NAA

GEOPHYSICAL SURVEY REPORT

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HOWICK HALL FARM
PENWORTHAM
LANCASHIRE

prepared for
Statera Energy Ltd

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HOWICK HALL FARM

PENWORTHAM, LANCASHIRE

GEOPHYSICAL SURVEY REPORT

Summary

Northern Archaeological Associates Ltd (NAA) was commissioned by Statera Energy Limited to undertake a geophysical survey of land at Howick Hall Farm, Penwortham, Lancashire (NGR: SD 50020 28201). The survey was required to assess the archaeological potential of the site in support of a planning application for the development of a battery storage facility. The survey was carried out on the 18th of July 2017 and covered an area of approximately 1.2 hectares of farmland under pasture at the time of survey.

Anomalies identified within the survey area are likely to relate to either modern or agricultural activity.

There are several weak and diffuse trends of an uncertain origin. Consequently it is uncertain if they are of an agricultural, modern or archaeological nature.

Above ground sources of magnetic 'noise' and modern material and debris in the topsoil caused several areas of magnetic disturbance in the south and west of the survey area.

CONTENTS

FIGURE LIST

DIGITAL CONTENTS

Report copy (PDF)

A4 scaled figures:

- Minimally processed data
- Processed data
- Interpreted data
- XY data
- Site grid map

Site photographs and catalogue

Disclaimer

The results of geophysical survey may not reveal all potential archaeology and do not provide a comprehensive map of the sub-surface, but only responses relative to the environment. Geological, agricultural and modern responses may mask archaeological features. Short-lived features may not give strong responses. Only clear features have been interpreted and discussed in this report.

1.0 INTRODUCTION

1.1 Northern Archaeological Associates Ltd (NAA) were commissioned by Statera Energy Limited to undertake a geophysical survey of land at Howick Hall Farm, Penwortham, Lancashire (NGR: SD 50020 28201: **Figure 1**). The survey was required to assess the archaeological potential of the site in support of a planning application for the proposed development of a battery storage facility. The area surveyed totalled approximately 1.2ha of farmland under pasture at the time of survey.

Location

1.2 The site was located to the west of the town of Penwortham, and the south-west of Preston, Lancashire. The area targeted was bordered by farmland to the north, east, and west, and the Penwortham Substation to the south. The topography of the survey area was generally level, lying at 15m AOD (above ordnance datum).

Geology

1.3 The solid geology of the survey area consists of sandstone of the Sherwood Sandstone Group with superficial deposits of Diamicton of Till, Devensian formation (BGS 2017). The soils are mapped as Salop (Soil Survey of England and Wales 1983), consisting primarily of stagnogley soils with slowly permeable subsoil in reddish drift generally derived from Permo-Triassic rocks (Jarvis *et al*. 1984, 270).

Archaeological background

1.4 No archaeological background information was provided for the compilation of this report.

1.5 Historic maps from 1848 show that there has only been minor changes to the layout of the site with the removal of a pond in the south of the proposed development area. Between 1947 and 2000 the Penwortham Substation was built to the south of the proposed development site and several field boundaries in neighbouring fields have been removed (National Library of Scotland 2017).

2.0 AIMS AND OBJECTIVES

2.1 The aim of the survey was:

- To attempt to characterise the nature of any sub-surface remains within the survey boundary and to identify possible concentrations of past activity in order to inform the requirement for any archaeological mitigation work at the site; and

- To produce a report including XY-trace plots, raw and processed greyscale images of the survey areas and interpretations of these results.

3.0 METHODOLOGY

3.1 The geophysical survey was undertaken as gradiometer survey using the Bartington Grad601-2 dual magnetic gradiometer system with data logger. The readings were recorded at a resolution of 0.1nT and data was collected with a traverse interval of 1m and a sample interval of 0.25m. All recorded survey data was collected with reference to a site survey grid comprised of individual 30m x 30m squares. The grid was established using Real Time Kinematic (RTK) differential GPS equipment and marked out using non-metallic survey markers. All grid nodes were set out with a positional accuracy of at least 0.1m as per existing guidelines (English Heritage 2008; CIfA 2014) and could be re-located on the ground by a third party. The base lines used to create the survey grids are shown on **Figure 2** and further details are available in **Appendix A.**

3.2 The processing was undertaken using Geoplot 3.0 software and consisted of standard processing procedures. Details of processing steps applied to collected data are given in **Appendix B**.

3.3 On the greyscale plot (**Figure 3 left and Figure 4 left**), positive readings are shown as increasingly darker areas and negative readings are shown as increasingly lighter areas. The XY-trace plot demonstrates the readings as offsets from a central line **(Figure 3 right)**. The interpreted data uses colour coding to highlight specific readings in the survey area **(Figure 4 right)**. In this report, the word anomaly is used to refer to any outstanding high or low readings forming a particular shape or covering a specific area. **Appendix C** details the terminology and characterisation of anomalies used for interpreting data.

Surface conditions and other mitigating factors

3.4 Field boundaries comprised hedgerow, tree, and metal fencing; metal gates were used for access into the site and surrounding fields. At the time of survey agricultural vehicles were located in the south and west of the survey area. It was necessary to avoid all metal objects to ensure that magnetic responses did not impinge on the survey results and mask potential buried features.

4.0 RESULTS (FIGURES 3 AND 4)

4.1 The gradiometer survey was successful and created clear results.

Description and interpretation

4.2 Across the survey area there are several weak and diffuse linear anomalies that have been characterised as trends. Although it is plausible that these anomalies relate to either modern or agricultural activity, they fail to produce the necessary patterning or increases in magnetic response to be interpreted fully and an archaeological interpretation cannot be completely dismissed.

4.3 There are two possible alignments of regularly spaced linear anomalies considered likely to relate to agricultural activity. Anomalies running on an east-west alignment appear more coherent, but it is unclear if they are caused by relatively modern ploughing or, given the current pasture land use, are indicative of earlier agricultural practices such as ridge and furrow. Anomalies on a north-south alignment have much weaker increases in magnetic values and a more fragmented form. Likewise, it is uncertain if these linear anomalies denote modern or medieval agricultural practices within the site.

4.4 There are several dipolar and bipolar anomalies that are likely to relate to ferrous or magnetically susceptible objects buried in the topsoil. Given the lack of anomalies likely to be indicative of buried archaeological features, these anomalies are considered likely to be modern in nature. Only dipolar and bipolar anomalies with a more coherent form have been shown on the interpretation as it is still possible that some of these may denote isolated material of archaeological origin.

4.5 Areas of external interference encapsulate concentrations of bipolar areas of disturbance in the south and west of the survey area. These correspond with the

location of above ground modern features including metal fences and agricultural vehicles which have highly magnetic properties.

5.0 CONCLUSIONS

5.1 Survey results have detected disturbances caused by above ground modern features and regularly spaced linear anomalies indicative of agricultural practices.

5.2 Several trends of an unknown nature have also been identified. As a consequence of their weak and diffuse nature a detailed interpretation is not possible and it is unclear if they are of an agricultural, modern or archaeological nature.

6.0 STORAGE AND CURATION

6.1 The records of the geophysical survey are currently held by NAA. All material will be appropriately packaged for long-term storage in accordance with national guidelines (English Heritage 2008; CIfA 2014).

REFERENCES

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Jarvis, R.A., Bendelow, V.C., Bradley, R.I., Carroll, D.M., Furness, R.R., Kilgour, I.N.L. and King, S.J. (1984) *Soils and their use in Northern England*. Harpenden

National Library of Scotland (2017) *Explore georeferenced maps* [online]. Available at http://maps.nls.uk/geo/find/#zoom=12&lat=53.7586&lon=-2.7390&layers=6&b=1&point=0,0 [Accessed 20/07/2017]

Soil Survey of England and Wales (1983) *Soils of England and Wales Sheet 1: Northern England*. Ordnance Survey, Southampton

APPENDIX A

TECHNICAL INFORMATION

Gradiometer Survey Instrumentation

The data was collected using Hand Held Bartington Grad 601-2 fluxgate gradiometers. The Bartington 601-2 is a single axis, vertical component fluxgate gradiometer comprising a data logger battery cassette and two sensors. The sensors are Grad-01-1000L cylindrical gradiometer sensors mounted on a rigid carrying frame, each sensor contains two fluxgate magnetometers with 1m vertical separation.

The gradiometer records two lines of data on each traverse, the grids are walked in a zig-zag pattern amounting to 15 traverses. The gradiometers are calibrated at the start of every day and recalibrated whenever necessary.

The difference in the magnetic field between the two fluxgates in each sensor is measured in nanoTesla (nT) and for this investigation the readings are measured at 0.1nT. The units' sensors can measure down to 1m from the ground level depending on the ground conditions.

Readings reach between +/-100nT and lower readings are created by upstanding or harder remains such as walls or areas of stone, higher readings are created by softer or cut features, such as ditches and pits (see below).

Limitations

Poor results can be due to several factors including short lived archaeological occupation/use or sites with minimal cut or built features. Results can also be limited in areas with soils naturally deficient in iron compounds or in areas with soils overlying naturally magnetic geology, which will produce strong responses masking archaeological features.

Overlying layers such as demolition rubble or layers of made ground can hide any earlier archaeological features. The presence of above ground structures and underground services containing ferrous material can distort or mask nearby features.

Particularly uneven or steep ground can distort results beyond the capabilities of processing to even out. Over processing of data can also obscure features.

Table 1: Survey summary

	Survey
Grid size	30mx30m
Traverse interval	1m
Reading interval	0.25m
Direction of 1st traverse	North-west
Number of Grids	22

Table 2: Grid co-ordinates (The base line is shown on Fig. 2)

Grid point (gp) A	**Grid point (gp) B**
NGR: 349991.0443 428131.2614	NGR: 350007.0178 428137.6197

APPENDIX B

DATA PROCESSING INFORMATION

The processing is undertaken using Geoplot 3.0 software, and the following processing techniques:

- Zero Mean Traverse - to remove directional effects inherent in the survey,
- Destagger - to shift the traverses back or forward to correct for user error,
- Clip - to enhance the weaker features, by reducing the readings above a set value,
- Despike - removing data points that are above an appropriate mean to reduce the appearance of dominant readings, created by modern ferrous objects distorting the results,
- Low pass filter - Decreases the correlation between neighbouring cells effectively smoothing the data
- Interpolation – reduces the blocky effect of the survey smoothing the appearance of the data.

Table 3: Processing steps

Minimal Processing	**Increased Processing**
• Zero Mean Traverse +5/-5 • Destagger: - All: 1	• Low Pass Filter • Interpolate Y, Expand - Linear ,x2

APPENDIX C

DATA VISUALISATION INFORMATION

Figures

The data is used to produce a series of images to demonstrate the results of surveys these are detailed below:

- Greyscale/Colourscale Plot – This demonstrates the results as a shaded drawing with highest readings showing as black, running through different shades to lowest showing as white. This can also be created using a colour pallet to demonstrate the different values.

- XY-trace Plot – This creates a line drawing showing the peaks and troughs of the readings as vertical offset from a centreline.

- Interpreted data – This is created to show features and particular high or low readings to re enforce and clarify the written interpretation of the data. This is based on the Greyscale plot but with different colours representing the various readings.

Magnetic anomalies and terminology

The different magnetic anomalies can represent different features created by soil and geology, human activity, modern or agricultural activity. Anomalies interpreted with a 'greater' categorisation are considered more likely to be of an archaeological nature; a more tentative interpretation is applied to those with a 'lesser' categorisation as a consequence of weaker increases in magnetic response or the anomalies incomplete patterning or irregular form.

In areas where mining activity has been recorded, it is possible that dipolar anomalies (often appearing as a broad sub-circular positive response with a negative halo) and amorphous areas containing bipolar responses are caused by mine shafts, pits and historic mineral extraction.

Positive linear anomalies have an increased magnetic response and are often caused by archaeological features, such as ditches and field boundaries but can also be natural.

Isolated anomalies or anomalies with a more amorphous form possibly represent infilled or thermomagnetic features that can be of an archaeological or natural origin. Areas of heating/burning or heated objects produce thermoremanent responses as this creates a magnetic field. These can appear as bipolar responses or as magnetic debris depending on whether it is in situ, or moved into place.

Negative linear anomalies represent earthworks, walls and other upstanding or compacted remains with a lower magnetic response compared to background readings. Isolated negative anomalies can represent archaeological or natural features.

Weak and diffuse anomalies with an uncertain origin are denoted by trends. It is possible that these belong to archaeological features, but given their weak signatures it is equally plausible that they relate to natural soil formations.

Regularly spaced linear anomalies are often caused by agricultural practices. Depending on their form and magnetic responses they either denote ridge and furrow, modern ploughing or land drains.

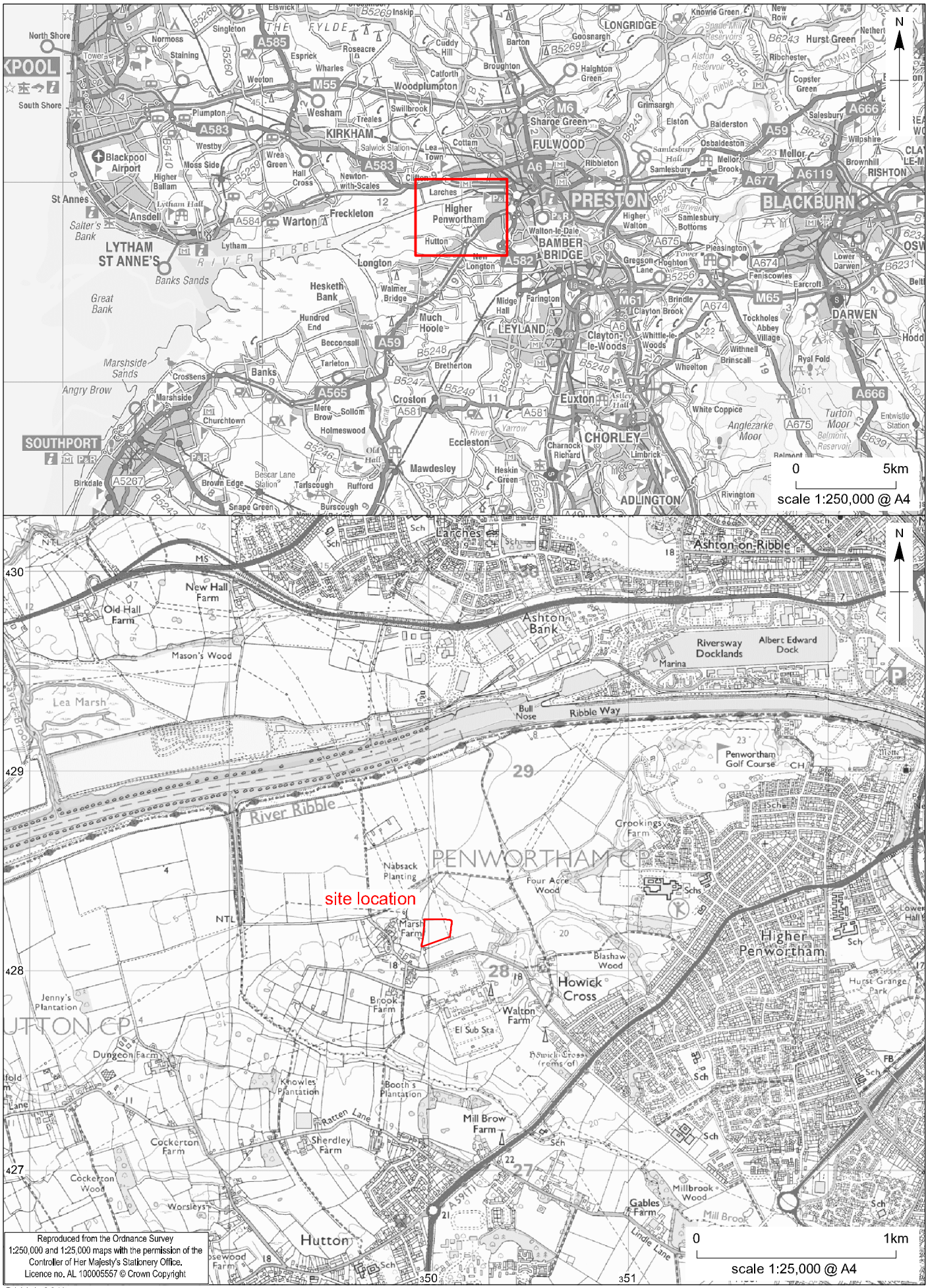
Dipolar readings are single positive responses with a surrounding negative response. Strong responses tend to be caused by ferrous objects. These responses have only been shown when located near to archaeological features. Given the former land uses of the survey area it is possible that identified dipolar anomalies relate to mining activity and are indicative of further pits and mine shafts.

Positive anomalies with associated negative responses (bipolar) denote features with a strong magnetic response, likely to be of a modern origin. Linear bipolar anomalies are often modern services such as cables; however weaker responses can be archaeological features such as earthworks.

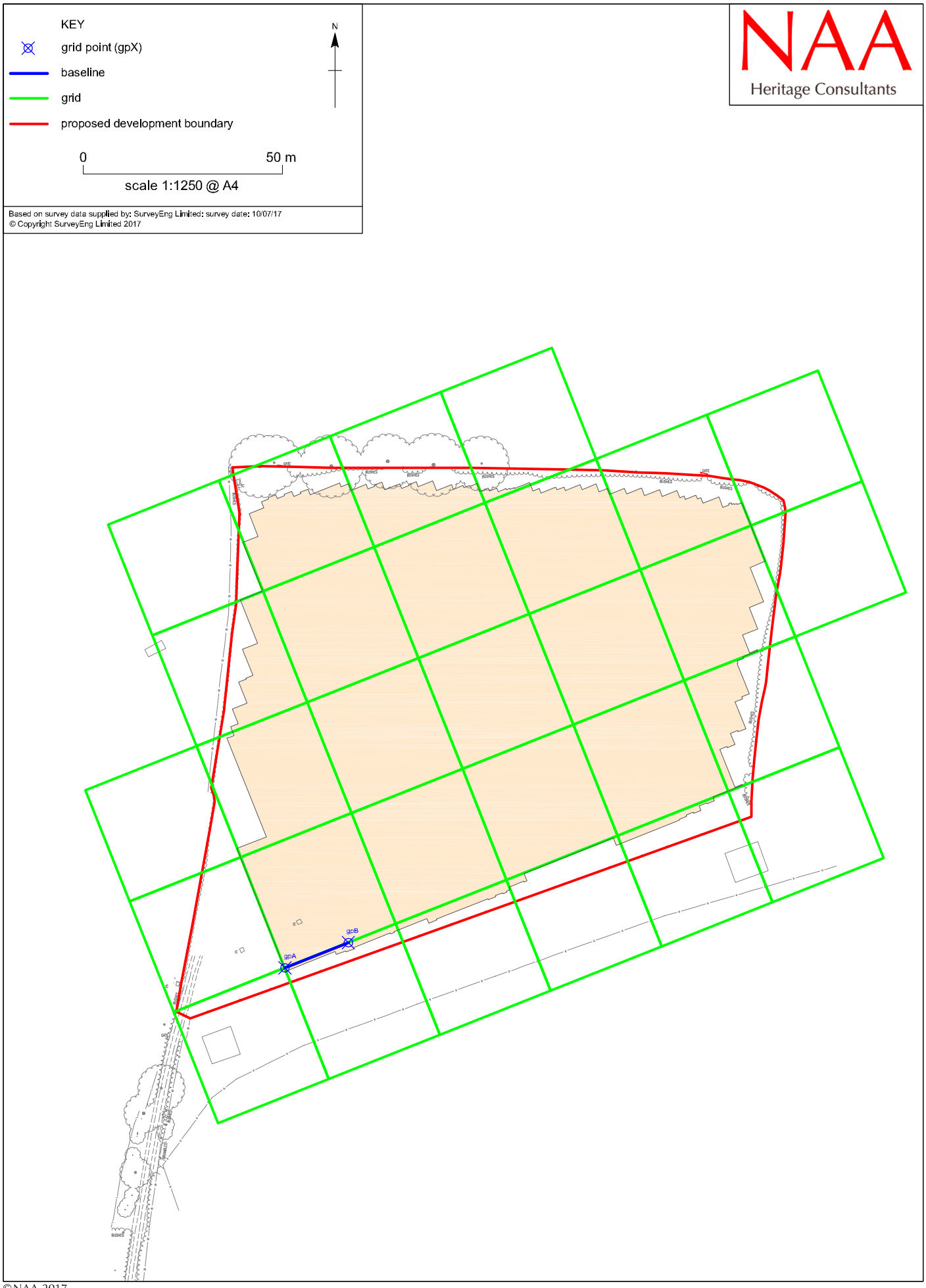
Increased magnetic response is caused by magnetic debris and is noticeable as areas of positive and negative responses, which can relate to general ground disturbance, spreads of ferrous debris or areas of rubble.

Areas of magnetic disturbance, often along the edges of survey areas are caused by standing metal structures such as fencing and buildings. This can cause interference extending out from the structure, across the area.

Variable weak magnetic responses can demonstrate natural features or changes in geology or soil type.



Howick Hall Farm, Penwortham, Lancashire: site location *Figure 1*



Howick Hall Farm, Penwortham, Lancashire: gradiometer survey grid location *Figure 2*

0 50 m

scale 1:1250 @ A3

N

Based on survey data supplied by: SurveyEng Limited: survey date: 10/07/17

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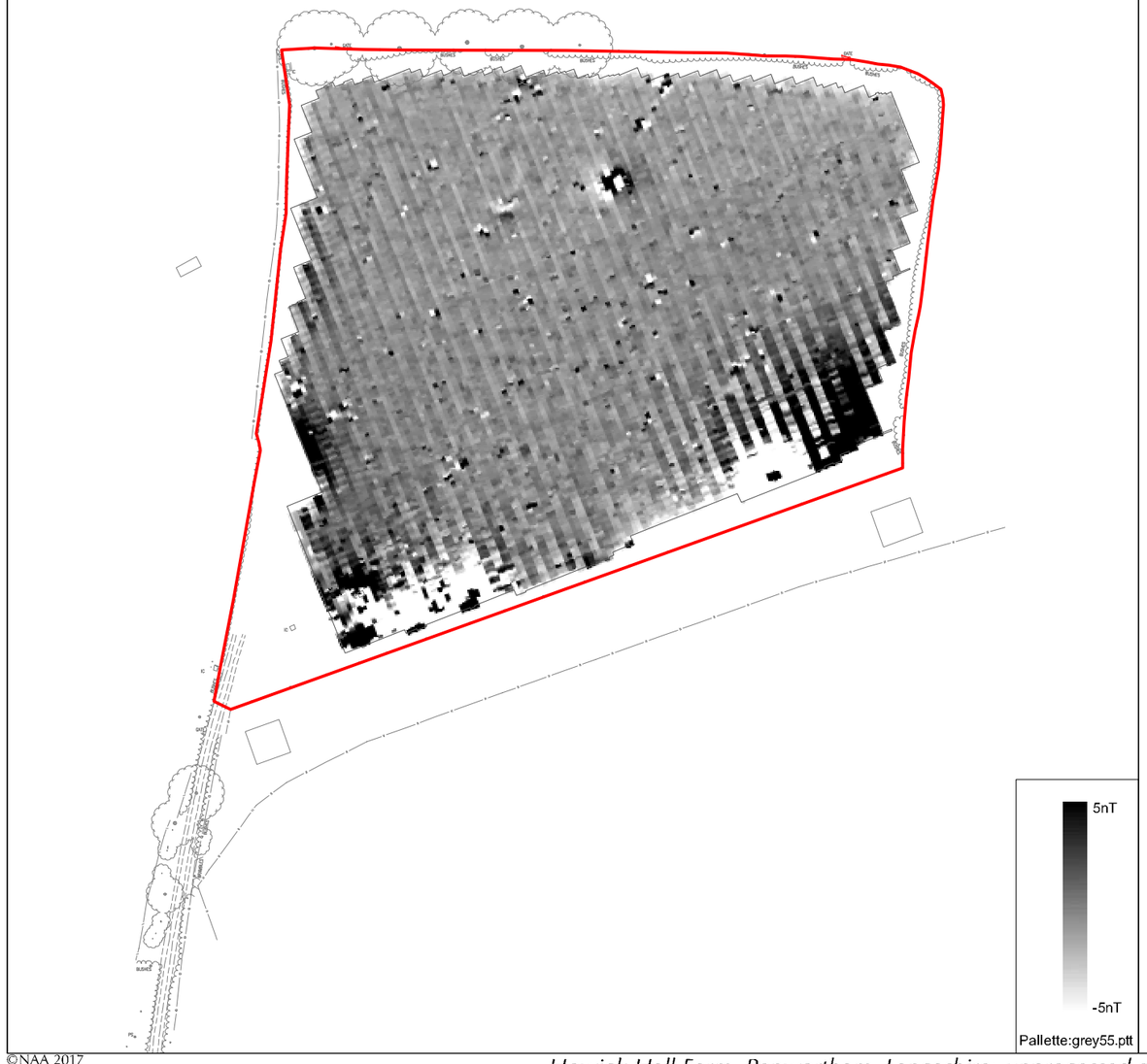

Howick Hall Farm, Penwortham, Lancashire: unprocessed greyscale and XY-trace plots of gradiometer survey results

Figure 3

0 50 m

scale 1:1250 @ A3

N

Based on survey data supplied by: SurveyEng Limited: survey date: 10/07/17

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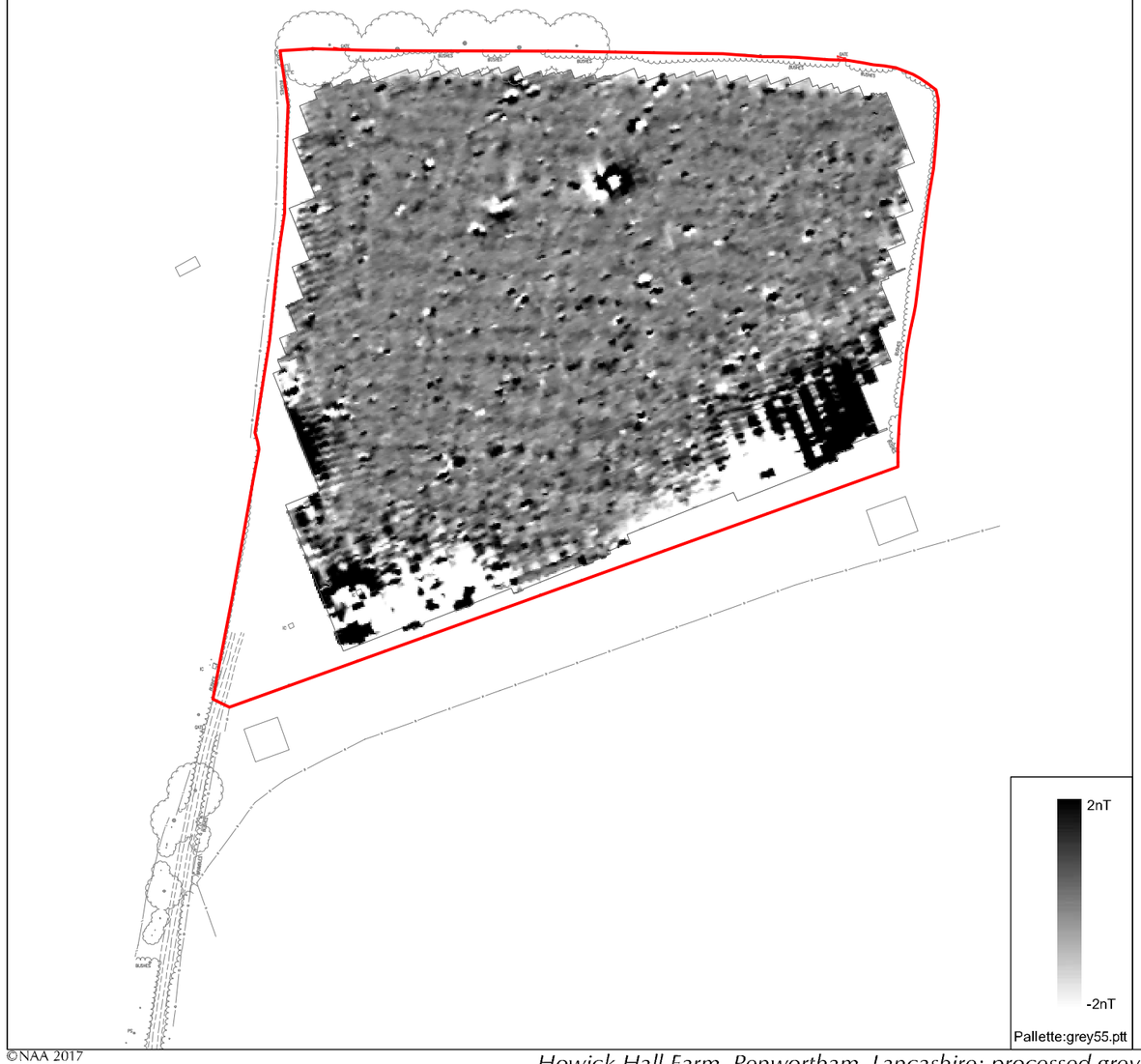

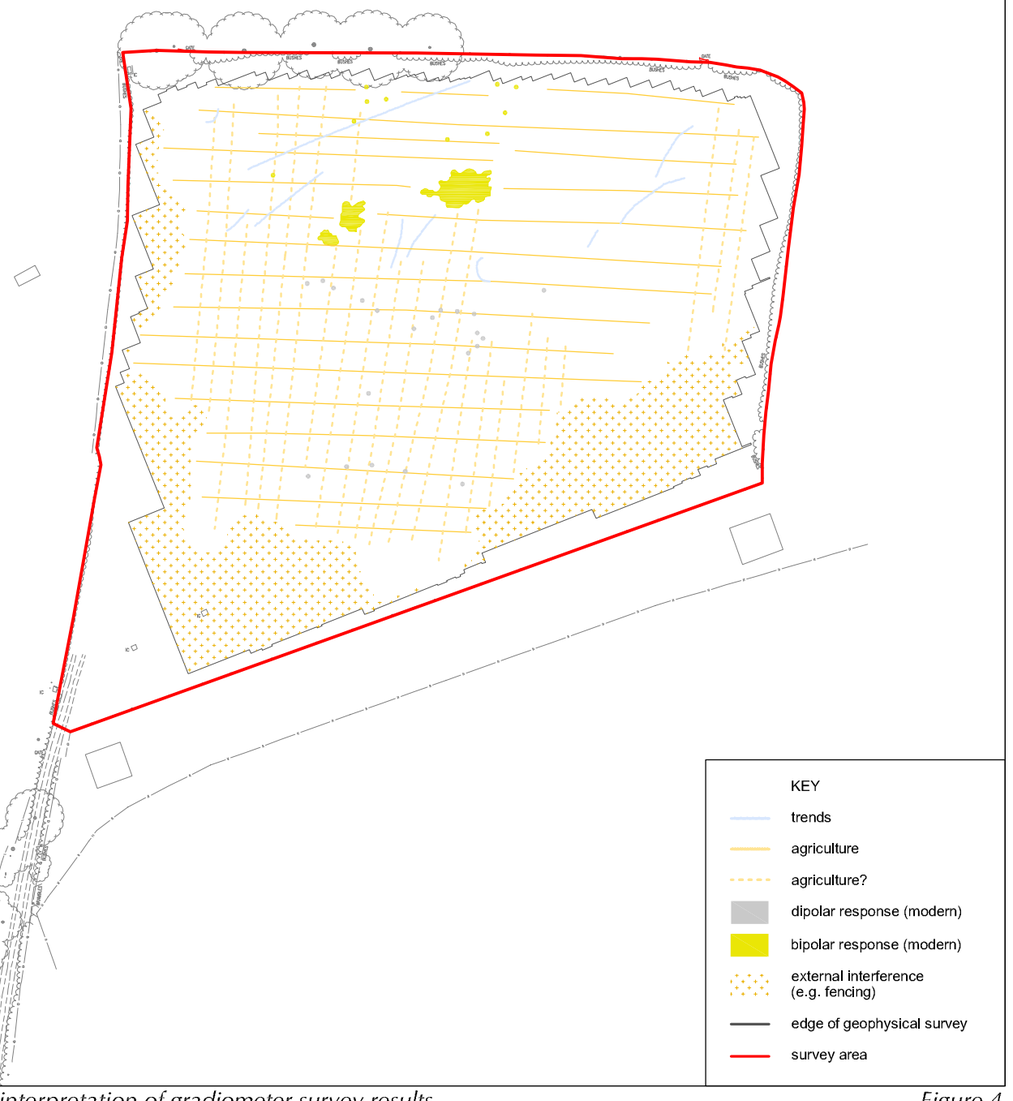

Howick Hall Farm, Penwortham, Lancashire: processed greyscale plot and interpretation of gradiometer survey results

Figure 4