LEEMING LANE/NORTHALLERTON ROAD, LEEMING BAR, NORTH YORKSHIRE.

REPORT ON A GEOPHYSICAL SURVEY.
OSA REPORT No: OSA12EV06 (Geophysics)

April 2012.

OSA

ON SITE ARCHÆOLOGY LTD

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Report Summary.

PROJECT NO:	OSA12EV06 (Geophysics)
SITE NAME:	Leeming Lane/Northallerton Road, Leeming Bar
COUNTY:	North Yorkshire
NATIONAL GRID REFERENCE:	SE 2889 8999
ON BEHALF OF:	Castlevale Group 2 Bailey Court Colburn Business Park Colburn North Yorkshire DL9 4QL
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TIMING:	Fieldwork April 2012 Report preparation April 2012
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1.0 Abstract.

A geophysical survey was carried out by On-Site Archaeology *in advance of the submission of a planning application for redevelopment of a complex of existing buildings, the construction of additional housing and associated infrastructure. As the archaeological significance of any buried heritage assets and therefore the implications of the proposals could not be adequately assessed on the basis of currently available information, in accordance with the recommendations of the National Planning Policy Framework (paragraph 128) a scheme of archaeological evaluation by geophysical survey was carried out.*

The survey has demonstrated the potential survival of archaeological remains in the eastern part of the site. Modern industrial debris was present over much of the western part of the site and this may have served to 'mask' further evidence of buried archaeological remains in that area, which includes the supposed course of Dere Street, a major Roman road with potential associated roadside settlement. The survey has revealed the presence of a number of potentially archaeological remains on the site. It may therefore be necessary to further evaluate the site by trial excavation to adequately understand the extent and significance of the remains.

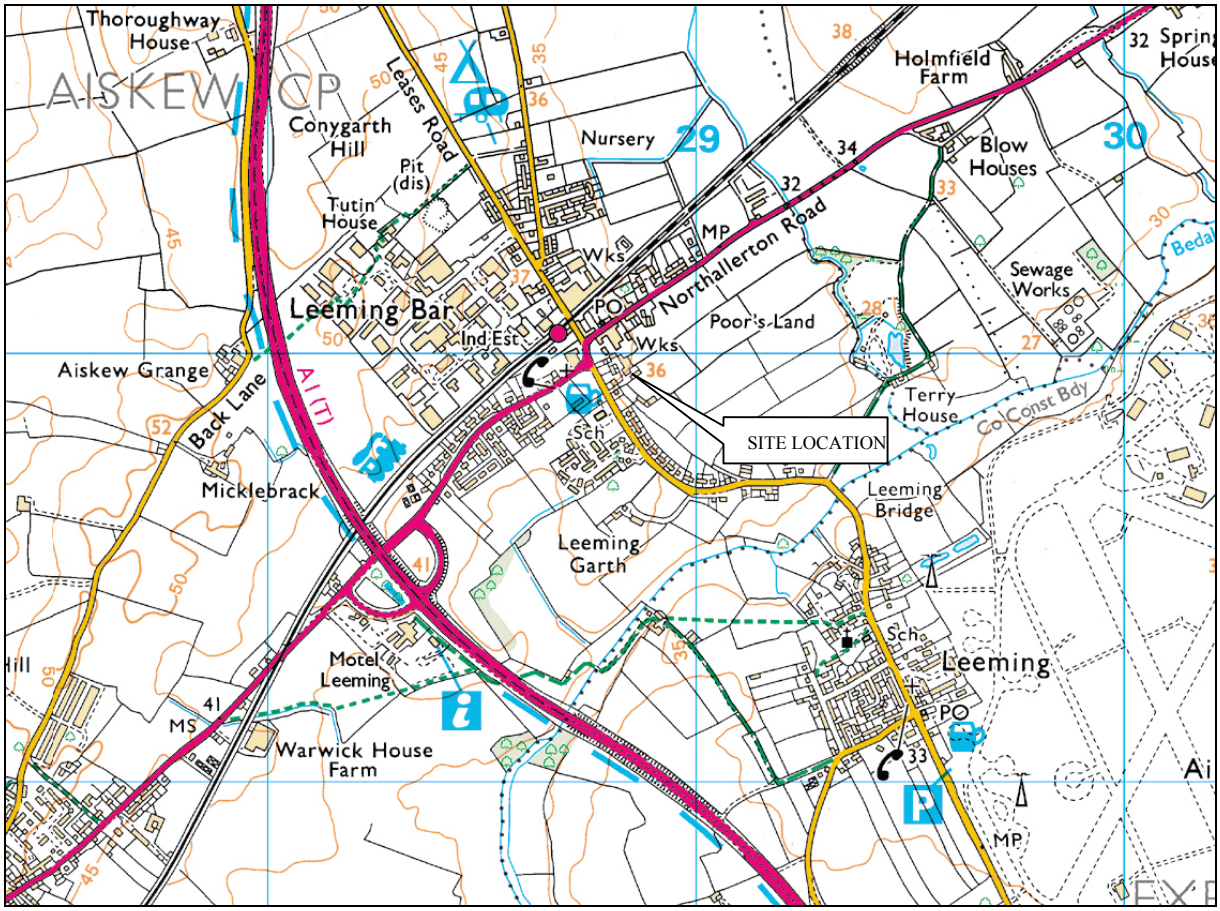

Figure 1: Site Location (NGR SE 2889 8999)

2.0 Site Location, Geology, Topography and Land Use.

The site considered by this report, centred at NGR SE 2889 8999, lies in the centre of the village of Leeming Bar at the junction of Northallerton Road and Leeming Lane (Figure 1) and the modern ground level lies at between 34.50m AOD to the south, up to a highest point of just below 36m AOD in the northwest corner.

The site is currently in mixed use, with arable agricultural land to the east, pasture to the south, a range of 19th and 20th century brick and concrete block buildings across much of the north, west and central parts, together with rough concrete, tarmac and gravel yards. The majority of the buildings and yards are used for retail and light industrial purposes, the exception being the residential Fairview Flats, located in the northeast corner of the site.

The bedrock geology comprises sandstone of the Sherwood Group, overlain by Devensian Glaciofluvial deposits of sand and gravel (British Geological Survey maps accessed via bgs.ac.uk/geologyviewer). Sandstone tends to yield poor results in geophysical surveys and over sand and gravel drift geology the response is highly variable, tending to range from good to moderate (English Heritage 2008, 15).

Only those parts of the site unoccupied by standing buildings and industrial debris were appropriate to undertake geophysical survey. Figure 2 shows the location of the geophysical survey in relation to the site boundary.

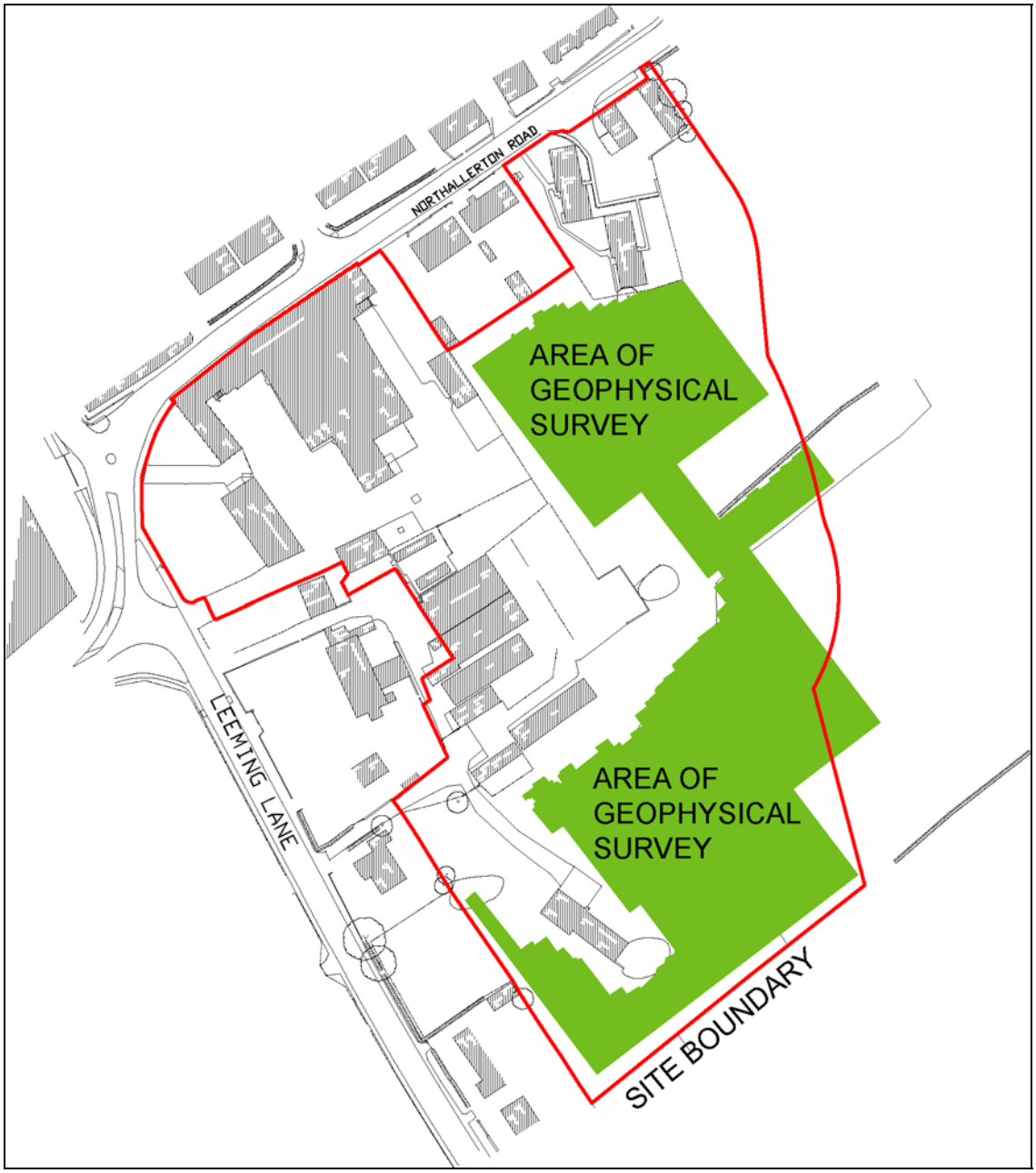

Figure 2: Location of survey (green) and site boundary (red)

3.0 Archaeological Background.

The site has been the subject of a desk-based assessment (On-Site Archaeology 2011), the principle findings of which are summarised below.

This prehistoric period is only tentatively represented within the vicinity of the site, in the form of a possible ring ditch recognised through Geophysical Survey towards the north. The archaeology of the Roman period in this area is clearly dominated by the proximity of the site to the major Roman Road of Dere Street. The line of the Roman Road can be fairly confidently traced close to the site immediately to the east of the current line of Leeming Lane. If this is indeed the case then parts of the road may lie just within the western limits of the site. Where the road has been revealed most recently during improvements to the A1, it was recorded as having a maximum width of 5.5m, being constructed using a layer of rounded stones and gravel, laid upon a cambered foundation of imported sand. No evidence for roadside ditches was recorded.

The programme of archaeological investigations undertaken to the south of Freeman's Way, approximately 150m to the south of the site, has confirmed that some form of Roman roadside settlement was located in the Leeming Bar area. The discovery of possible stone foundations, Roman tile and samian pottery suggests that this settlement is of a fairly high status, and it has been suggested that this may be a villa. An alternative interpretation, given the roadside situation, is that is could represent a *Mansio*.

Leeming is not named in the Domesday Survey in 1086. Leeming is first named, with reference to the river, rather than a specific settlement, in the 12th century. A chapel, dedicated to St John The Baptist was certainly present at Leeming by the first half of the 14th century, as a chantry was founded here in 1332. The site is likely to lie within fields to the side of the main road throughout the medieval period. The site remained in agricultural landuse relatively unchanged for much of the post-medieval period. One change that did take place during the mid 18th century was to the local road network. The local stretch of the great north road, between Boroughbridge and Catterick, was upgraded to a Turnpike during this period, the earliest Act dating from 1743. The stretch of road to the south of the Leeming Bar crossroads with the Northallerton to Bedale road was moved slightly to the west of its earlier line, before curving back to the east to cross the Leeming Beck via the current bridge, which was constructed in the later 18th century. It was almost certainly through the turnpiking that this part of the road left the original Roman course of Dere Street.

Substantial development of the site began in the second half of the 19th century. Much of the northwestern part of the site was occupied by a series of extensive buildings labelled "Agricultural Implement Works" and to the south of these lies a gasometer. Additional buildings were constructed on the western and northern parts of the site up to the late 20th century.

4.0 Methodology.

4.1 General.

The surveys and reporting were conducted in accordance with the current professional guidelines "Geophysical Survey in Archaeological Field Evaluation" (English Heritage 2008) and "Draft Standard and Guidance for Archaeological Geophysical Survey" (Institute for Archaeologists 2010).

Geophysical surveying enables the relatively rapid and non-invasive identification of potential archaeological features within landscapes and can involve a variety of complementary techniques such as magnetometry, electrical resistivity, ground-penetrating radar and electromagnetic survey. Some techniques are more suitable than others in particular situations, depending on a variety of site-specific factors including the nature of likely targets; depth of likely targets; ground conditions; proximity of buildings, fences or services and the local geology and drift.

In this instance, although the site borders on a built up area and exiting roads, the presence of a documented Roman road running across the site suggested that associated archaeological features would likely be present in the development area. On sites of this type, cut features such as ditches or pits are often found in association with settlement and historic land use. Other types of feature such as trackways, and possibly fired features (such as kilns and hearths) might also be present (see above).

Magnetic survey is generally well suited to the detection of such features in a range of conditions, and it is usually an effective and rapid means of assessment of the extent of archaeological deposits over large areas. Geological conditions play a significant role in the successful identification of archaeological deposits with this technique. Sandstone tends to yield poor results and over sand and gravel drift geology the response is highly variable (English Heritage 2008, 15), although depth of deposits will also play a significant role in detection.

It should be noted, whilst useful for the remote identification of archaeological anomalies, magentometry is also affected by changes in the magnetic gradient caused by geological composition or by ferrous material in the soil and above the surface. Service access points, conduits, metal fences/ buildings, and modern ferrous objects in the topsoil all produce elevated magnetic responses. Where these features exist in the survey area, more subtle fluctuations resulting from archaeological features can sometimes be masked.

4.2 Fieldwork methodology.

For archaeological survey the most frequently used magnetic technique in Britain is Gradiometry (using hand held Fluxgate Gradiometers) which detects and records minor variations in the vertical component of the local magnetic field of near surface soils and subsoils. These variations are caused by changes in a soil's magnetic susceptibility or permanent thermo-remnant magnetisation that in many cases can reflect archaeological

activity and the form and extent of discrete features. Data is collected at regular intervals over a gridded area producing a continuous coverage over the site.

The data collection for the survey was carried out at the western end of two fields bordering on agricultural buildings on the east side of Leeming Lane over an area of approximately 1 hectare. The survey area was divided into 30m grid units and in total, 16 grid squares or half squares comprising 10,800m^2 were surveyed. The survey grids were tied-in to known Ordnance Survey points using a Leica GPS900. The GPS900 is an RTK GPS unit providing survey quality location information accurate to around 10mm.

Data collection was carried out using two Bartington Grad 601 fluxgate gradiometers with automatic data logging facilities. Samples were recorded using an interval of 0.25 x 1 m in accordance with current archaeological guidelines (English Heritage 2008), yielding 3600 measurements per 30m square. The instrument sensitivity was set to 0.03nT within a +/- 100nT range ensuring the accurate recording of small variation in the local magnetic gradient.

4.3 Processing and data treatment.

Following initial field survey, data was prepared and processed using a series of software tools to eliminate data defects resulting from local conditions or collection problems. Once defects have been identified, images are prepared using a greyscale representation of the relative strength of magnetic response in the survey areas. The greyscale plots provide a graphic‘ 2D image’ of subsurface magnetic conditions and form the basis of the interpretation diagram in Figure 9. (Additional ‘X/Y trace’ plots are also included where applicable, and in this case data has been presented in X/Y for comparison of processed results).

For processing, Geoscan *Geoplot 3.0* software was used for initial data processing and Golden Software’s *Surfer* used for the production of both raw and processed data plots.

The following processing and image enhancement functions have been applied to the data (see Appendix 1 for details):

Clip – Clips or limits data to specified maximum or minimum values; to eliminate the effects of very strong magnetic responses often caused by modern features; Clipping such responses makes statistical calculations more realistic for the determination of potential archaeological anomalies (which generally display weaker magnetic variation than those for large ferrous features).

Despike – Used to locate and reduce the effects of random ferrous responses in the survey area, which most commonly result from iron objects near to the surface. NB. Some features cannot be successfully eliminated using ‘despike’ (especially if they are caused by larger iron objects in topsoils) without compromising the nearby data, and in these cases they are left in the dataset and marked accordingly.

Although metallic pollution in the topsoil was not overly problematic in this survey, some despiking was necessary. The parameters used for the despike process to remove random responses from metal in the topsoil were: radius of X4x Y1 readings for local averaging with a threshold of 3.0. A 'mean spike replacement method' was applied using the despike filter in Geoplot 3.0 software.

Zero Mean Traverse – For removing striping effects in the data caused by the orientation of the instrument sensors; also removes traverse striping caused by abnormally strong responses caused by ferrous pollution. NB the use of Zero Mean Traverse can mask or remove natural linear anomalies that run parallel to the traverse direction, and thus it is only applied after reviewing the clipped date for any such responses. For settings see Appendix 2 below.

Interpolation – Increases the number of data points in a survey on one or both axes. In this instance survey data was collected using a 0.25 x 1m sampling interval, and for final graphic preparation clipped and processed data was interpolated on the Y-axis resulting in a smoothed greyscale plot. Geoplot's *sin x/x* interpolation method was used for this process.

5.0 Results.

The data is presented here using greyscale and x/y plots in its raw format with minimal processing to give an impression of the full range data statistics (Figures 3 and 4). Darker greys and blacks represent elevated magnetic readings, and lighter values lower readings, while middle grey indicates the 'survey average' response of the underlying geological conditions.

Magnetic values are measured here in Nanotesla (*nT)* and the Bartington is configured at a sensitivity of 0.3 *nT* and records data within a range of -100nT/ +100nT. Within this range most archaeological and geological features occupy relatively low magnitude with respect to the survey zero (typically between -20 and +20 nT).

Responses of very high magnitude in the top and bottom end of this usually result from isolated random or major features with a high iron content, both of which were present in the survey, and particularly at the edges of the filed where fences and gates or buildings are located. In sections such as near the abandoned cottage and access road to the southwest, landfill is present (including a large proportion of brick and concrete rubble) on the surface and a high level of magnetic noise is associated with such areas.

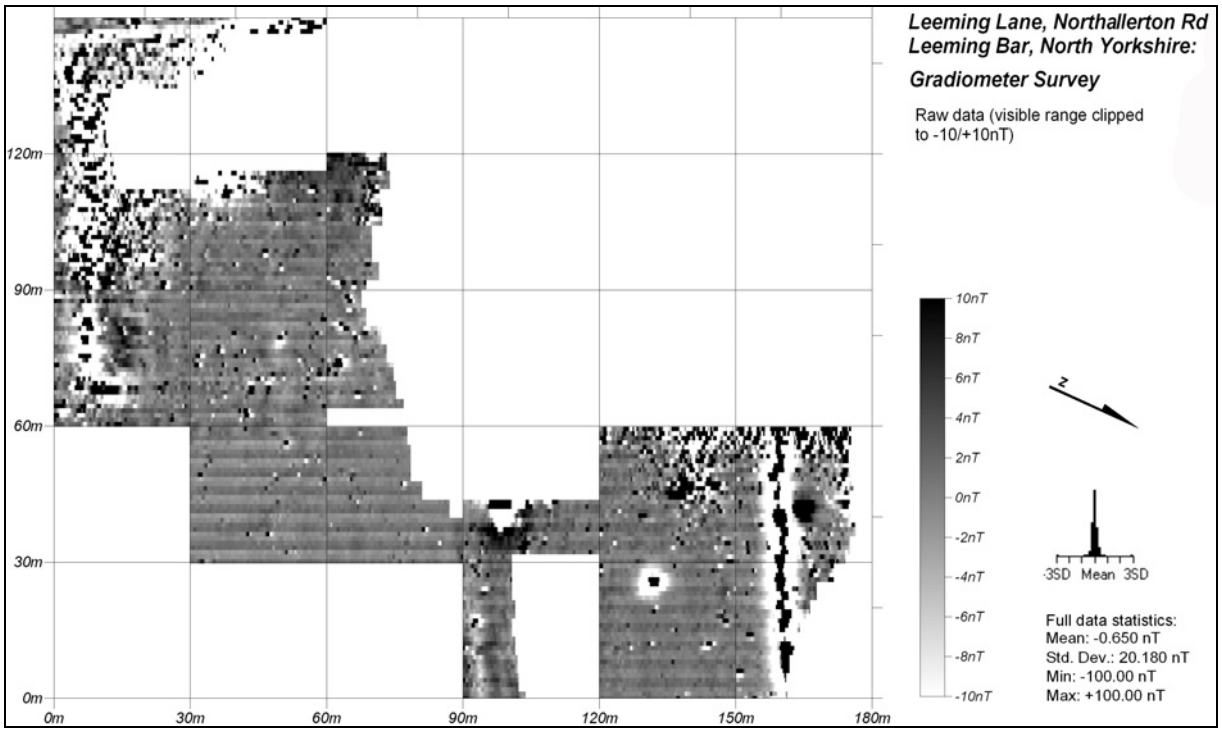

Figure 3: Greyscale plot of raw results

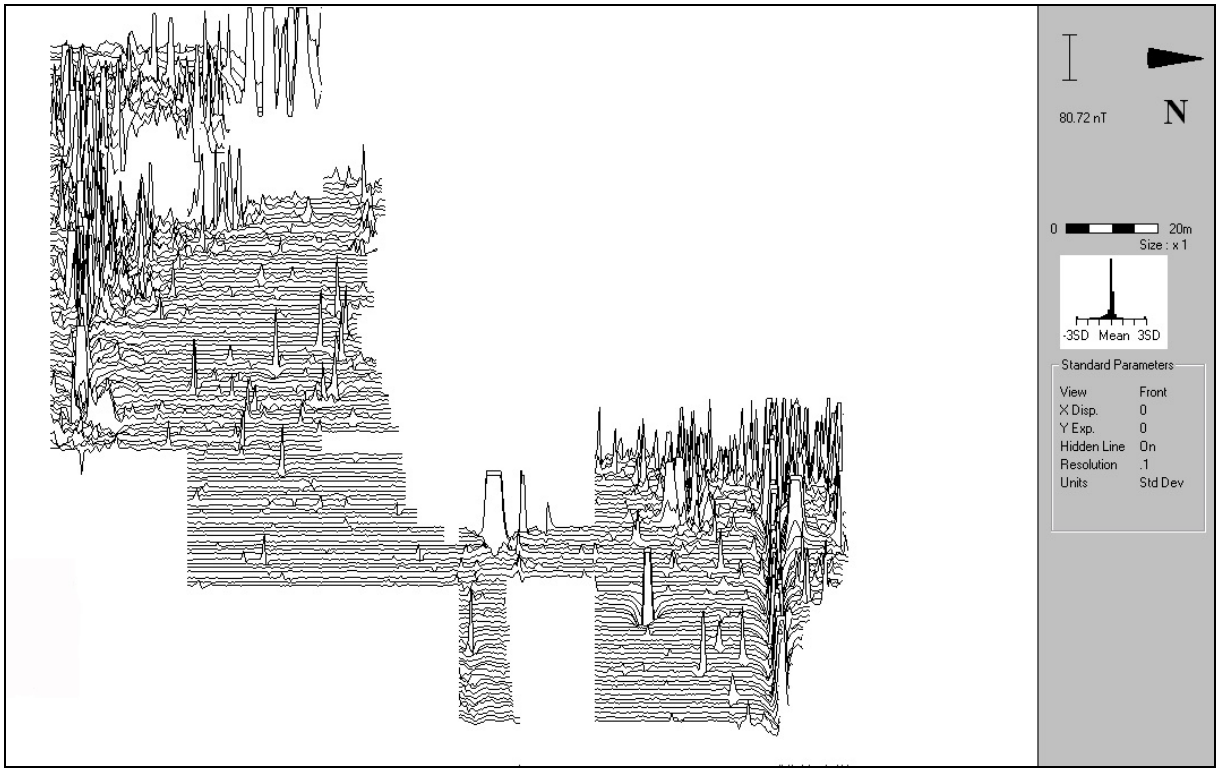

Figure 4: X/Y plot of raw results

Processed Data

Processing of results was undertaken to eliminate data anomalies. As outlined above these include*, Clip, Despike, ZMT, and Interpolate*. The results are displayed in Figures 5, 6 and 7.

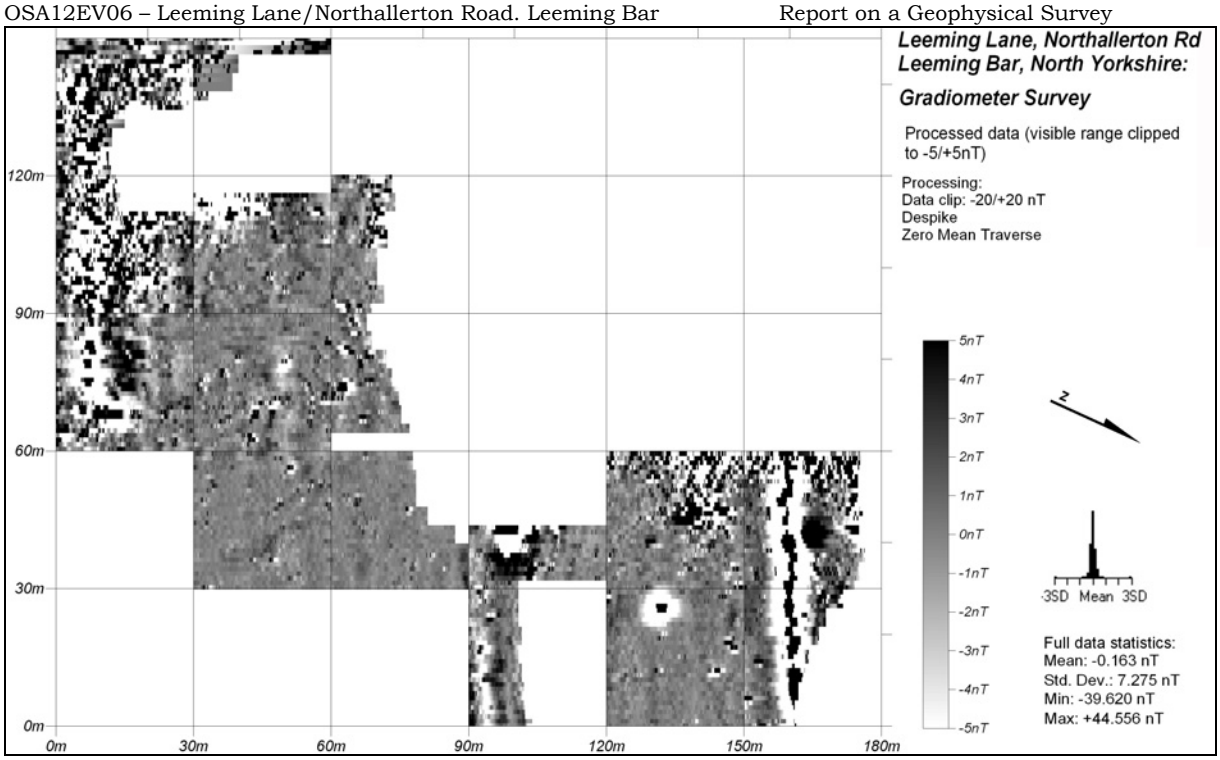

Figure 5: Greyscale plot of processed results

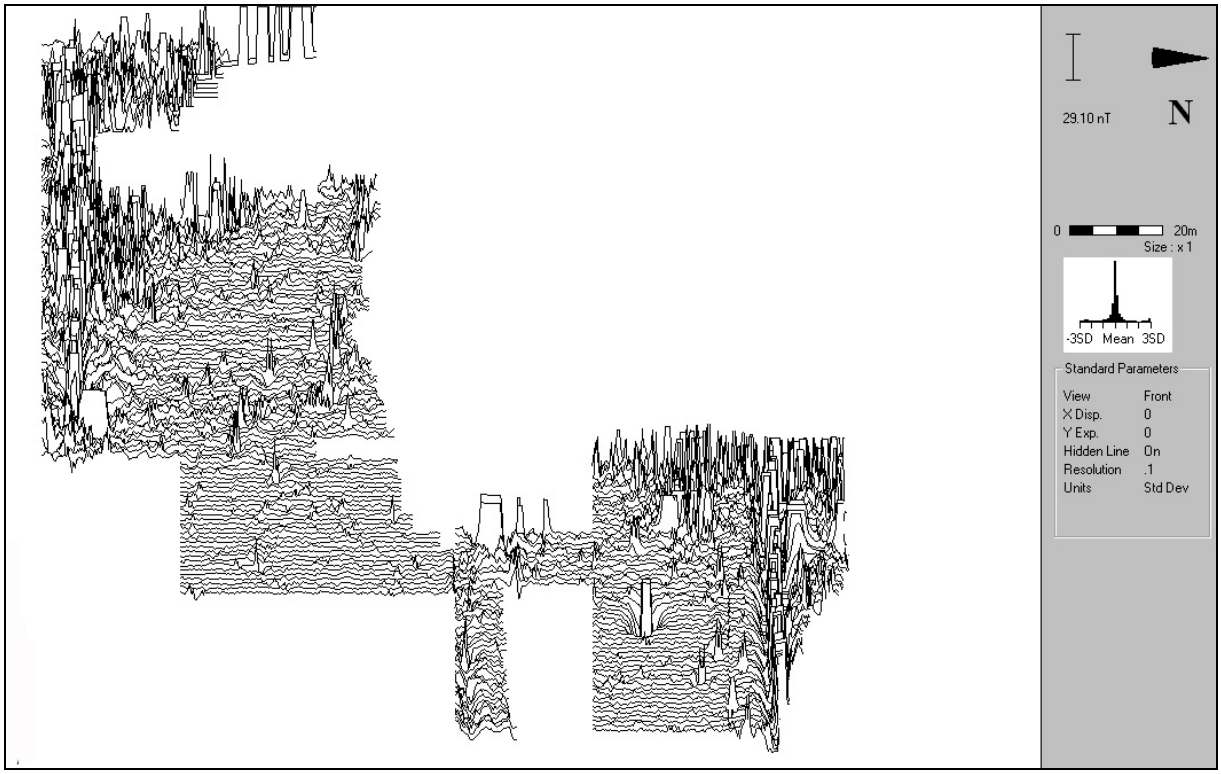

Figure 6: X/Y trace plot of processed results

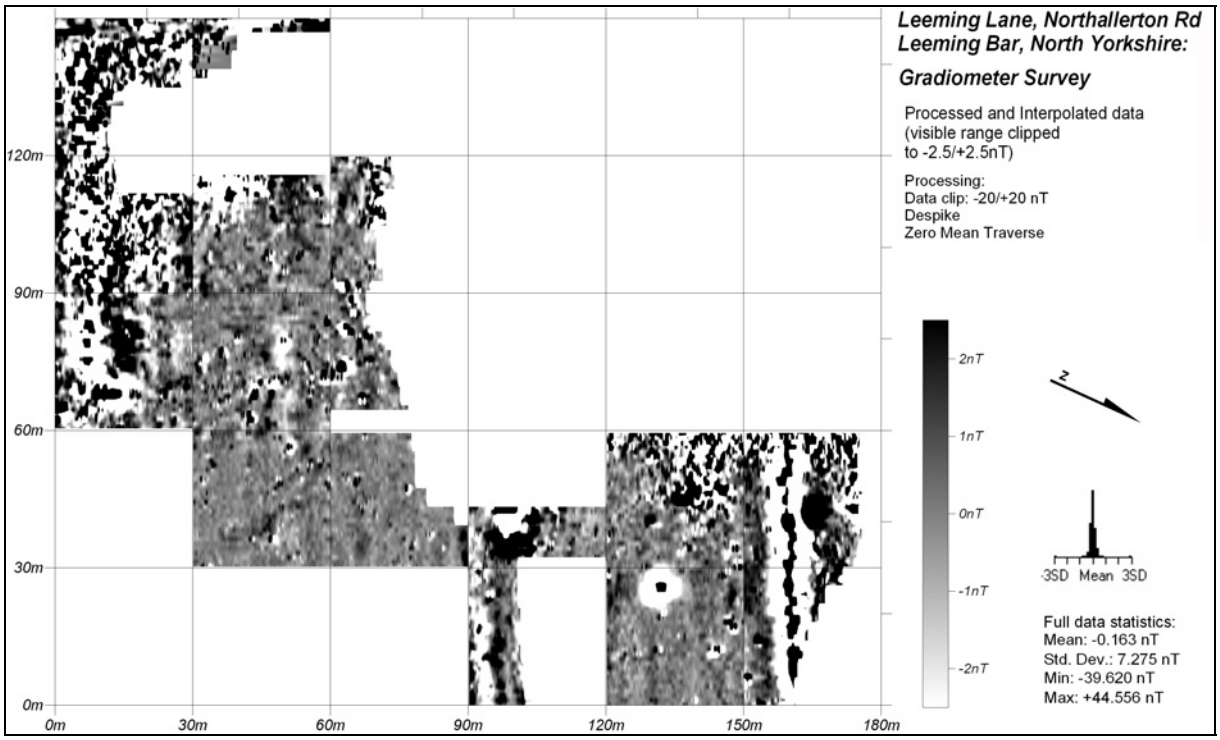

Figure 7: Greyscale plot of processed results. Data interpolated and low pass filtered for a smoother image

6.0 Interpretation.

Figures 8 and 9 illustrate interpretation of anomalies within the survey area. For discussion see below.

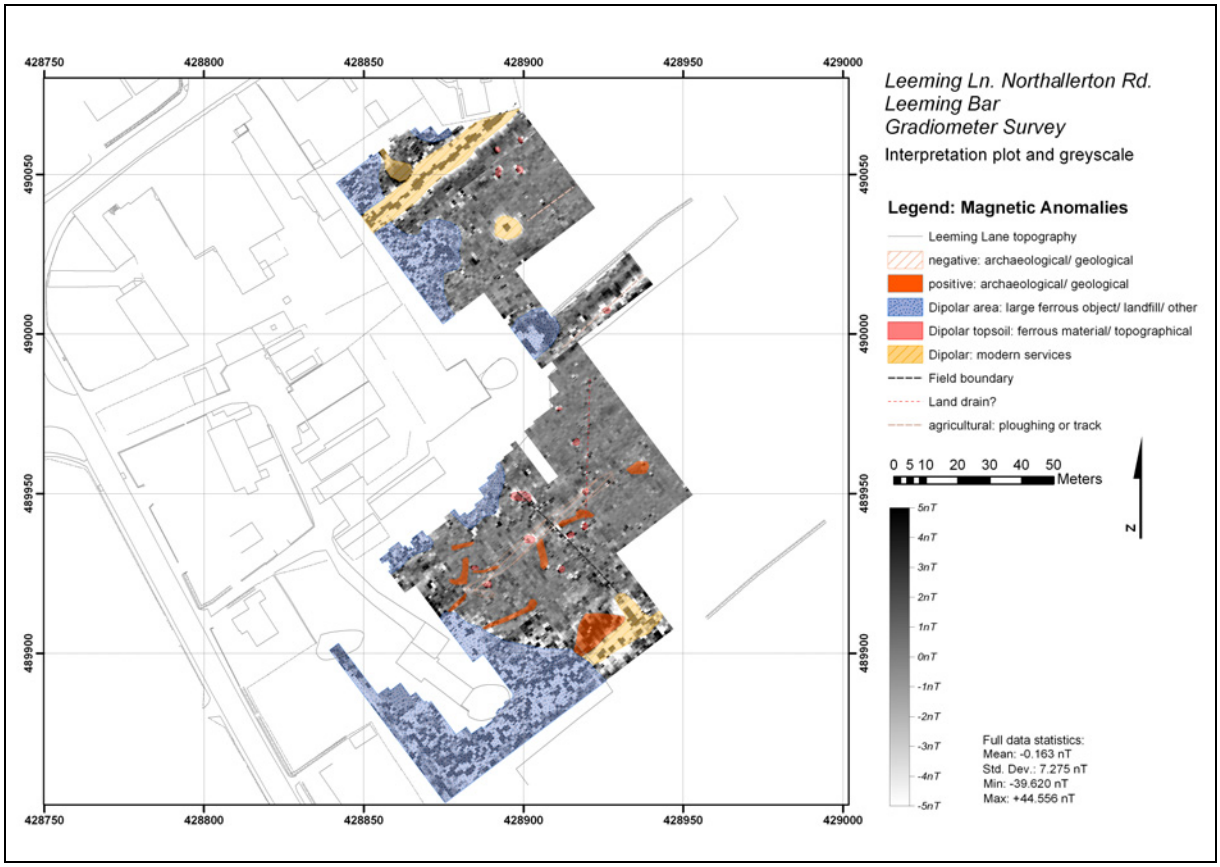

Figure 8: Greyscale plot with colour coded interpretation: greyscale range clipped to –2/+2 nT

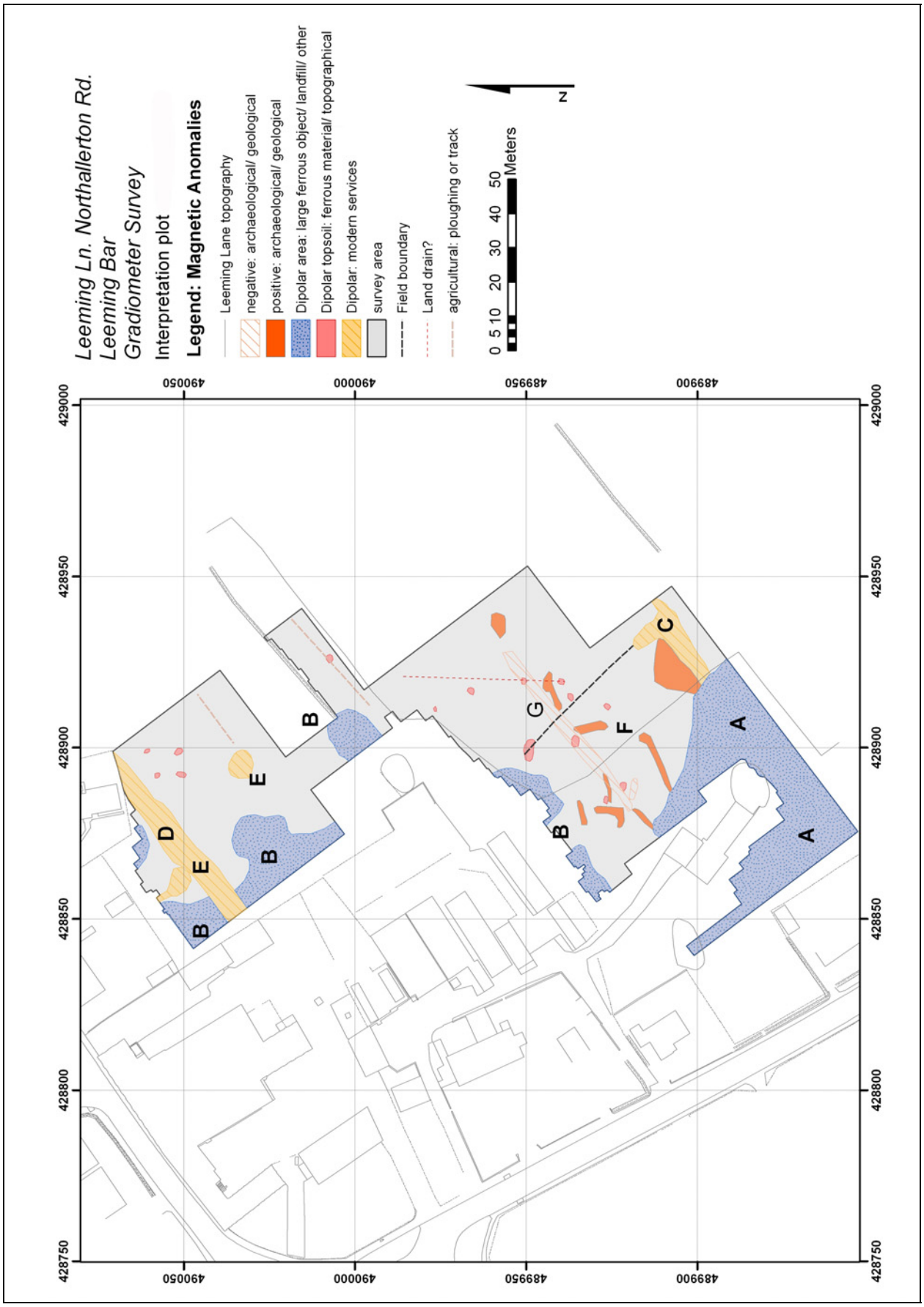

Figure 9: Interpretation with significant anomalies labelled

Terminology: In magnetic survey, responses are described by *Nano Tesla* values in relation to the survey '*zero'* or *mean.* Therefore, '*positive'* refers to elevated or enhanced magnetic values, '*negative'* refers to lower values, and '*dipolar'* refers to responses that consist of an elevated peak and a negative trough. Depending on their origin and structure, each of these can constitute linear features, localised features, or area features.

The combination of factors including: subsurface/ surface conditions, the depth of the anomaly, and material composition all affect the form of magnetic responses. The categories of response present at Leeming Lane are varied and are caused by features ranging from modern installations to natural and possibly archaeological origin. Most notable in the survey are the strong responses along the western portion of the site where the open fields meet the built-up area. Magnetic values in this part of the survey mainly result from the current land use as an agricultural yard and barns. There are also two strong responses associated with dip- wells in the northern survey area.

Beyond this, fluctuations in the background soil magnetism resulting from geological conditions or archaeological deposits is limited. A small proportion of responses of this sort may indicate near surface archaeology, but these are very limited in extent and also unclear in their specific form.

Figures 8 and 9 show an interpretation of anomaly types with various categories of anomaly outlined in the associated legend. Categories are as follows with specific anomalies labelled alphabetically where relevant:

1. *Dipolar area: large ferrous object/ landfill/ other* – Along the western border of the surveyed area a number of agricultural buildings, a disused cottage in the southwest portion and a chain link fence (**B**) in the northwest have produced a significant degree of magnetic noise in these areas.

Of particular note is the extended area of dipolar 'noise' surrounding the disused cottage (**A**). These responses suggest a formerly paved area or perhaps and extensive deposit of hardcore (mostly bricks and concrete around the cottage).

These responses are further confused by the presence of a water or gas conduit (**C)** running on an east west alignment to the south of the cottage and has a branch leading to the north align the western side of the building. There is a manhole cover visible on the surface accessing this conduit.

Within the northern and central parts of the survey area, landfill, paving, and a metal fence have produced high magnitude responses long the western border (indicated as a group marked B on interpretation plot).

2. *Dipolar modern services* – A linear response running on an east/ west alignment within the northern part of the survey (**D**) suggests a metal conduit. This is flanked by responses from dip wells to north and south marked (**E**).

A similar service conduit is present on the same alignment along the southern boundary of the development area (mentioned above as **C**) but its exact alignment is confused by the

high levels of magnetic noise associated with the cottage described in 1.

3. *Dipolar responses associated with ferrous material in topsoil*- A range of isolated dipolar responses across the survey area indicate the likely presence of ferrous objects near the surface in the topsoil. They are limited and none suggest an in situ archaeological deposit.

4. *Positive: Archaeological/ geological* – In the south-western portion of the survey area several non distinct linear responses of slightly elevated magnetic readings with respect to average background soil magnetism are evident (**F**). The surface topography undulates somewhat and it is likely that these anomalies reflect the variable depth of the topsoil and shallow subsoils to be associated with a yard for the cottage that lies to the west. It is also possible that they result from buried deposits (archaeological or geological), but it is impossible to confirm a positive attribution in either case.

5. *Negative: archaeological/ geological:* - In association with these is a linear feature of similarly non distinct form marked as (**G**) on the interpretation plot which displays values slightly lower than average background soil magnetism. The alignment of this feature with modern field systems suggest that it is contemporary with modern land use and it is most likely associated with a field boundary or similar. It is however, worth noting that no such field boundary is visible on the historic map sources included in the desk-based assessment.

7.0 Discussion and Conclusions.

The evaluation has not revealed significant evidence for the presumed line of the Roman road within the southwest corner of the site. However, this part of the site included a high level of magnetically 'noisy' overburden, which has the effect of obscuring potentially archaeological features.

Much of the data reflects modern features or limited extent geological and topographical variation over the site. It is possible that a number of features in the southern part of the site (F and G on Figure 9) may reflect archaeological responses. Whilst these do not suggest extensive intact archaeological deposits, there remains the possibility that these may represent roadside settlement associated with the Roman road of Dere Street.

The high level of masking resulting from magnetically 'noisy' overburden in around the area of the disused brick cottage and along the western border of the survey area hinder further geophysical interpretation using magnetic survey in this area. It is here – closer to course of Dere Street - that archaeological deposits are most likely to be preserved, although interpretation of anomalies directly to the west of this building is inconclusive.

Because of the degree of masking by more recent material, and because of the unclear nature of the archaeological anomalies on the southern part of the site, it is recommended that evaluation trenching be carried out.

8.0 Appendix 1: Methodology.

Survey area	Leeming Lane, Leeming Bar, North Yorkshire	
Crop types	Pasture	
Geology	Sandstone (solid), sand and gravel (drift)	
Instrumentation	Bartington Grad 601-2 Leica GPS900	
Software	Geoplot 3.00, ArcGIS 9.3, AutoCAD 2004, ArcGIS 9.3 Surfer	
Survey	Resolution: Sample Interval: Traverse interval: Grid Size: Cell size: Traverse method Survey Date	0.03nT/m used in 100nT range 0.25m 1m 30x30m 1x0.25m Zig-Zag May 2012
Processing	Using Geoplot 3.0 software: Clip, Despike, Zero Mean Grid, Zero Mean Traverse, Interpolation	
Coordinate system	GB Ordnance Survey	
Staff	Ben Gourley	

9.0 Appendix 2: Processing Methodology.

All processing and image preparation was done using Geoplot 3.00 software

Data Statistics: min/ max/mean and std. dev:

Mean: 0.650 nT

Std. Dev.: 20.180 nT

Min: -100.00

Max: 100.00

Processing procedures:

Despike: Search radius X=4 Y=1, Threshold: 3, Replacement method: Mean

Zero mean traverse: using Threshold Standard Deviation= 0.25

Zero mean traverse: using Geoplot Presets Grid=All, LMS=On. Pos.Threshold = +5, Neg.Threshold = -5.

Interpolate Using Geoplot Sin X/X on y-axis.

10.0 Appendix 3: Equipment used.

Bartington Grad 601- 2 dual fluxgate gradiometer. Data is stored in a non-volatile memory.

Full technical specification is available via http://www.bartington.com/templates/asset-relay.cfm?frmAssetFileID=102

Geoscan Geoplot 3.0 software http://www.geoscan-research.co.uk/page9.html

Leica GPS900 RTK dual frequency GPS. The GPS900 is a dual-frequency, geodetic, real-time RTK receiver with a potential accuracy of Kinematic (phase) Horizontal: 10mm + 1ppm and moving mode after initialisation Vertical: 20mm + 1ppm.

Full technical data and specification for the GPS900 may be obtained from http://www.leica-geosystems.com/en/downloads-downloads-search_74590.htm?search=true&product=GPS900

11.0 Appendix 4: Bibliography.

British Geological Survey *OpenGeoscience* http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html

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