detected in all three datasets from across the fort and the ground immediately surrounding it. The small survey area to the north of The Morritt Arms Hotel revealed nothing that could be assigned attributed an archaeological origin.

References

BGS 2014	British Geological Survey, Geology of Britain Viewer http://mapapps.bgs.ac.uk/geologyofbritain/home.html 1:50,000 scale geology, centred on 408433,513112. Accessed 17/01./2014.
EH 2008	*Geophysical Survey in Archaeological Field Evaluation.* English Heritage, Portsmouth.
EH 2014	English Heritage PastScape: Greta Bridge (Monument No. 19926) http://www.pastscape.org.uk/hob.aspx?hob_id=19926 Accessed 17/01/14
SSEW 1983	*Soils of England and Wales. Sheet 1, Northern England*. Soil Survey of England and Wales, Harpenden.



N

0 metres 2000

1:50,000 @ A4

Site Location

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Cowburn Farm, 21 Market Street
Thornton
Bradford
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+44 (0)1274 835016

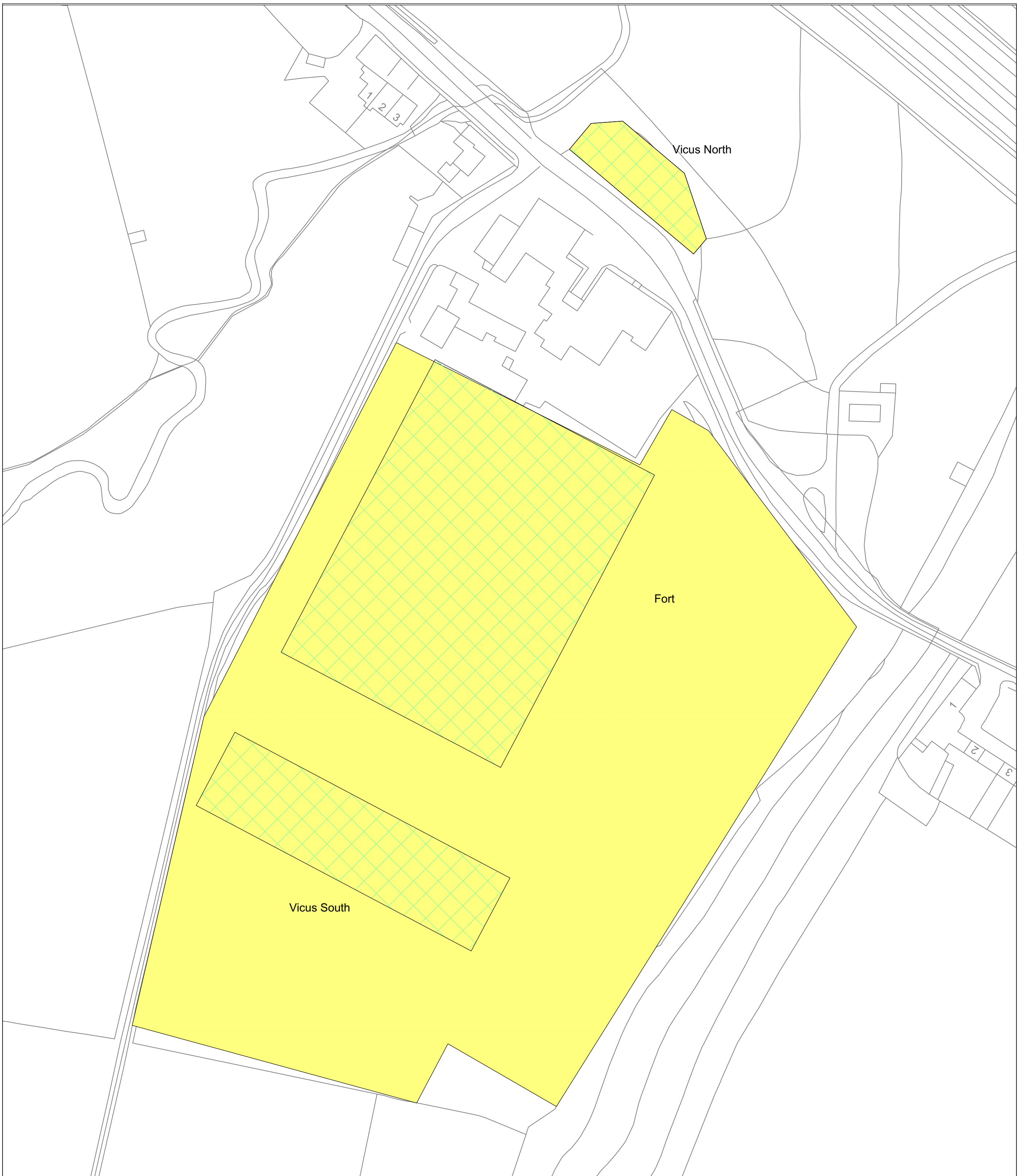
GSB PROSPECTION Ltd

Project: G1383 Greta Bridge

Title: Site Location Diagram

Drawn by: JMT

Figure 1



Magnetometer Survey Area

Earth Resistance Survey Area

N

0 metres 80

1:2000 @ A4

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Title: Location of Survey Areas

Drawn by: EWatson

Figure 2

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Cowburn Farm, 21 Market Street
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Title: Magnetometer [All Areas] - Greyscale Plot

Drawn by: EWatson

Figure 3

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N

0 metres 80

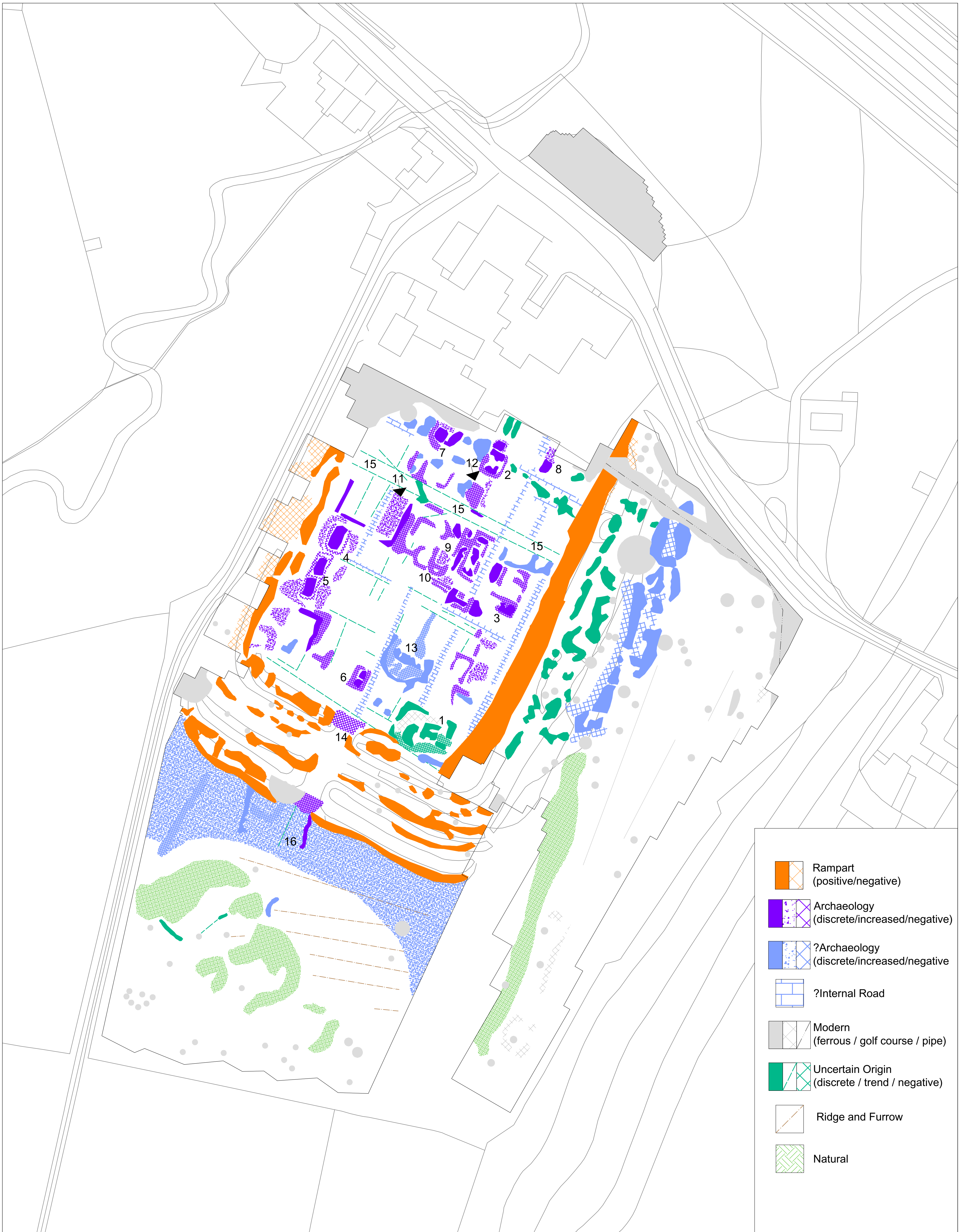
1:2000 @ A3

Project: G1383 Greta Bridge

Title: Magnetometer - [All Areas] Greyscale Plots

Drawn by: EWatson

Figure 4



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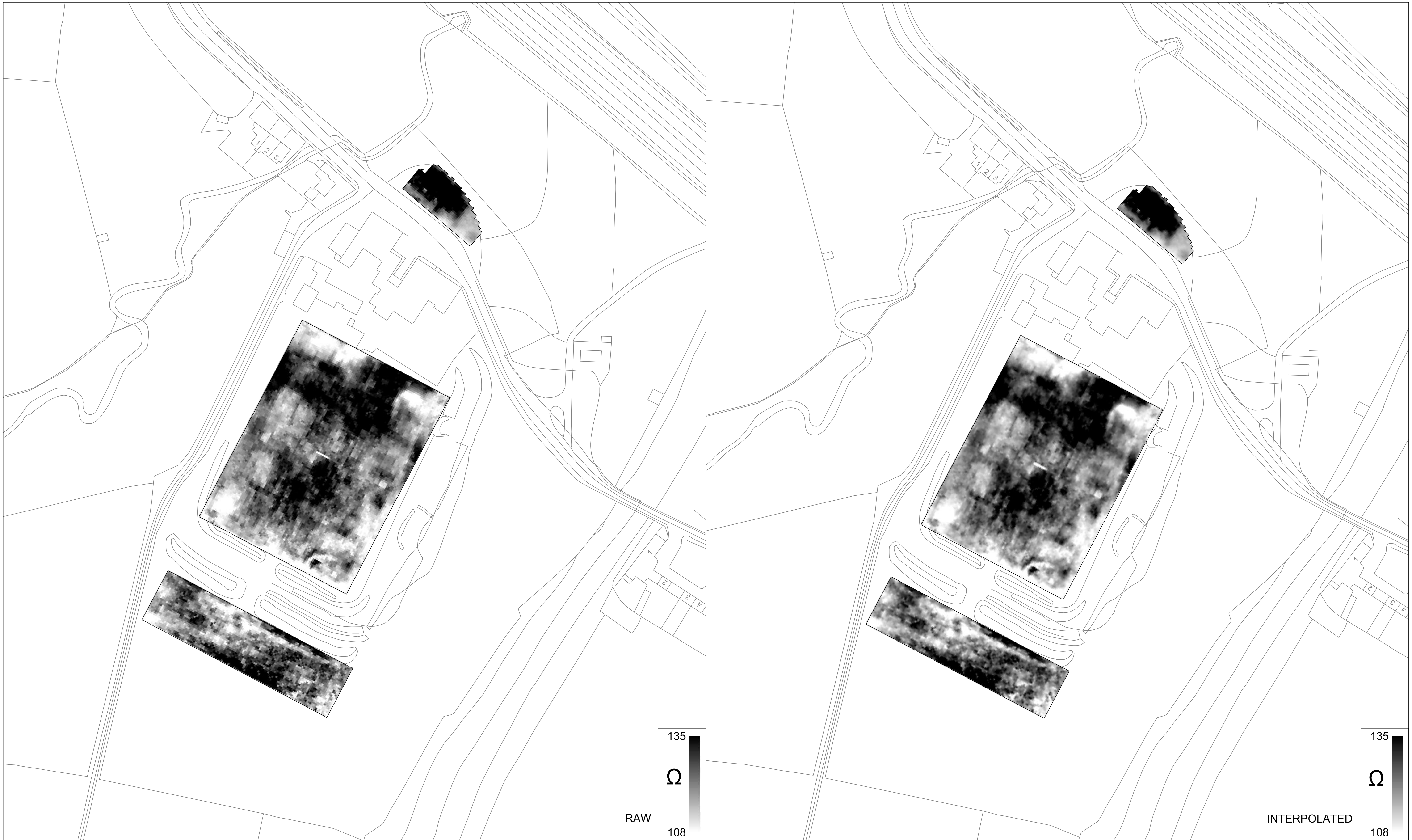
Project: G1383 Greta Bridge

Title: Magnetometer [All Areas] - Interpretation Plot

Drawn by: EWatson

Figure 5



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N

0 metres 80

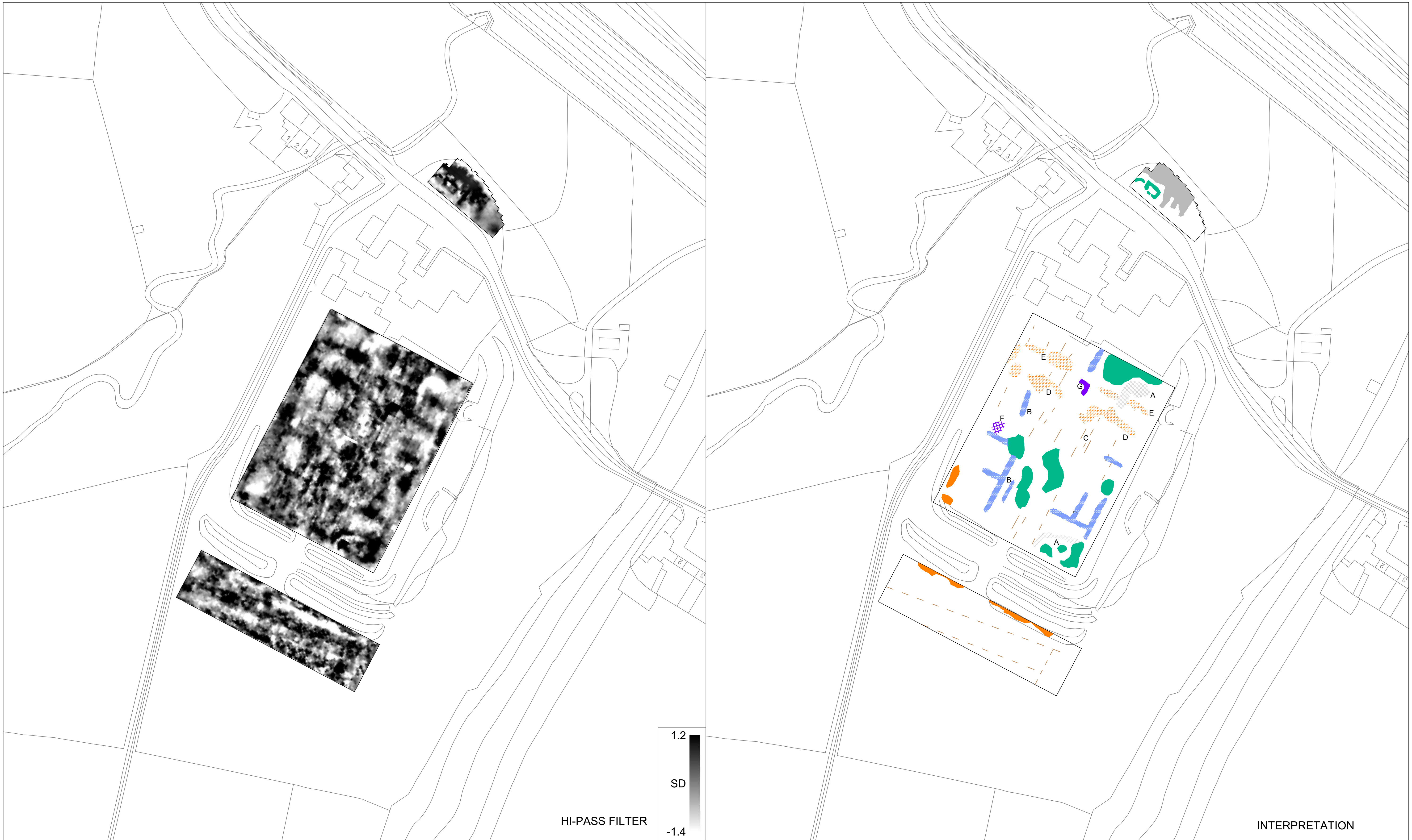
1:2000 @ A3

Project: G1383 Greta Bridge

Title: Resistance [All Areas] - Greyscale Plot

Drawn by: EWatson

Figure 6



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N

0 metres 80

1:2000 @ A3

Rampart / ?Rampart

Archaeology (high resistance / low resistance)

?Archaeology - Road

Uncertain Origin (discrete anomaly)

Agricultural (trend)

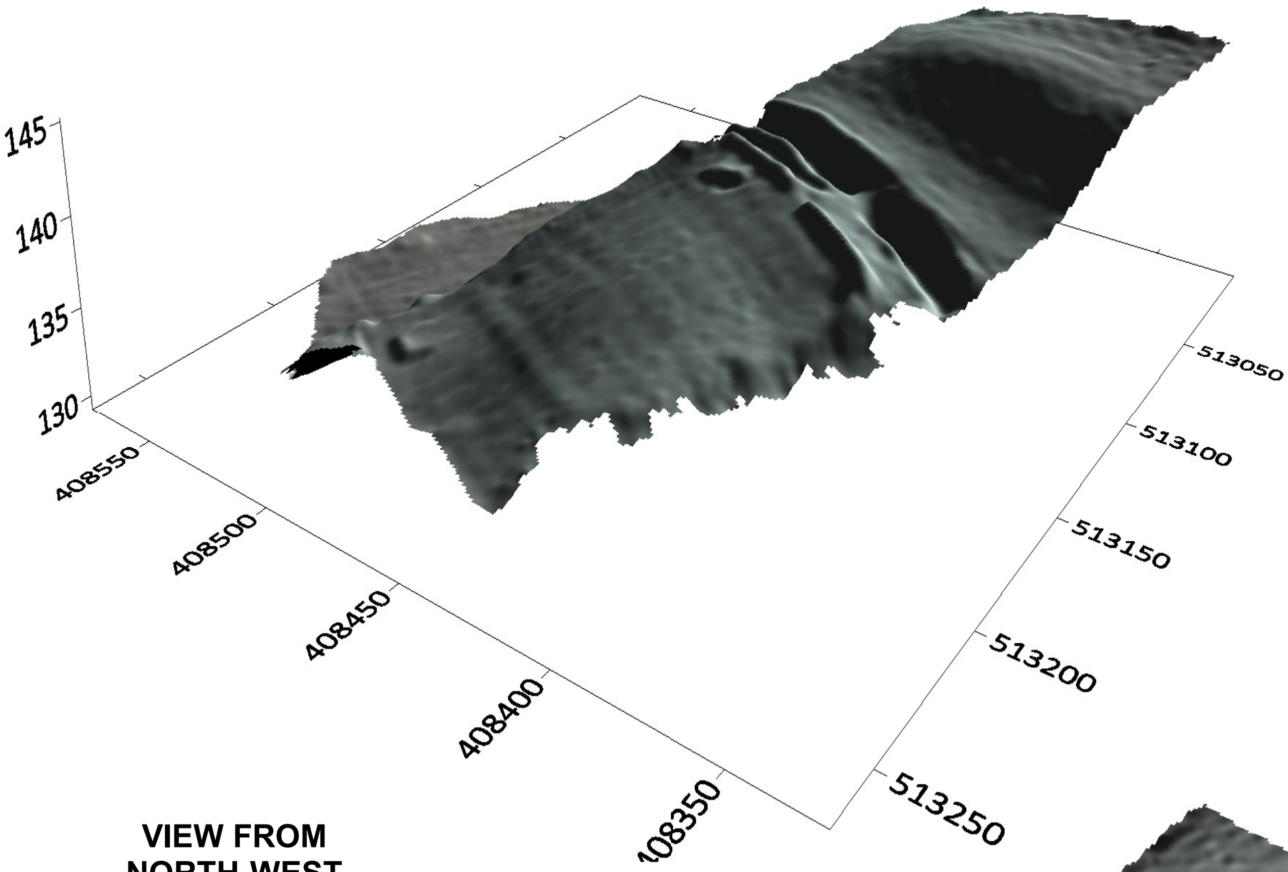
Modern (made ground / golf course)

Project: G1383 Greta Bridge

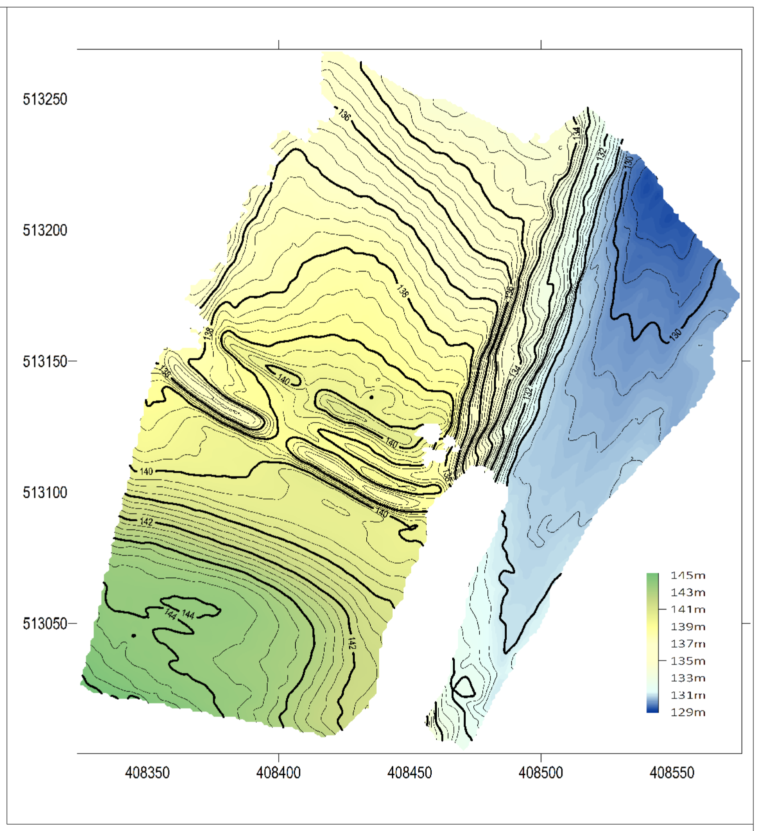
Title: Resistance [All Areas] - Greyscale Plot / Interpretation

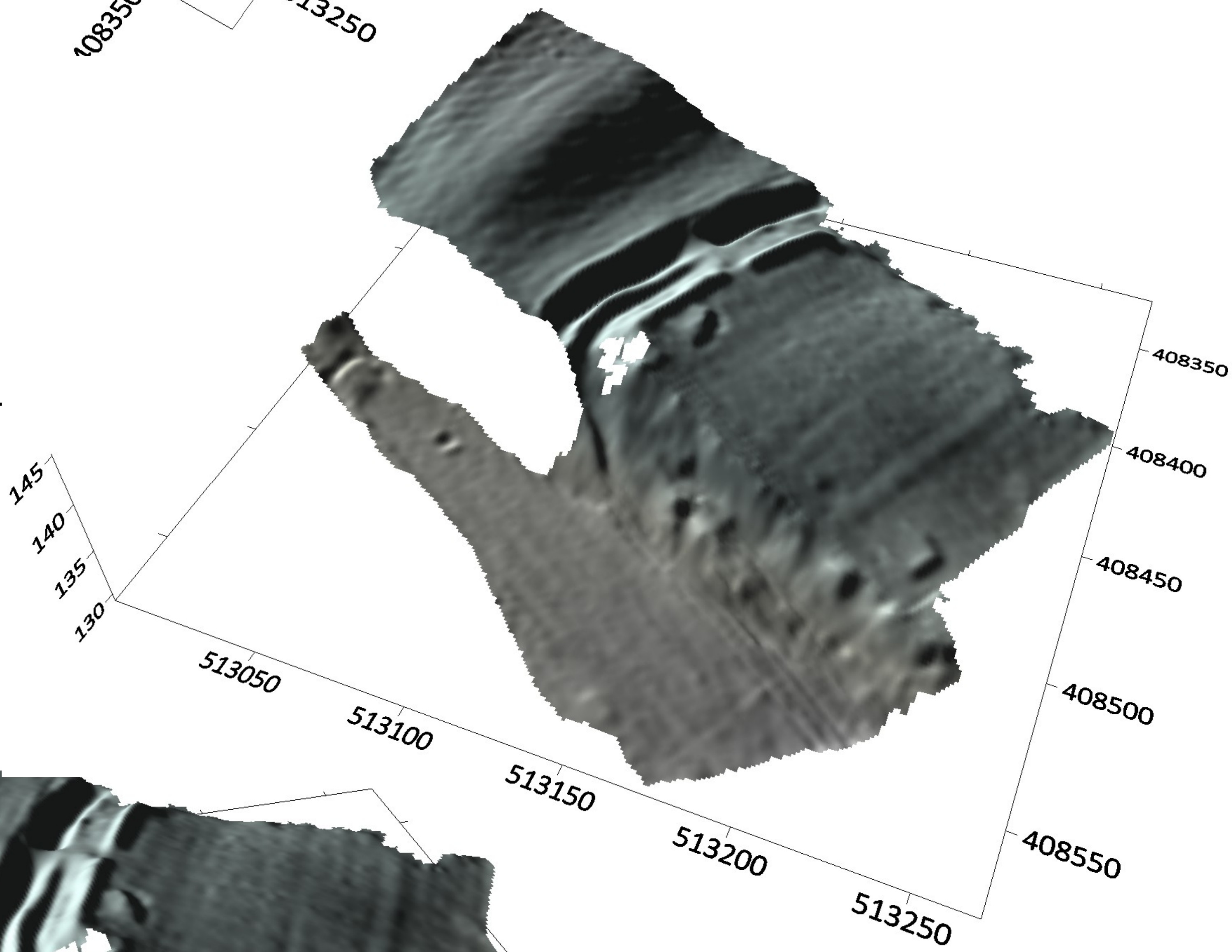
Drawn by: EWatson

Figure 7

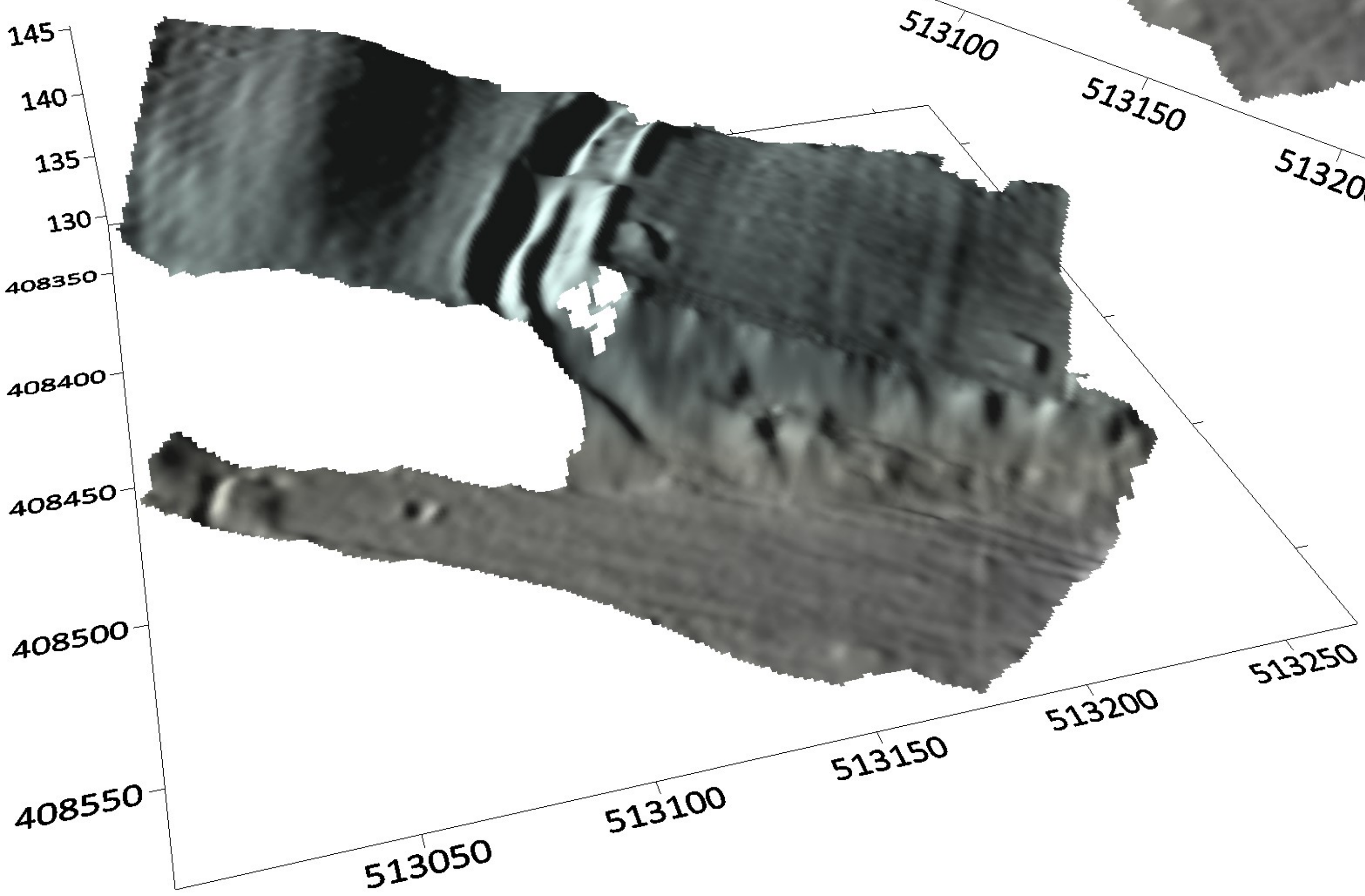


VIEW FROM
NORTH-WEST





VIEW FROM
SOUTH-EAST



VIEW FROM
EAST

For Scale
See Plot Axes
-
OSGB36 Co-ordinates
-
Height in Metres Above Sea-level

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Title: Fort & Environs Topographic Model

Drawn by: JAA

Figure 8

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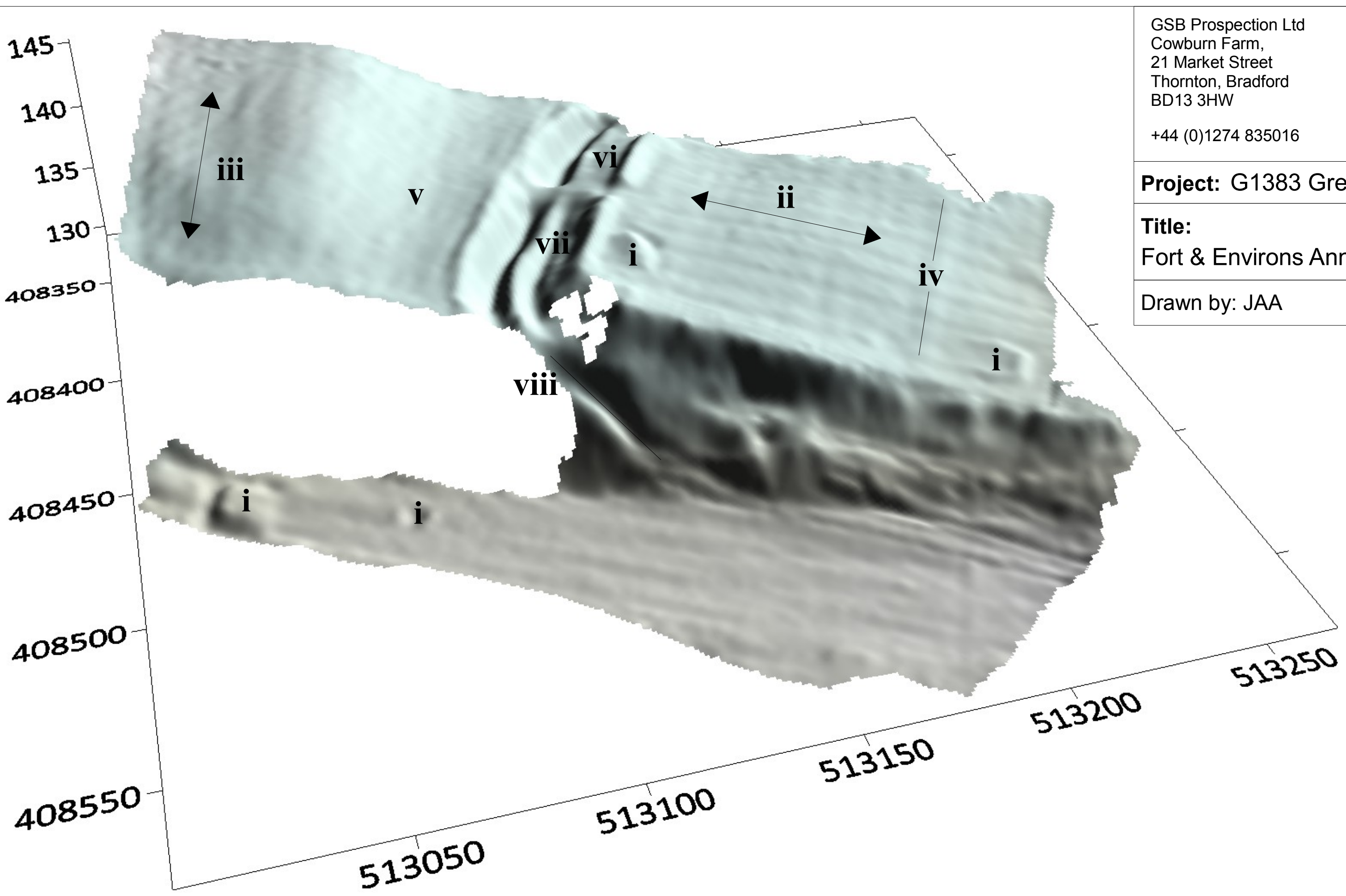
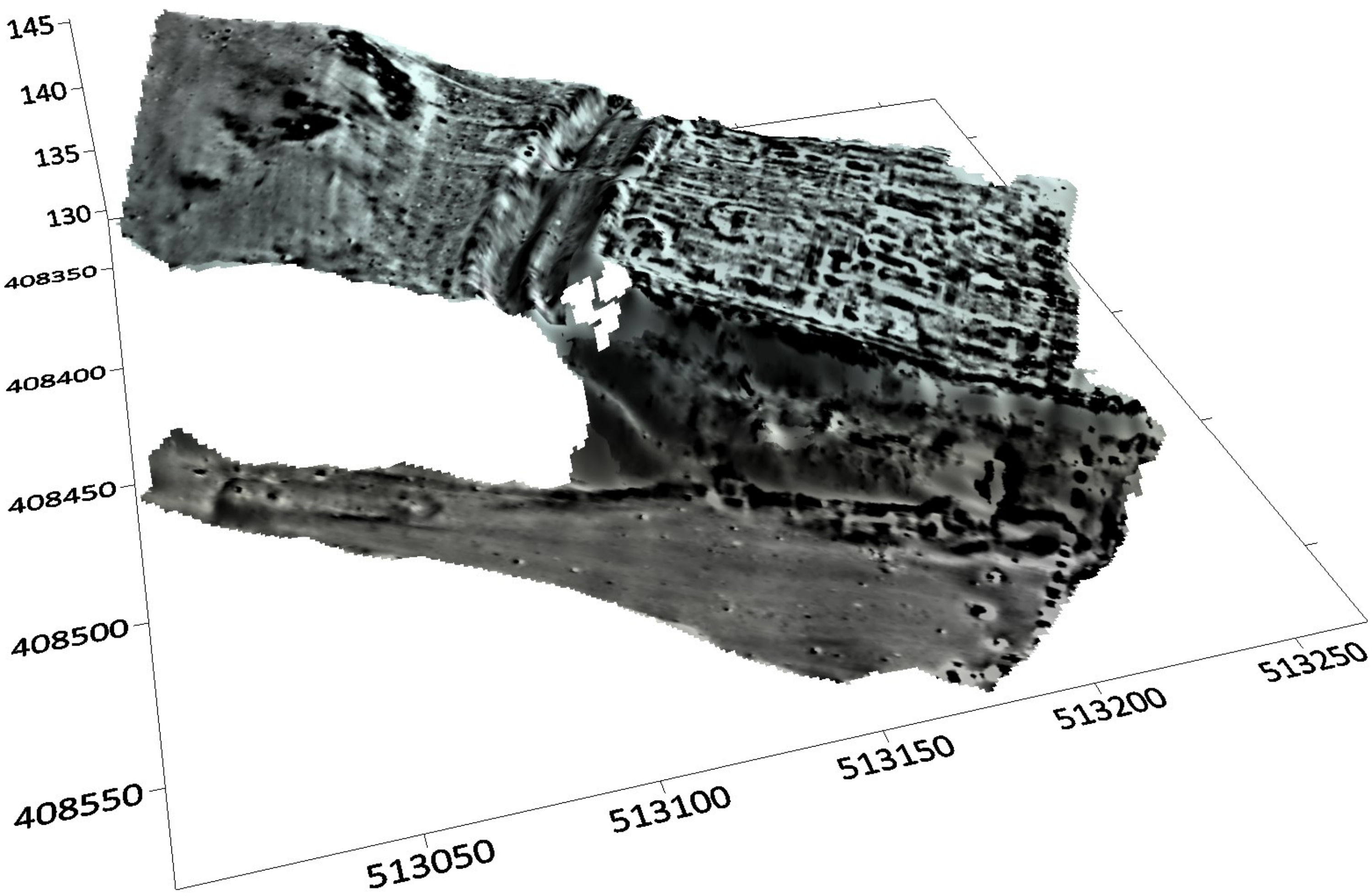
Title:
Fort & Environs Annotated Topographic Model Plus Data Overlay

Drawn by: JAA

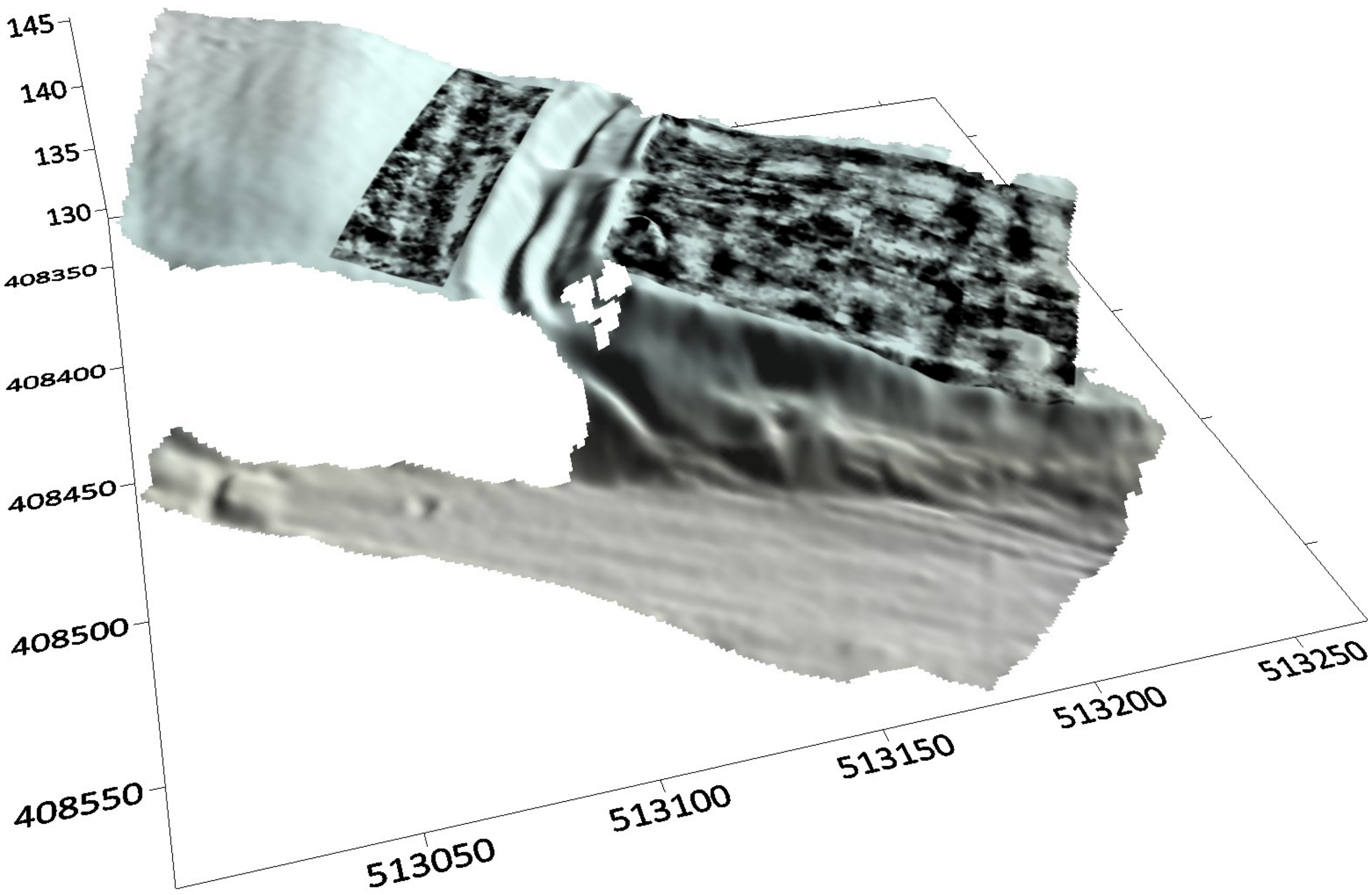
Figure 9



For Scale
See Plot Axes
-
OSGB36 Co-ordinates
-
Height in Metres Above Sea-level



-5 nT +5
Magnetic Data
[Gridded & Zero Mean Traverse]



-1 Std. Dev. +1
Resistance Data
[High-pass Filtered]

VIEW FROM EAST

Appendix - Technical Information: Magnetometer Survey

Instrumentation: Bartington *Grad*601-2 / GSB CARTEASY^{N} Cart system

Both the Bartington and CARTEASY^{N} instruments operate in a gradiometer configuration which comprises fluxgate sensors mounted vertically, 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. The Bartington instrument can collect two lines of data per traverse with gradiometer units mounted laterally with a separation of 1.0m. The CARTEASY^{N} system has four gradiometer units mounted at 0.75m intervals across its frame – rather than working in grids, the cart uses an on-board survey grade GNSS for positioning. The cart system allows for the collection of topographic data in addition to the magnetic field measurements.

Data Processing

Zero Mean Traverse	This process sets the background mean of each traverse within each grid to zero. The operation removes striping effects and edge discontinuities over the whole of the data set.
Step Correction (Destagger)	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.
Interpolation	When geophysical data are presented as a greyscale, each data point is represented as a small square. The resulting plot can sometimes have a 'blocky' appearance. The interpolation process calculates and inserts additional values between existing data points. The process can be carried out with points along a traverse (the x axis) and/or between traverses (the y axis) and results in a smoother greyscale image.

Display

XY Trace Plot	This involves a line representation of the data. Each successive row of data is equally incremented in the Y axis, to produce a stacked profile effect. This display may incorporate a hidden-line removal algorithm, which blocks out lines behind the major peaks and can aid interpretation. The advantages of this type of display are that it allows the full range of the data to be viewed and shows the shape of the individual anomalies. The display may also be changed by altering the horizontal viewing angle and the angle above the plane.
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.
3D Surface Plot	This is similar to the XY trace, but in 3 dimensions. Each data point of a survey is represented in its relative position on the x and y axes and the data value is represented in the z axis. This gives a digital terrain, or topographic effect.

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.

Archaeology	This term is used when the form, nature and pattern of the response are clearly or very probably archaeological and /or if corroborative evidence is available. These anomalies, whilst considered anthropogenic, could be of any age.
?Archaeology	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.
Increased Magnetic Response	An area where increased fluctuations attest to greater magnetic enhancement of the soils, but no specific patterns can be discerned in the data and no visual indications on the ground surface hint at a cause. They may have some archaeological potential, suggesting damaged archaeological deposits.
Industrial / Burnt-Fired	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.
Old Field Boundary	Anomalies that correspond to former boundaries indicated on historic mapping, or which are clearly a continuation of existing land divisions.
Ridge & Furrow	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.
Ploughing	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
Natural	These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions. Smaller, isolated responses which do not form such obviously 'natural' patterns but which are, nonetheless, likely to be natural in origin may be classified as *?Natural*.
Uncertain Origin	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 *?Archaeology* and *?Natural* or (in the case of linear responses) *?Archaeology* and *?Ploughing*; occasionally they are simply of an unusual form.
Magnetic Disturbance	Broad zones of strong dipolar anomalies, commonly found in places where modern ferrous or fired materials (e.g. brick rubble) are present. They are presumed to be modern.
Ferrous	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.

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 - Technical Information: Resistance Survey

Instrumentation Geoscan RM15 resistance meter (with optional MPX multiplexer)

This instrument measures the electrical resistance of the earth, using a system of four electrodes (two current and two potential.) Depending on the arrangement of these electrodes an exact measurement of a specific volume of earth may be acquired. This resistance value may then be used to calculate the earth resistivity. The most common arrangement is the Twin Probe configuration which involves two pairs of electrodes (one current and one potential): one pair remain in a fixed position, whilst the other measures the resistance variations across a grid. The resistance is measured in ohms and, when calculated, resistivity is in ohm-metres. The resistance method as used for standard area survey employs a probe separation of 0.5m, which samples to a depth of approximately 0.75m. The nature of the overburden and underlying geology will cause variations in this depth.

Data Processing

Despike	In resistance survey, spurious readings can occasionally occur, usually due to a poor contact of the probes with the surface. This process removes the spurious readings, replacing them with values calculated by taking the mean and standard deviation of surrounding data points.
Grid Edge Match	If a twin probe survey is carried out over several sessions it is not always possible to position the remote probes to adequately compensate for broad changes in ground moisture. This can give rise to distinct edges between adjacent grids where data have been collected at different times. The grid edge match function removes these discontinuities.
High Pass Filter	Carried out over a whole resistance data-set, the filter removes low frequency, large scale spatial detail, such as that produced by broad geological changes. The result is to enhance the visibility of the smaller scale archaeological anomalies that are otherwise hidden within the broad 'background' change in resistance.
Low Pass Filter	This process removes high frequency, small scale spatial detail, making it useful for smoothing data or enhancing larger weaker features. It can be applied across a whole data-set or limited to a specific area.
Interpolation	When geophysical data are presented as a greyscale, each data point is represented as a small square. The resulting plot can sometimes have a 'blocky' appearance. The interpolation process calculates and inserts additional values between existing data points. The process can be carried out with points along a traverse (the x axis) and/or between traverses (the y axis) and results in a smoother greyscale image.

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.
Relief Plot	This is a method of display that creates a three dimensional effect by directing an imaginary light source on a given data-set. Particular elements of the results are highlighted depending on the angle of strike of the light source. This display method is particularly useful when applied to resistance data to highlight subtle changes in resistance that might otherwise be obscured.

Interpretation Categories

Wall / Foundation / Drain / Bank	These are (usually) high resistance anomalies forming patterns that clearly indicate that they represent some type of structural remains and there is evidence for such features from other sources (documentary, cropmarks etc).
?Wall / ?Foundation / ?Drain / ?Bank	Other evidence (documentary, cropmarks, other geophysics results etc.) suggests the presence of structural remains but the resistance anomalies themselves are weak, poorly defined and / or form incomplete patterns, thereby reducing confidence in the interpretation. (For example: there is an expectation of a building at a known site; some resistance anomalies are present which clearly indicate wall lines of part of the building but these 'fade out' and become indistinct. The indistinct responses will be classified as ?Wall etc.)
Ditch	These are (usually) low resistance anomalies forming patterns that clearly indicate that they represent some type of archaeological ditch feature (as opposed to drainage ditches or similar) and there is evidence for such features from other sources (documentary, cropmarks etc).
?Ditch	As with the ?Wall category above, a reduced confidence is applied when the response becomes indistinct and / or the pattern is fragmentary.
Archaeology (High/Low Resistance)	Well-defined anomalies forming patterns that indicate archaeology but where no supporting evidence exists. The anomalies are sub-categorised into high and low resistance.
?Archaeology (High/Low Resistance)	Weak / poorly defined anomalies forming incomplete patterns that suggest archaeology might be present. No supporting evidence exists. This is the least confident of the archaeological interpretations.
Ridge & Furrow	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.
Ploughing	Parallel linear anomalies or trends with a narrower spacing, sometimes aligned with existing boundaries, indicating more recent cultivation regimes.
Natural (High/Low Resistance)	These are anomalies (often broad zones of higher or lower resistance) that are probably natural in origin; either caused by the underlying geology, or localised natural variations in soil moisture.
Landscaping / Topography	An interpretation assigned when the topography or other evidence suggests these factors might be responsible.
Modern (High/Low Resistance)	Anomalies which can be directly attributed to known modern features.
Uncertain Origin (High/Low Resistance)	Anomalies which stand out from the background yet show little to suggest an exact origin. Either archaeological, natural or modern factors may be responsible, but it has not been possible to determine the most likely cause. The anomalies are sub-categorised into high and low resistance.

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