

**GEOPHYSICAL SURVEY OF PROPOSED  
WASTEWOOD PROCESSING PLANT,  
POLLINGTON AIRFIELD, NORTH  
YORKSHIRE AND EAST RIDING OF  
YORKSHIRE**

HFA Site Code: PAF 2008  
Grid Ref.: SE 6017 2089 (approximate centre)

A programme of research carried out on behalf of

**Humber Field Archaeology**

by

**GeoQuest Associates**



## **SUMMARY**

A fluxgate magnetometer has been used to carry out an archaeological geophysical survey on the site of a proposed waste wood processing plant on Pollington Airfield in the counties of North Yorkshire and the East Riding of Yorkshire. A total of about 13.14ha was surveyed using a fluxgate gradiometer logging data at 0.25m intervals, along traverses spaced 1.0m apart. The site was found to be characterised by extremely weak geomagnetic anomalies, indicative of very low soil susceptibilities, a fact confirmed by the absence of any anomalies over the sites of backfilled trial pits or topographic features. However, the general absence of contamination by surface ferrous litter has aided detection of weak geomagnetic anomalies of potential archaeological interest. The geophysical data confirm the presence of a trackway seen as a cropmark in aerial photographs, while further ditches possibly indicative of enclosures and additional tracks have been located. Owing to the tenuous nature of the geophysical anomalies, the confidence level assigned to many of the features is low, and hence further characterisation via trial trenching may be advisable.

## 1 INTRODUCTION

1.1 The aim of this report is to describe the methodology and results of geophysical surveys on sample areas at Pollington Airfield, in North Yorkshire and the East Riding of Yorkshire (Figure 1). Dalkia Bioenergy Ltd (DBE) are evaluating a scheme for the site which will involve the processing of waste wood for biofuel production and the survey forms part of a comprehensive site assessment being undertaken by Humber Field Archaeology for DBE through their consultants *ethical partnership*. The results of the geophysical survey will inform further stages of site investigation which may include trial trenching or monitored topsoil strip, in order to further characterise the archaeology.

1.2 The research was carried out by staff from GeoQuest Associates during the period 26<sup>th</sup> November to 2<sup>nd</sup> December 2008, at which time all parts of the study area were in arable cultivation. A total of about 13.14ha were mapped in 5 blocks, which are characterised as follows:

**Areas 1 & 2:** A pair of 200x100m sample blocks, separated by 60m, bordering the M62 motorway. Here the land had recently been ploughed, harrowed and reseeded for a cereal crop which had grown to a maximum height of 5cm. Although soils here are generally well drained, the blocks were positioned to avoid an area of boggy ground and also straw bale storage areas on the northern side of the adjacent runway where the ground was heavily disturbed.

**Area 3:** A 200x100m sample located on a part of the central airfield where grass had regrown within old stubble to a height of 15cm. Again, the sample block was offset from the adjacent runway to avoid large straw bale storage areas and disturbed topsoils.

**Areas 4 & 5:** Together these comprised the largest sample, positioned to map and characterise a ditched trackway seen as a cropmark on aerial photographs. The westernmost part of these samples is located on level harrowed ground, bearing a 5cm tall leaf crop. Soils here are generally more sandy than elsewhere in the study area. Straw bale storage compounds and associated soil disturbance are present along the northern side of the adjacent runway, which therefore defined the southernmost limit of the geophysical survey. A bank of straw bales are located along the adjacent western field boundary to form bunkers for waste wood storage. A wood crusher, steel-framed recycling building and other items of plant are also located between the bunkers.

1.3 Cropmarks recorded on air photographs provide evidence that the site is located in a rich and varied archaeological landscape that contains traces of enclosures, boundary ditches and trackways, probably dating from the late prehistoric or Romano-British periods. Of particular interest is the ditched trackway seen traversing Area 5 from NW to SE over a distance of several hundred metres. Medieval settlement is present in the immediate area, suggesting that features dating from this period may also be present. The WWII airfield at Pollington (designated Snaith) operated between 1940 and 1945 and it is possible that subsoil remains, in the form of associated installations, may survive in the subsoil.

## 2 THE GEOPHYSICAL SURVEY

2.1 Baselines for the geophysical survey were constructed according to the definitions given in Figure 1. As described above, the sample blocks were offset from strawbale storage compounds and areas of soil disturbance to minimise disturbance to the geophysical data.

Coordinates of features detected by the survey can be determined relative to these baselines or OS detail by extraction from the associated CAD file that forms part of the site archive.

- 2.2 Measurements of vertical geomagnetic field gradient were recorded using a Geoscan FM36 fluxgate gradiometer with 0.05nT/m resolution. A zig-zag traverse scheme was employed and data were logged in grid units of 20x20m at 1.0x0.25m intervals, thus providing 1600 measurements per grid.
- 2.3 Data obtained from the survey were downloaded on-site into a portable graphics computer for quality checks and initial processing. These data were subsequently transferred to a laboratory computer for final processing, interpretation and archiving.
- 2.4 The GeoQuest InSite® software was used to process the gridded geophysical data and thus convert the field readings into two continuous-tone grey-scale images. In Figures 2 and 3 a convention has been used that shows positive magnetic anomalies as dark grey and negative magnetic anomalies as light grey. Figures 4 and 5 show the data after processing with a low-pass filter: this algorithm reduces 'speckle' in the images due to surface micro-topography and soil susceptibility noise, thus improving the visibility of anomalies of deeper (i.e. of archaeological) origin. Further details of the data processing procedures are given in Appendix A.
- 2.5 An archaeological interpretation of the geophysical survey is presented in Figures 6, 7 and 8. A key defines the colours and fill styles used in these drawings, while feature codes **f1** and **f2**, etc, are included in Figure 8 for reference in the discussion below.

### **3 INTERPRETATION**

#### **General**

- 3.1 Geomagnetic anomalies throughout the study area were found to be extremely weak, necessitating frequent checks on the instrument stability, and particular care in traverse-handling to minimise artefacts in the geophysical data. The low amplitude anomalies indicate very weak soil magnetic susceptibilities, further evidence for which is demonstrated by the following:
  - Geophysical survey of Areas 3, 4 and 5 included a number of backfilled trial pits, the upcast from which remained clearly visible on the surface as contrasts in colour, grain size and lithology. No magnetic anomalies coinciding with these pits were detected, indicating very low susceptibilities (and minimal contrast) in both topsoil and subsoil layers.
  - Ploughing usually gives rise to a distinctive texture in geomagnetic data, due to the surface microtopography thereby created, plus progressive sorting of heavier, more magnetic mineral grains. However, no such texture is evident.
- 3.2 With the exception of expected areas close to the headland and bale storage sites, the survey blocks contain very low densities of surface iron litter, as shown by small magnetic dipoles. This characteristic has facilitated the detection of minor geophysical anomalies of archaeological interest.

#### **Areas 1 & 2**

- 3.3 **f1:** Intense magnetic dipoles have been detected along the southern boundaries of both these sample blocks, close to areas where straw bales are stored, and where soils are heavily disturbed. The magnetic dipole clusters probably reflect breakage and movement of hardcore material away from the runway edges, together with iron litter from the handling machinery. Further magnetic materials may be present had there once been WWII facilities adjacent to the runways, which have since been demolished.
- 3.4 **f2:** A striking feature of the data image in Area 1 is a 4m wide, positive magnetic anomaly traversing the western half of the block in a north-south direction. The style of the anomaly is consistent with a former field boundary or silted stream channel. A smaller, rectilinear anomaly has been detected immediately to the east, possibly indicating an enclosure extending from this boundary feature.
- 3.5 No geophysical anomalies of archaeological interest have been detected in Area 2.

### **Area 3**

- 3.6 Geophysical data obtained in this area are indistinguishable in character (noise, anomaly magnitude, etc) from data recorded elsewhere on site, despite the differing style of landuse, microtopography and cultivation. This again supports the view that soil magnetic susceptibility values on this site are very low.
- 3.7 **f3:** A pattern of extremely weak and diffuse magnetic lineations may be present in the eastern quarter of the sample block, oblique to the plough direction and close to the detection limit of the fluxgate magnetometer used. These provide tentative evidence for a set of 3 or more ditches forming part of a trackway or enclosure which appears to continue south beyond the area surveyed.
- 3.8 **f4:** A prominent (though weak) positive magnetic lineation is seen traversing through the centre of the block in a north-south direction, providing good evidence for a soil-filled ditch (or land drain) at least 135m long. However, it is worthwhile noting that this feature is oriented towards the cellphone mast, suggesting that it may instead mark the trace of a cable duct for this facility or some other installation dating from WWII.

### **Area 4**

- 3.9 **f5 & f6:** Two diffuse magnetic lineations appear to be present in a cruciform configuration, possibly indicating ditched trackway(s) or sections of enclosures. These anomalies are again close to the limit of detection and further clarification of their target character by trial trenching may be required. In addition, there may be a need to test whether feature **f6** continues southwards, connecting with ditch feature **f9** seen in Area 5.

### **Area 5**

- 3.10 This was the largest of the survey blocks designated by the project design (6.18ha) and was positioned to encompass a known ditched trackway mapped by aerial photography. In addition to confirming the presence of the trackway, a number of minor features of archaeological interest have been located, although with variable confidence owing to the weak and diffuse character of the magnetic anomalies.

- 3.11     **f1:** Two compact clusters of magnetic dipoles are present, both probably associated with debris dating from the site's original use as an airfield. The dense concentration near the weighbridge, in particular, suggests a deposit of brick and iron debris from demolition of a building.
  
- 3.12     **f7:** The known trackway is seen as a pair of lineations with weak-moderate intensity, spaced 8m apart, which can be traced for about 255m through the long axis of the survey block. The variable appearance of the anomaly pair may indicate variable preservation, actual gaps in the boundary ditches or a changing magnetic contrast of the fill relative to the surrounding subsoil. From the results it appears that the trackway continues on a bearing south-east beyond the survey, towards the adjoining runway.
  
- 3.13     **f8:** A relatively strong, positive lineation in the eastern corner of the block provides convincing evidence for two sides of a ditched enclosure, possibly with an entrance on the western side. A trial trench positioned immediately to the east could test for a connection between this feature and the southern extent of ditch-type anomaly **f4** in Area 3.
  
- 3.14     **f9:** Careful examination of the eastern half of the data image reveals one or more discontinuous lineations, which trend approximately north-south for a distance of about 90m. The quality of the survey data precludes a detailed interpretation although, due to the proximity of trackway **f7**, it is possible that the anomalies reflect sections of further trackway or associated enclosures.
  
- 3.15     **f10 & f11:** Towards the north-western limit of detected trackway **f7** there appears to be a complex pattern of rectilinear magnetic anomalies that may indicate one or more rectangular ditched enclosures. A suggested interpretation is presented in Figure 8, although resolution of detail in this part of the block is hindered by interference from a possible pipeline (**f13**) and debris in the headland. Of particular note is the possible existence of a 10m square ditched feature within enclosures **f10** and **f11** whose general geometry appears consistent with Romano-British style tenements bordering the adjacent ditched roadway.
  
- 3.16     **f12:** Several minor, positive magnetic lineations have also been detected, few longer than 20 or 30m, whose archaeological significance is uncertain. However, a more prominent example can be traced south-east from the western field boundary for about 100m, before possibly turning south-west to follow the modern plough direction. This and the more minor examples may correspond to enclosure ditches but owing to the diffuse nature of the geophysical signal, a more rigorous interpretation is not possible.
  
- 3.17     **f13:** A chain of strong magnetic dipoles along the field boundary adjoining the waste wood storage area suggest that a buried iron pipeline or cable duct exists in this position. Reference to a site utility plan will help to resolve this interpretation.

## 4     **SUMMARY AND CONCLUSIONS**

- 4.1     A fluxgate magnetometer has been used to carry out an archaeological geophysical survey on the site of a proposed waste wood processing plant on Pollington Airfield which

straddles the boundary between North Yorkshire and the East Riding of Yorkshire. The site was found to be characterised by extremely weak geomagnetic anomalies, indicative of very low soil susceptibilities, a fact confirmed by the absence of anomalies over the locations of backfilled trial pits. However, the general absence of contamination by surface ferrous litter has aided detection of weak geomagnetic anomalies of potential archaeological interest. The geophysical data confirm the presence of a trackway seen as a cropmark in aerial photographs, while further ditches possibly indicative of enclosures and additional tracks have been located. Owing to the tenuous nature of the geophysical anomalies the confidence level assigned to many of the features is low, and hence further characterisation via trial trenching may be advisable.

## 5 CONFIDENCE LIMITS

- 5.1 The following are the levels of confidence which we assign to the features inferred from the geophysical data:

FEATURE	INTERPRETATION	CONFIDENCE LEVEL, %									
		10	20	30	40	50	60	70	80	90	100
f1	Ferrous litter										
f2	Boundary/channel										
f3	Ditches										
f4	Ditch, drain or duct										
f5 & f6	Ditches										
f7	Ditch trackway										
f8	Ditched enclosure										
f9	Ditches										
f10 & f11	Ditches/enclosures										
f12	Ditch										
f13	Pipe										

## 6 CREDITS

Survey & Report: M. J. Noel PhD, FRAS  
Date: 5<sup>th</sup> December 2008

**Note:** Whilst every effort has been taken in the preparation and submission of this report in order to provide as complete an assessment as possible within the terms of the brief, GeoQuest Associates cannot accept any responsibility for consequences arising as a result of unknown and undiscovered sites or artefacts.

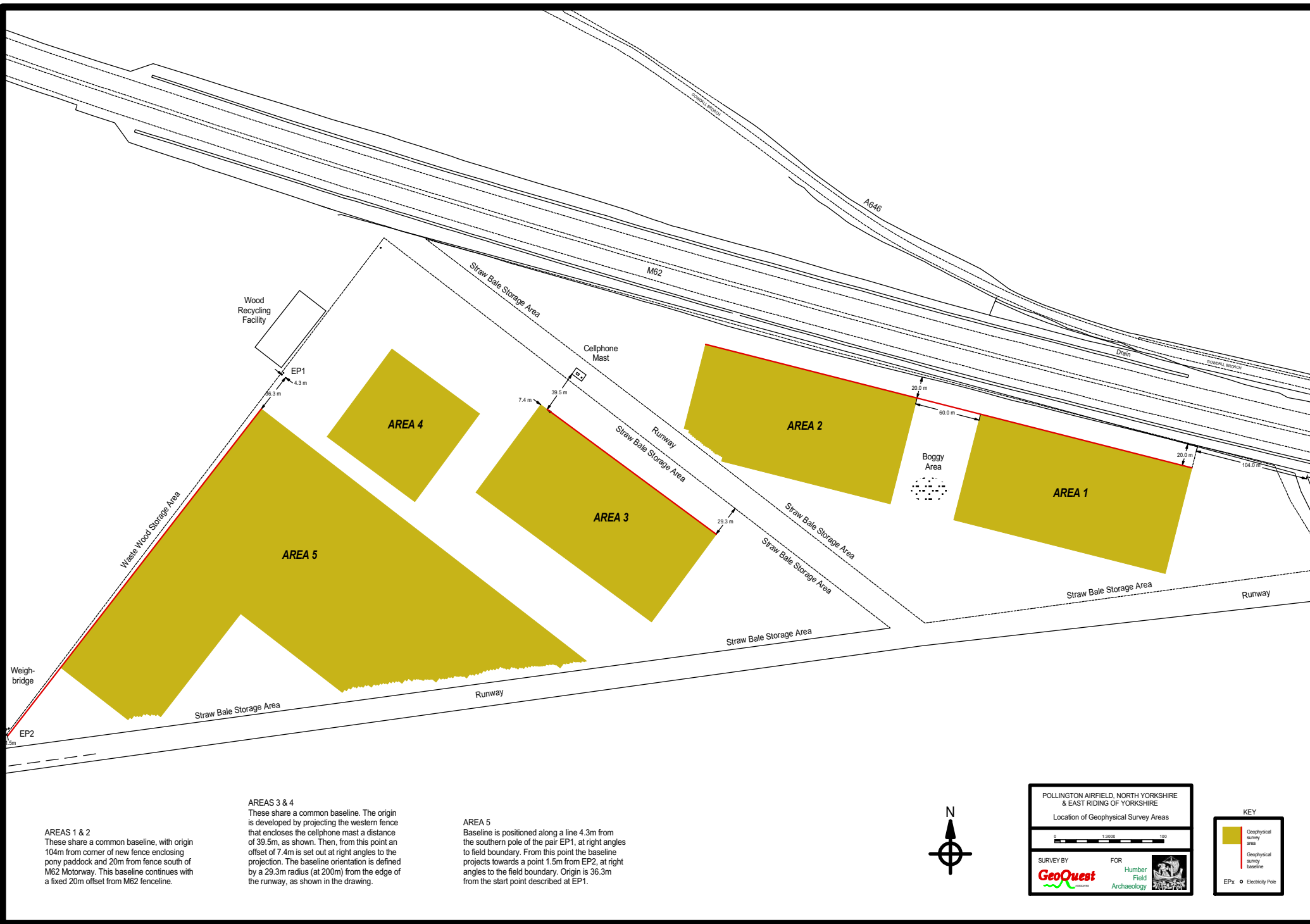


FIGURE 1



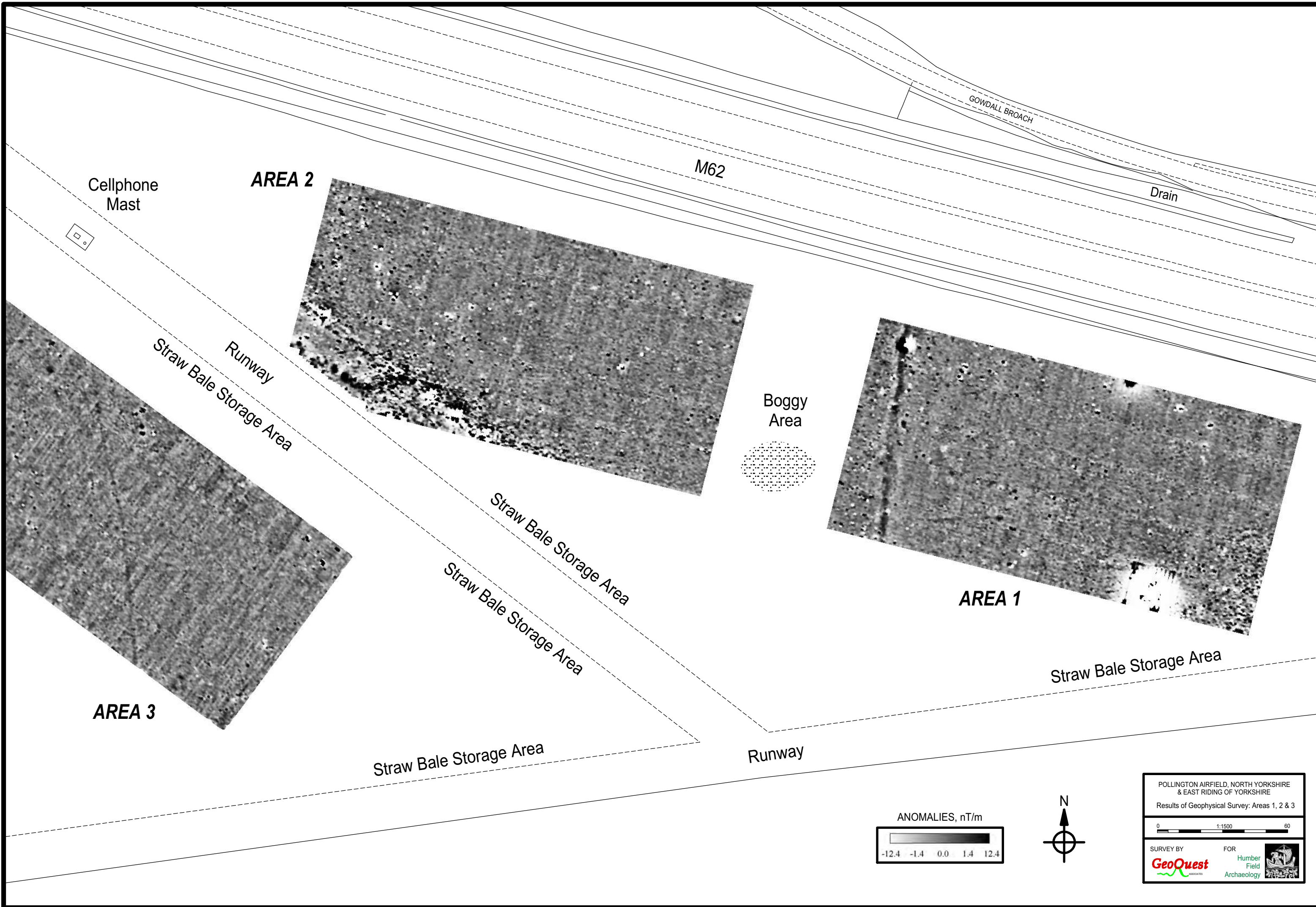


FIGURE 2



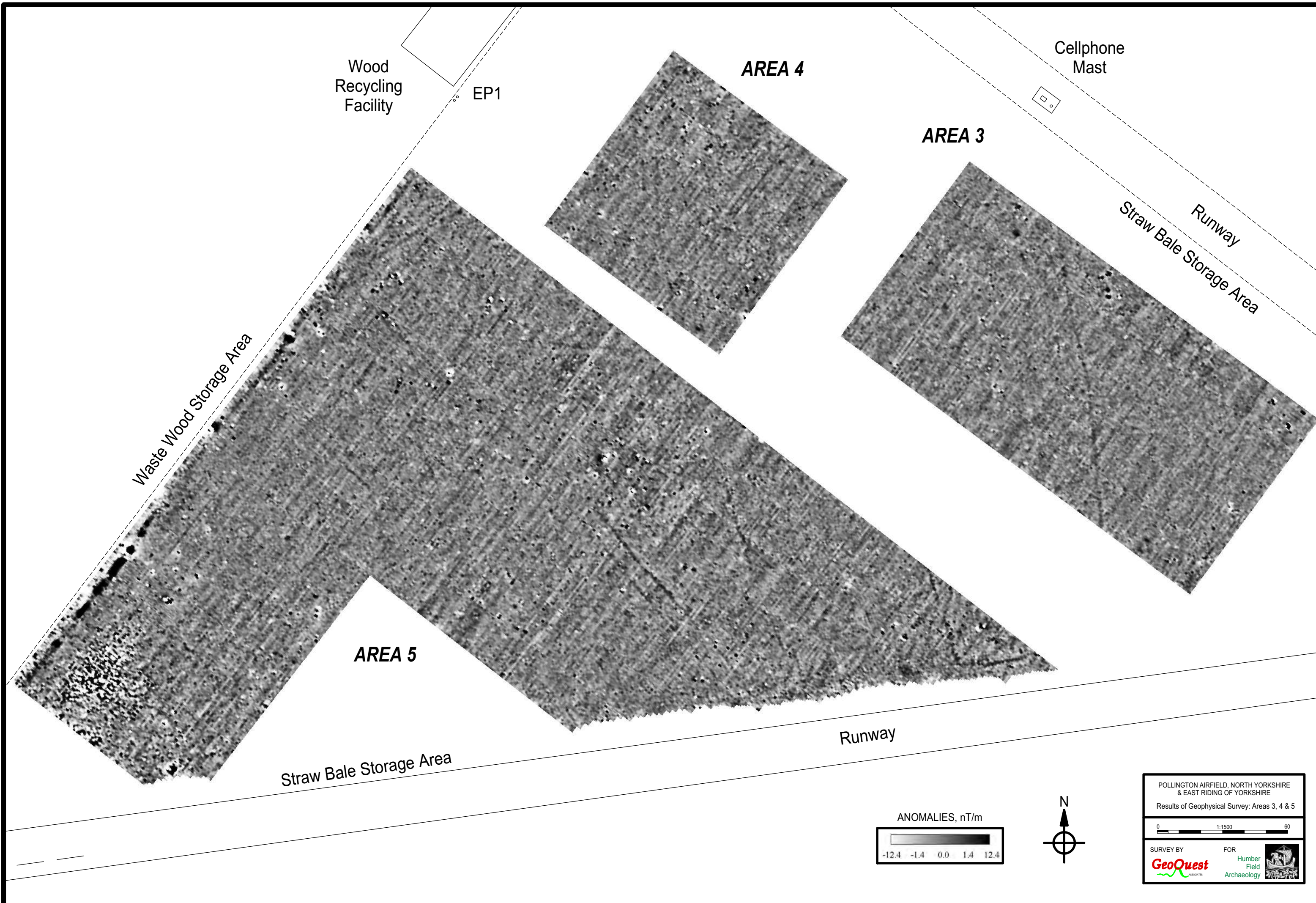


FIGURE 3



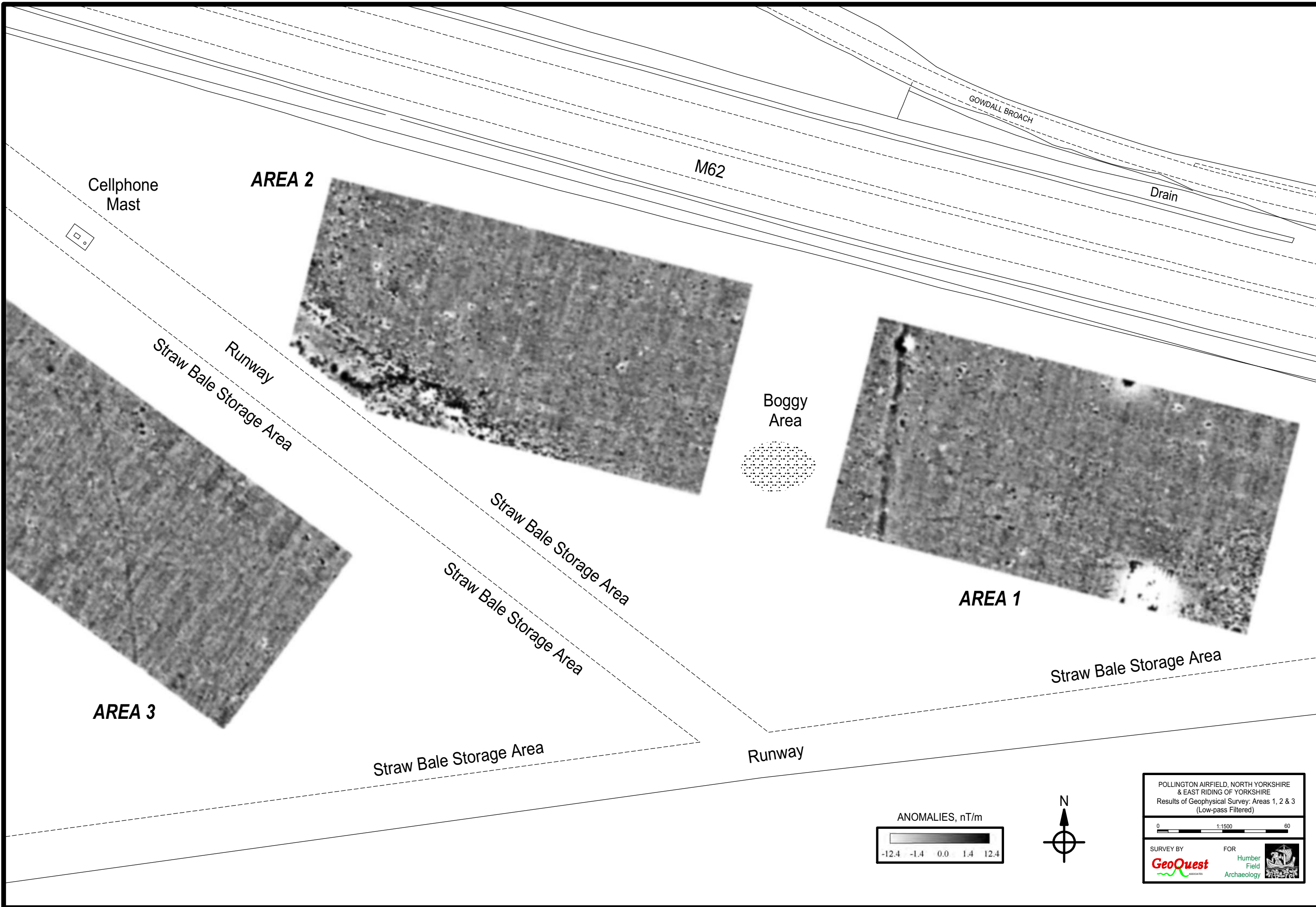


FIGURE 4

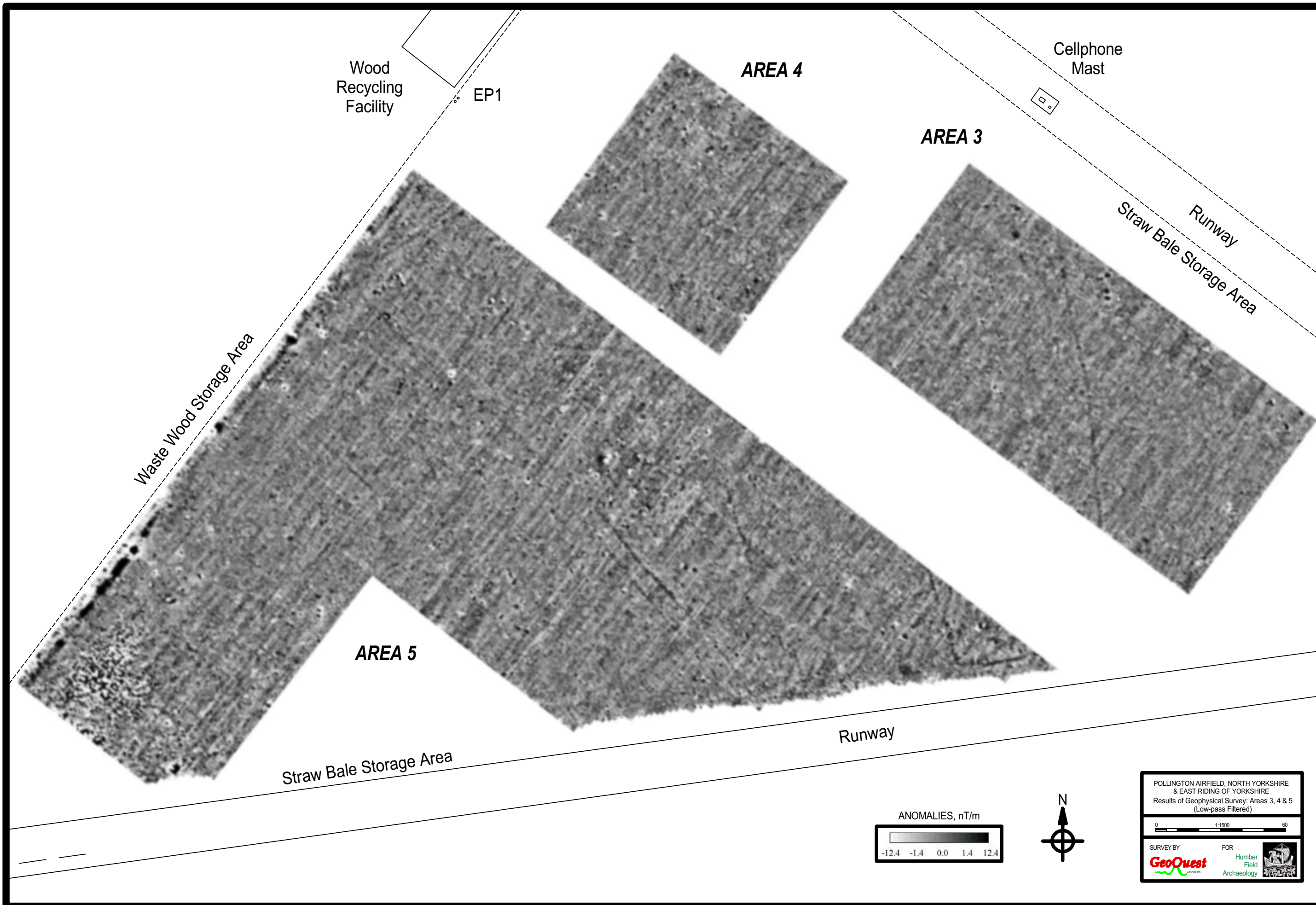


FIGURE 5







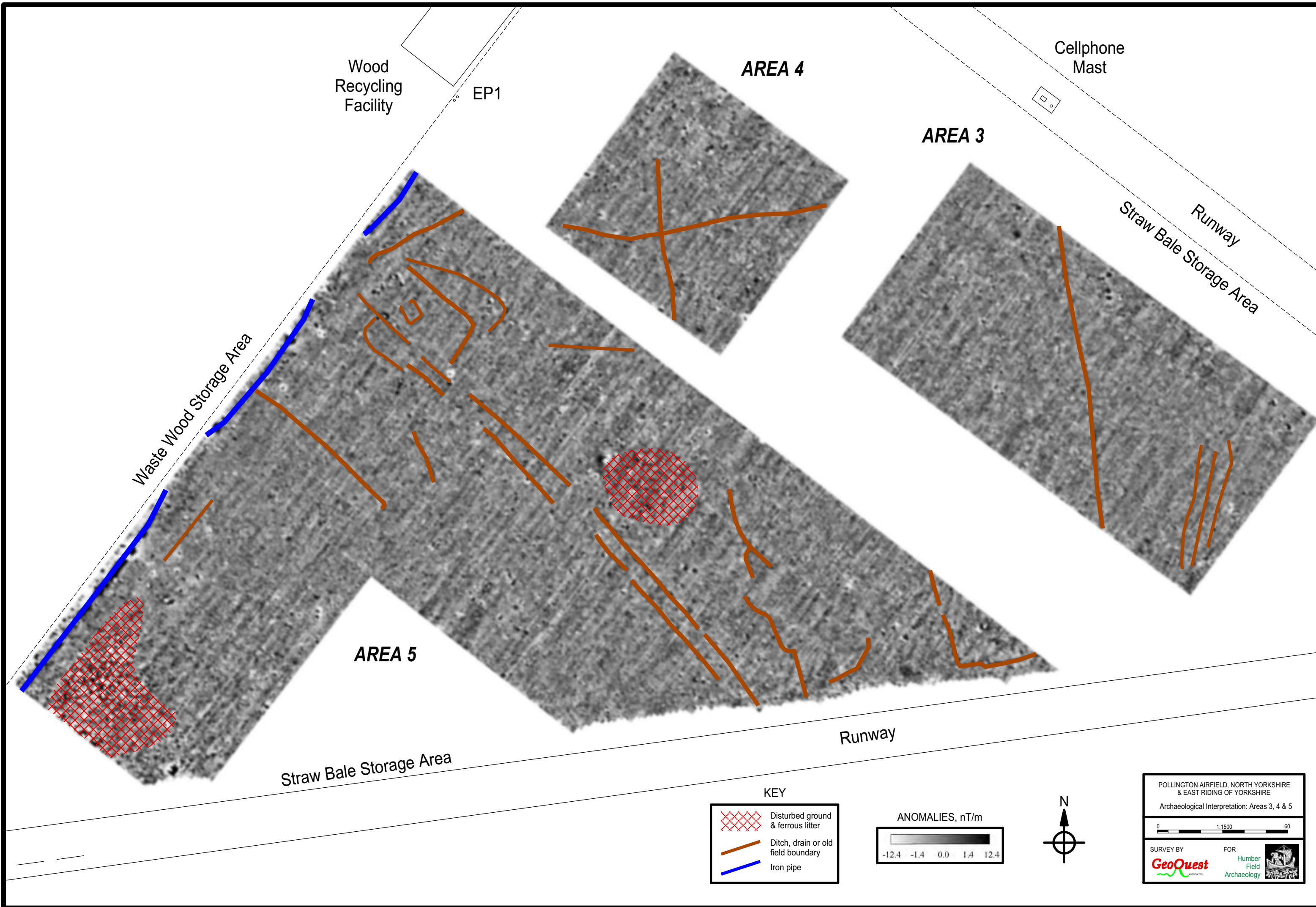


FIGURE 7

## **APPENDIX A**

### **DATA PROCESSING**

#### **PROCESSING THE SURVEY DATA**

The geophysical images contained in this report were prepared within Microsoft Windows® using the InSite® program published by GeoQuest Associates. Geophysical images were then placed onto a map which was digitised from the Ordnance Survey, edited and then plotted using a computer aided drafting (CAD) system and colour inkjet printer.

Data were downloaded from the meter to a portable computer in the field for storage, visualisation and quality control (QC) assessment. These data were then transferred to a laboratory computer for final processing, printing and archiving.

A number of process steps have been applied to the geophysical data obtained during the survey and those which have been used are linked to the main flow path by arrows. Steps were applied in the order shown and are designed to reduce artifacts in the data and enhance geophysical features of archaeological interest. The following sections describe each step in more detail.

#### **REMOVE STRIPING**

Reduces a data artifact comprising alternating changes in level in readings logged along zig-zag traverses. This artifact is common in fluxgate magnetometer data. InSite uses a proprietary algorithm to reduce this error.

#### **INFILL SMALL BLANK AREAS**

Fills isolated blank data cells with the mean of near-neighbours or a suitable approximation entered manually. Small blank areas will have been logged if it was not possible to obtain a geophysical reading over, for example, a manhole cover in the case of a resistivity survey.

#### **REMOVE SPIKES**

Replaces isolated, anomalously high or low values with the mean of near neighbours or a suitable approximation entered manually. 'Spike' readings are commonly associated with ferrous litter or poor electrical contact in the case of geomagnetic and resistivity data, respectively.

#### **REDUCE WALK HARMONICS**

Reduces a regular oscillation in traverse data caused by walking movements of the operator during a geomagnetic survey. InSite employs a fast Fourier transform to determine the optimum amplitude and phase of the walk-induced harmonic which is then subtracted from each traverse.

## **REDUCE SHEAR ARTIFACTS**

Corrects for apparent shear in geomagnetic anomalies surveyed by zig-zag traversing in a geomagnetic survey. The shearing effect arises from the interaction of the operator+magnetometer with the geomagnetic field and also from the lag in the instrument response to changes in the field. InSite uses a proprietary algorithm to reduce this error.

## **CORRECT FOR METER DRIFT**

Corrects for a linear drift in the meter calibration with time. Such drift is a common problem with fluxgate magnetometers, particularly during periods of rapid air temperature change. InSite uses least-squares regression on the mean of data along each traverse to estimate the change in calibration level across each grid. This gradient is then removed from the data.

## **ADJUST GRID MEAN LEVELS**

Adjusts for differences in the mean level in data grids due to changes in instrument calibration (fluxgate magnetometer survey) or alteration in remote electrode spacing (resistivity survey).

## **INTERPOLATE AND COMBINE**

Combines grids to form an array of regularly-spaced data on a square mesh. InSite uses bilinear interpolation to accomplish this.

## **LOW PASS FILTER**

If this process task is indicated then a 3x3 or 5x5 boxcar filter has been used to smooth the data and reduce noise or 'speckle' seen in the original image.

## **HIGH PASS FILTER**

If this process task is indicated then a 3x3 or 5x5 filter, with appropriate coefficients, has been used to pass short-wavelength information into the resulting image.

## **EDGE DETECT FILTER**

Signifies that a Sobel, Laplace or other specialised filter has been applied to enhance significant lateral transitions in the geophysical image.

## **DIRECTIONAL FILTER**

This filter is equivalent to illuminating the data from one direction to produce a pseudo-relief image. Directional filtering is usually employed to aid the identification of subtle anomalies in resistivity data. This filter highlights features trending at right angles to the direction of illumination.

## **NOTE**

GeoQuest Associates can supply the geophysical images presented in this report in a variety of digital formats for visualisation on microcomputers running Microsoft Windows. These formats include the TIF, BMP and PCX standards.



