

Bradley Surface Mining Scheme, Leadgate, County Durham

geophysical survey phase 2 (highways)

on behalf of

UK Coal Mining Ltd

Report 2007
September 2008

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Contents

1. Summary	1
2. Project background	2
3. Archaeological and historical background	3
4. Landuse, topography and geology	4
5. Geophysical survey	4
6. Conclusions	6
7. Sources	6
Appendix: Project specification	8

Figures (inside back cover)

Figure 1: Location of Survey

Figure 2: Geophysical survey

Figure 3: Geophysical interpretation

Figure 4: Archaeological interpretation

Figure 5: Trace plot of geophysical data

1. Summary

The project

- 1.1 This report presents the results of a geophysical survey conducted in advance of proposed alterations to the junction of the A693 and the A692 roads north-east of Leadgate in Co Durham. The works comprised a geomagnetic survey of approximately 0.5ha and were undertaken further to an earlier programme of geophysical survey to the north of the A692 road for the proposed Bradley Surface Mining Scheme (Archaeological Services 2008).
- 1.2 The works were commissioned by UK Coal Mining Ltd and conducted by Archaeological Services Durham University.

Results

- 1.3 Possible soil-filled features such as gullies or small ditches were identified in the survey.
- 1.4 Traces of former ridge and furrow cultivation were also detected.

2. Project background

Location (Figure 1)

- 2.1 The study area was located next to the junction of the A693 and A692 roads, north-east of Leadgate in County Durham (NGR centre: NZ 1400 5241), and covered approximately 1ha. The site was bounded by the A693 to the south, the A692 to the west and thick gorse to the north and east. Earlier surveys for the proposed Bradley Surface Mining Scheme were undertaken to the west of the A692.

Development proposal

- 2.2 The proposal is for the remodelling of the junction of the A692 and A693 roads. This will be required in the event that UK Coal Mining Ltd gain planning permission for the proposed Bradley Surface Mining Scheme on the west side of the A692.

Objective

- 2.3 The principal aim of the survey was to assess the nature and extent of any sub-surface features of potential archaeological significance within the proposed development area, so that an informed decision may be made regarding the nature and scope of any further scheme of archaeological works that may be required in advance of development.

Methods statement

- 2.4 The survey has been undertaken in accordance with a specification provided by Durham County Council Archaeology Section (provided as an Appendix to this report) and a Written Scheme of Investigation provided by Archaeological Services and approved by Durham County Council Archaeology Section.

Dates

- 2.5 Fieldwork was undertaken on the 1st August 2008. This report was prepared between 4th August and 9th September 2008.

Personnel

- 2.6 Fieldwork was conducted by Graeme Attwood (Supervisor) and Andrea Dixon. This report was prepared by Graeme Attwood and Duncan Hale, the Project Manager, with illustrations by Edward Davies.

Archive/OASIS

- 2.7 The site code is **BSM08-2**, for **Bradley Surface Mining Scheme 2008** phase **2**. The survey archive will be deposited with the Bowes Museum. Archaeological Services is registered with the **Online AccesS** to the **Index** of archaeological investigationS project (OASIS). The OASIS ID number for this project is **archaeol3-48128**.

3. Archaeological and historical background

- 3.1 An archaeological desk-based assessment of the area was conducted by Tyne & Wear Museums Archaeology (TWM Archaeology 2006). Additional information has since been collated by the Pont Valley Network and supplied to the County Archaeologist for consideration (Pont Valley Network 2007). Earlier this year Archaeological Services Durham University conducted an extensive geophysical survey programme for the proposed Bradley Surface Mining Scheme to the west of the current study area (Archaeological Services 2008). Information from all these sources is summarised here.
- 3.2 There are no known prehistoric sites within the immediate area though some cropmarks on aerial photographs could relate to prehistoric features.
- 3.3 There is no known evidence for Romano-British features within or adjacent to the site. Dere Street Roman Road runs approximately 500m to the west of the site and Roman forts are located at Ebchester and Lanchester.
- 3.4 There are no known early medieval features within or in the immediate vicinity of the site, though place-name evidence suggests an Anglo-Saxon origin for some nearby settlements including Iveston, Medomsley, Bradley and Billingside.
- 3.5 References to the above villages were first documented in the 12th and 13th centuries. Medieval cultivation remains in the form of broad ridge and furrow are evident on aerial photographs of the site. Bradley Hall, which lies about 500m north of the site, was originally a medieval moated hall, though it was rebuilt in both the 17th and 19th centuries.
- 3.6 From the post-medieval period up to the 20th century coal-mining has played a significant role in the history and landscape of this general area and, to some extent, the study site. Collieries were present all around the present site at Medomsley, Eden, Pont Head and Pontop, which were served by the Pont Valley Waggonway and later waggonways (including the Western Way) and tramways. Areas of early surface mining and bell-pitting are evident on aerial photographs of the study area. Post-medieval farmsteads were located at West and East Billingside and narrow ridge and furrow remains (presumed to be post-medieval) have also been identified on aerial photographs of the site.
- 3.7 The geophysical surveys detected traces of ridge and furrow cultivation and former field boundaries across much of the proposed open-cast area to the west, as well as occasional magnetic anomalies which could reflect the remains of ditch features. Remains of early surface mining, generally in the form of clusters of bell-pits, were detected across the central and southern parts of that area. The surveys did not identify any geomagnetic evidence for the 'Western Way' waggonway.

4. Landuse, topography and geology

- 4.1 At the time of survey the proposed development area comprised a field of scrubland. Due to the thickness and height of much of the scrub it was not possible to survey the whole area, however all the accessible land was surveyed.
- 4.2 The survey area was situated on a north-facing bank sloping from 265m OD in the north-east to 260m OD in the south-west.
- 4.3 The underlying solid geology of the area comprises Carboniferous (Westphalian) Pennine Middle Coal Measures, which are overlain by Devensian till.

5. Geophysical survey

Standards

- 5.1 The surveys and reporting were conducted in accordance with English Heritage guidelines, *Geophysical survey in archaeological field evaluation, 2nd edition* (David, Linford & Linford 2008); the Institute of Field Archaeologists Technical Paper No.6, *The use of geophysical techniques in archaeological evaluations* (Gaffney, Gater & Ovenden 2002); and the Archaeology Data Service *Geophysical Data in Archaeology: A Guide to Good Practice* (Schmidt 2002).

Technique selection

- 5.2 Geophysical survey enables the relatively rapid and non-invasive identification of sub-surface features of potential archaeological significance and can involve a variety of complementary techniques such as magnetometry, earth electrical resistance, 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.
- 5.3 In this instance, it was considered likely that cut features such as ditches and pits might be present on the site, and that other types of feature such as trackways, wall foundations and fired structures (for example kilns and hearths) might also be present.
- 5.4 Given the anticipated shallowness of targets and the non-igneous geological environment of the study area a geomagnetic technique, fluxgate gradiometry, was considered appropriate for detecting the types of feature mentioned above. This technique involves the use of hand-held magnetometers to detect and record anomalies in the vertical component of the Earth's magnetic field caused by variations in soil magnetic susceptibility or permanent magnetisation; such anomalies can reflect archaeological features.

Field methods

- 5.5 A 30m grid was established across the survey area and tied-in to known, mapped Ordnance Survey points using a Trimble Pathfinder Pro XRS global positioning system (GPS) with real-time correction providing sub-metre accuracy.
- 5.6 Measurements of vertical geomagnetic field gradient were determined using a Bartington Grad601-2 dual fluxgate gradiometer. A zig-zag traverse scheme was employed and data were logged in 30m grid units. The instrument sensitivity was set to 0.1nT, the sample interval to 0.25m and the traverse interval to 1.0m, thus providing 3600 sample measurements per 30m grid unit.
- 5.7 Data were downloaded on site into a laptop computer for initial processing and storage and subsequently transferred to a desktop computer for processing, interpretation and archiving.

Data processing

- 5.8 Geoplot v.3 software was used to process the geophysical data and to produce both a continuous tone greyscale image and a trace plot of the raw (unfiltered) data. The greyscale image and interpretations are presented in Figures 2-4; the trace plot is provided in Figure 5. In the greyscale image, positive magnetic anomalies are displayed as dark grey and negative magnetic anomalies as light grey. A palette bar relates the greyscale intensities to anomaly values in nanoTesla.
- 5.9 The following basic processing functions have been applied to the dataset:

<i>clip</i>	clips, or limits data to specified maximum or minimum values; to eliminate large noise spikes; also generally makes statistical calculations more realistic.
<i>zero mean traverse</i>	sets the background mean of each traverse within a grid to zero; for removing striping effects in the traverse direction and removing grid edge discontinuities.
<i>destagger</i>	corrects for displacement of anomalies caused by alternate zig-zag traverses.
<i>interpolate</i>	increases the number of data points in a survey to match sample and traverse intervals. In this instance the data have been interpolated to 0.25 x 0.25m intervals.

Interpretation: anomaly types

- 5.10 A colour-coded geophysical interpretation plan is provided in Figure 3. Three types of geomagnetic anomaly have been distinguished in the data:
- | | |
|--------------------------|---|
| <i>positive magnetic</i> | regions of anomalously high or positive magnetic field gradient, which may be associated with high magnetic susceptibility soil-filled structures such as pits and ditches. |
|--------------------------|---|

- negative magnetic* regions of anomalously low or negative magnetic field gradient, which may correspond to features of low magnetic susceptibility such as wall footings and other concentrations of sedimentary rock or voids.
- dipolar magnetic* paired positive-negative magnetic anomalies, which typically reflect ferrous or fired materials (including fences and service pipes) and/or fired structures such as kilns or hearths.

Interpretation: features

- 5.11 A colour-coded archaeological interpretation plan is provided in Figure 4.
- 5.12 Discontinuous, weak, curvilinear positive magnetic anomalies have been detected in the central part of the survey area, possibly reflecting soil-filled features such as gullies or small ditches.
- 5.13 Positive and negative magnetic anomalies oriented north-east/south-west have been detected throughout the survey area; these almost certainly reflect traces of former ridge and furrow cultivation.
- 5.14 A weak, discontinuous positive magnetic anomaly oriented north-west/south-east may reflect a small track which is visible on the ground.
- 5.15 Small, discrete dipolar magnetic anomalies have been detected across the survey area. These almost certainly reflect items of near-surface ferrous and/or fired debris, such as horseshoes and brick fragments, and in most cases have little or no archaeological significance. A sample of these is shown on the geophysical interpretation plan, however, they have been omitted from the archaeological interpretation plan.

6. Conclusions

- 6.1 A geomagnetic survey was undertaken prior to proposed alterations to the junction of the A692 and A693 roads.
- 6.2 Possible soil-filled features were identified in the survey.
- 6.3 Former ridge and furrow cultivation has also been identified.

7. Sources

Archaeological Services 2008 *Bradley Surface Mining Scheme, Leadgate: geophysical surveys*, unpublished report **1855** for UK Coal Mining Ltd, Archaeological Services Durham University

David, A, Linford, N, & Linford, P, 2008 *Geophysical survey in archaeological field evaluation, 2nd edition*, English Heritage

Gaffney, C, Gater, J, & Ovenden, S, 2002 *The use of geophysical techniques in archaeological evaluations*, Technical Paper **6**, Institute of Field Archaeologists

Pont Valley Network 2007 *A brief study of the history in and around Billingside*, unpublished report, and additional material collated by the Pont Valley Network and supplied to the Durham County Archaeologist

Schmidt, A, 2002 *Geophysical Data in Archaeology: A Guide to Good Practice*, Archaeology Data Service, Arts and Humanities Data Service

TWM Archaeology 2006 *Bradley County Durham Archaeological Desk-based Assessment*, unpublished report **88** for UK Coal, Tyne & Wear Museums Archaeology

Appendix: Project specification

**SPECIFICATION FOR ARCHAEOLOGICAL GEOPHYSICAL SURVEY:
On Land (Highways work) near proposed
Bradley Open Cast Coal Site
LEADGATE
Co. Durham**

1.0 Site Location

- 1.1 The proposed development site lies to the north of the A692 at West Billingside near Leadgate, County Durham.
- 1.2 The proposed development area (PDA) is centred on OS grid reference NZ13999 52411 (see Figure 1). The PDA is bounded by the A693 on the west and the A692 to the north. The eastern side is scrub land
- 1.3 The site is currently agricultural and scrub land and covers a total area of c. 0.95ha.
- 1.4 Contractors are urged to note that the pond on the north side of the A692 contains great crested newts. This may have an implication to the archaeological works and advice must be sought.

2.0 The Development

- 2.1 The client for this work is UK Coal Mining Ltd.
- 2.2 It is proposed to replace the existing T-junction between the A692 and A693 roads to the east of Leadgate. These works will be required if UK Coal are successful in securing planning permission for an open-cast coal scheme.
- 2.3 Planning permission has not yet been sought. The results of this evaluation work will be submitted in support of any future planning application and be used to determine the level of archaeological mitigation which may be required.

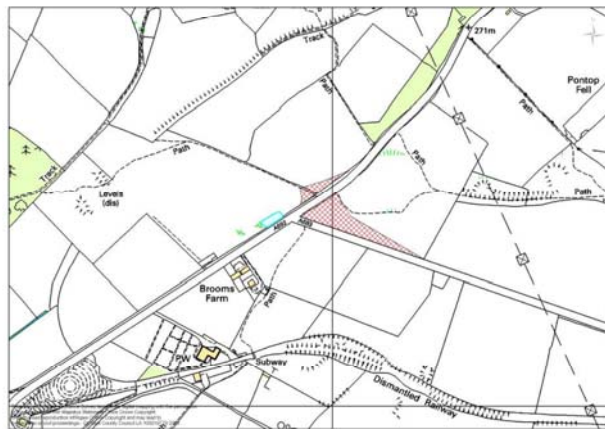


Figure 1: Site location shown in red hatching (© Durham County Council)



3.0 Background

- 3.1 An archaeological assessment for the proposed coal scheme development has been conducted by Tyne and Wear Museums on behalf of the developer. This work was carried out in 2006 and is available for consultation in the SMR. Additionally, geophysical survey was carried out by Archaeological Services Durham University on the coal scheme site in early 2008. Both of these documents must be consulted by prospective tenderers.
- 3.2 Briefly, the assessment has indicated that the proposed development may impact upon known and unknown archaeological resources most likely dating to the Medieval/Post Medieval in terms of agricultural remains and settlement as well as industrial heritage remains. Detailed analysis of aerial photos has indicated a high potential for extant industrial heritage remains or potential prehistoric features. There is a limited possibility that prehistoric remains may exist on the site.
- 3.3 The geophysical survey found traces of medieval agricultural activity as well as remains of early surface mining, including bell-pits. Several magnetic anomalies were noted through the study area which may be remains of ditch features of unknown dates. No evidence was noted for the location of early wagon ways which are reputed to cross the site.

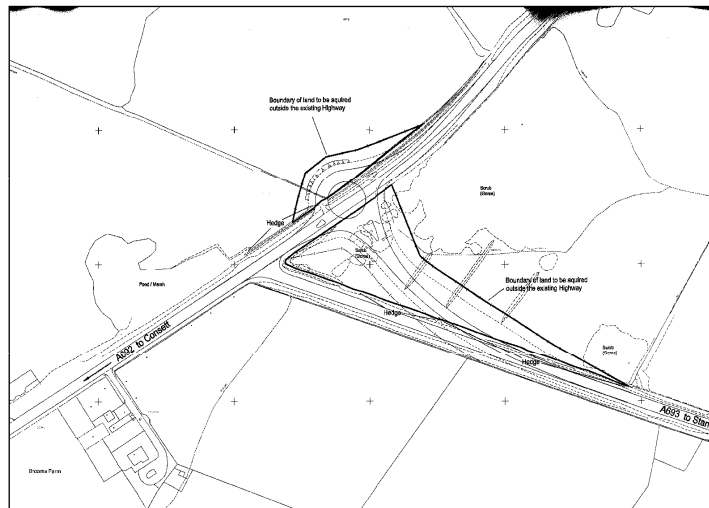


Figure 2: Layout of the scheme (not to scale) © DCC Highways

4.0 Archaeological brief

- 4.1 This brief sets out the standards and methodology for the geophysical survey and how it must be carried out. Any further works which may be required to mitigate the impact of the proposed development will be dealt with under a separate brief as a condition of future detailed planning permission.
- 4.2 In order to evaluate the archaeological potential for remains of any period, the site must be sampled by geophysical survey.



- 4.3 The overall objectives of the evaluation are to determine if there are any deposits or features relating to archaeological/historical land use, paying particular attention to the Industrial landscape. Specific aims and objectives must be indicated by the appointed archaeological contractor and must take into account the recently published research framework for the North-East (NERRF).
- 4.4 **This brief does not constitute the "written scheme of investigation" which must be submitted by the developer and approved by the planning authority in advance of development commencing on the site.**

Geophysical survey

- 4.5 The use of remote sensing geophysical techniques (magnetometer survey, unless another method can be shown to be more effective) will be required to help define the potential archaeological features which may exist on the site. Recent guidance from English Heritage (in press) regarding geophysical survey recommends that large samples, i.e. over 50%, are undertaken.
- 4.6 Given the small size of the development area, the survey must cover 100% of the PDA except where ground conditions, vegetation or water cover makes it impracticable. In addition a buffer zone around field boundaries and buildings may be needed to reduce interference from fences, footpaths and debris often associated with field boundaries. Partial grids should not be excluded due to the small size of the survey area. The archaeological contractor must liaise with the client over development layout and discuss the final survey sample with the DCC Assistant Archaeology Officer.
- 4.7 The overall purpose of the geophysical survey will be:
- to establish the presence/absence, and nature of any archaeological anomalies within the area specified
 - to define the extent of any such anomalies, and to characterise, if possible
 - to establish the presence/absence, and nature of any known modern anomalies within the area of proposed development which may affect the results
- 4.8 Methodologies must be clearly costed in the tender document and information on how the contractor proposes to conduct the work clearly set out in the project design document.
- 4.9 A survey grid of 30m x 30m must be placed across the site and must be accurately tied in to local topographic features and overlaid onto an OS map base. The grid tie-in information should be made available in, or with, the final report so that the location plan can be related to the OS National Grid. Once the survey is complete any markers used must be removed from site. The results, including archaeological interpretation of the data must be set out in a report format with maps and must be available to aid placement of the subsequent evaluation trenches.
- 4.10 Depending on the results of the evaluation phase, further works may be required to mitigate the impact of the development on any archaeological remains. This will be dealt with by a separate brief should this be required.

5.0 OASIS

- 5.1 The Durham County Council Archaeology Section supports the Online Access to Index of Archaeological Investigations (OASIS) Project. The overall aim of the OASIS project is to provide an online index to the mass of archaeological grey literature that has been produced as a result of the advent of large scale developer funded fieldwork.
- 5.2 The archaeological contractor must therefore complete the online OASIS form at <http://ads.ahds.ac.uk/project/oasis/> within 3 months of completion of the work. Contractors are



advised to ensure that adequate time and costings are built into their tenders to allow the forms to be filled in.

- 5.3 Technical advice must be sought in the first instance from OASIS (oasis@ads.ahds.ac.uk) and not from Durham County Council Archaeology Section.
- 5.4 Once a report has become a public document by submission to or incorporation into the SMR, Durham County Council Archaeology Section will validate the OASIS form thus placing the information into the public domain on the OASIS website.
- 5.5 The archaeological consultant or contractor must indicate that they agree to this procedure within the specification/project design/written scheme of investigation submitted to Durham County Council Archaeology Section for approval

6.0 Health and Safety Policy

- 6.1 Contractors are expected to abide by the 1974 *Health and Safety Act* and its subsequent amendments as stated in the *Construction and Design Management Regulations 1994*. Appropriate provision of first aid, telephone and safety clothing as described in the *SCAUM* manual on archaeological health and safety must be followed. Each site must have a nominated safety officer.
- 6.2 The undertaking of a risk assessment prior to the commencement of works is required. A copy of the risk assessment must be circulated to the client and any other sub-contractors working on the site at the same time. Contractors must ensure that all staff working on the site are fully briefed on all health and safety issues relating to the site prior to working there.
- 6.3 Adequate and secure safety fencing must be placed around excavated trenches in order to inhibit easy access by the public. Clear signage regarding excavation trenches must be displayed on the fences and site perimeter as necessary. These items must be agreed with the client prior to work commencing and detailed in the WSI.
- 6.4 Contractors are advised to identify the location of any services or overhead wires which may cross the site and ensure that they are clearly marked before trenching commences so that they can be avoided.
- 6.5 The archaeological contractor is responsible for all on-site safety issues in relation to the archaeological works.

7.0 Publication

- 7.1 All assessments, evaluations and watching briefs which do not progress to further excavation and research (with the relevant post-excavation and publication scheme and costs), must have a time and budget allocation identified for publication. This must be to a minimum standard to include a summary of the work, findings, dates, illustrations and photographs and references to where the archive is lodged.
- 7.2 Editors of regional journals, either the *Durham Archaeological Journal* or *Archaeologia Aeliana* must be contacted for information on outline publication costs, fuller figures may be worked out on completion of the watching brief. As the final note is largely unpredictable in advance a contingency sum must be set aside at the outset of work in the tender.
- 7.3 County Durham Archaeology Section produces an annual publication every March which highlights the archaeological work conducted in the county over the previous 12 months. To this end, it is now a requirement of every specification that a précis of archaeological works conducted in the county as a result of PPG16 must be submitted to the DCC Archaeology Section.



- 7.4 The précis must be no more than 500 words in length and it would be appreciated if JPEG or TIFF images of a minimum of 300dpi are also included. The summary must be sent to the County Archaeologist by the beginning of December of the same year in which the work was conducted.

8.0 The Report

- 8.1 At least two paper copies of the report must be sent to the client as well as one bound paper copy to the HER as well as **one digital copy with images** which can be used to enhance the on-line HER website *Keys To The Past* (PDF on CD-Rom is acceptable). The geophysical survey report must include the following:

- executive summary
- a site location plan to at least 1:10,000 scale with 10 figure central grid reference
- OASIS reference number
- contractor's details including date work carried out
- nature and extent of the proposed development, including developer/client details
- description of the site location and geology
- geophysical technical and processing information
- geophysical results
- geophysical discussion and interpretation
- a plot of the raw geophysical data (to an appropriate scale)
- geophysical plots must show the location of modern intrusions (i.e. services etc)
- geophysical X-Y trace and greyscale and/or dot density plots (to an appropriate scale)
- geophysical interpretative feature map (to an appropriate scale)
- discussion of the results of field work
- suggestions regarding the need for, and scope of, any further archaeological work, including publication
- bibliography

- 8.2 A report synthesising the results of the works must be produced for the client and the County Durham HER. This must include a site location plan with NGR references, and also be accompanied by additional plans/map extracts to display noted and recorded archaeological features as appropriate.

- 8.3 The report must be presented in an ordered state and contained within a protective cover/sleeve or bound in some fashion (loose-leaf presentation is unacceptable). The report must contain a title page listing site/development name, district and county together with a general NGR, the name of the archaeological contractor and the developer or commissioning agent. The report must be page numbered and supplemented with sections and paragraph numbering for ease of reference.

- 8.4 The report must seek to identify any deposits remaining on or associated with the site that will remain following the completion of the evaluation.

9.0 The Tender

- 9.1 Tenders for the work must include a method statement and the following:
- 9.2 Brief details of the organisation and the number of staff who are proposing to carry out the work including any relevant specialisms or experience.
- 9.3 The earliest date at which the work can be commenced and the amount of notice required to initiate the fieldwork.



- 9.4 Details concerning proposed methods of recording.
- 9.5 Statement agreeing to complete the OASIS forms on completion of the evaluation report.
- 9.6 An estimate of how long the work will take broken down by time and cost in terms of data collection and report production (the anticipated extent of the work must be confirmed with the client in advance) on a *per diem* basis where possible (this is particularly in reference to the specialists' costs). The tender must include a breakdown of costs attributable to:
- travelling and subsistence
 - geophysical survey
 - report production
 - archiving deposition charge
 - publication
 - administration
 - other

12.0 Submission of Report

- 12.1 This evaluation must be considered as a project in its own right. At least **two copies of the report** must be sent to the client. A third paper copy of the report and a **PDF on CD-ROM with digital images** (JPEG's) of the site for the *Keys To The Past* website must be sent to the Archaeology Section, Durham County Council for inclusion into the County Durham Archaeological Archive (HER) at:

Archaeology Section, Adult and Community Services, Culture & Leisure, Durham County Council, Rivergreen Centre, Ayclay Heads, Durham, DH1 5TS.

12.0 The Archive

- 12.1 The site archive comprising the original paper records and plans, photographs, negatives etc, must be deposited at the Bowes Museum at the completion of the work. This must be in accordance with both the County Archaeological Archive policy and the Durham County Council Historic Environment Record Revised Charging Scheme (2008-09). Both of these are available from DCC Archaeology if required.

12.0 Notice

- 12.1 The County Archaeologist must be given two weeks notice in writing of the commencement of evaluation works. During such works the County Archaeologist or his nominated representative must be allowed access to the site and excavations at all reasonable times.

13th June 2008
L White
DCC Archaeology



Adult and Community Services: Culture & Leisure: Archaeology

6



Archaeological Services
University of Durham

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County Durham
geophysical survey phase 2 (highways)

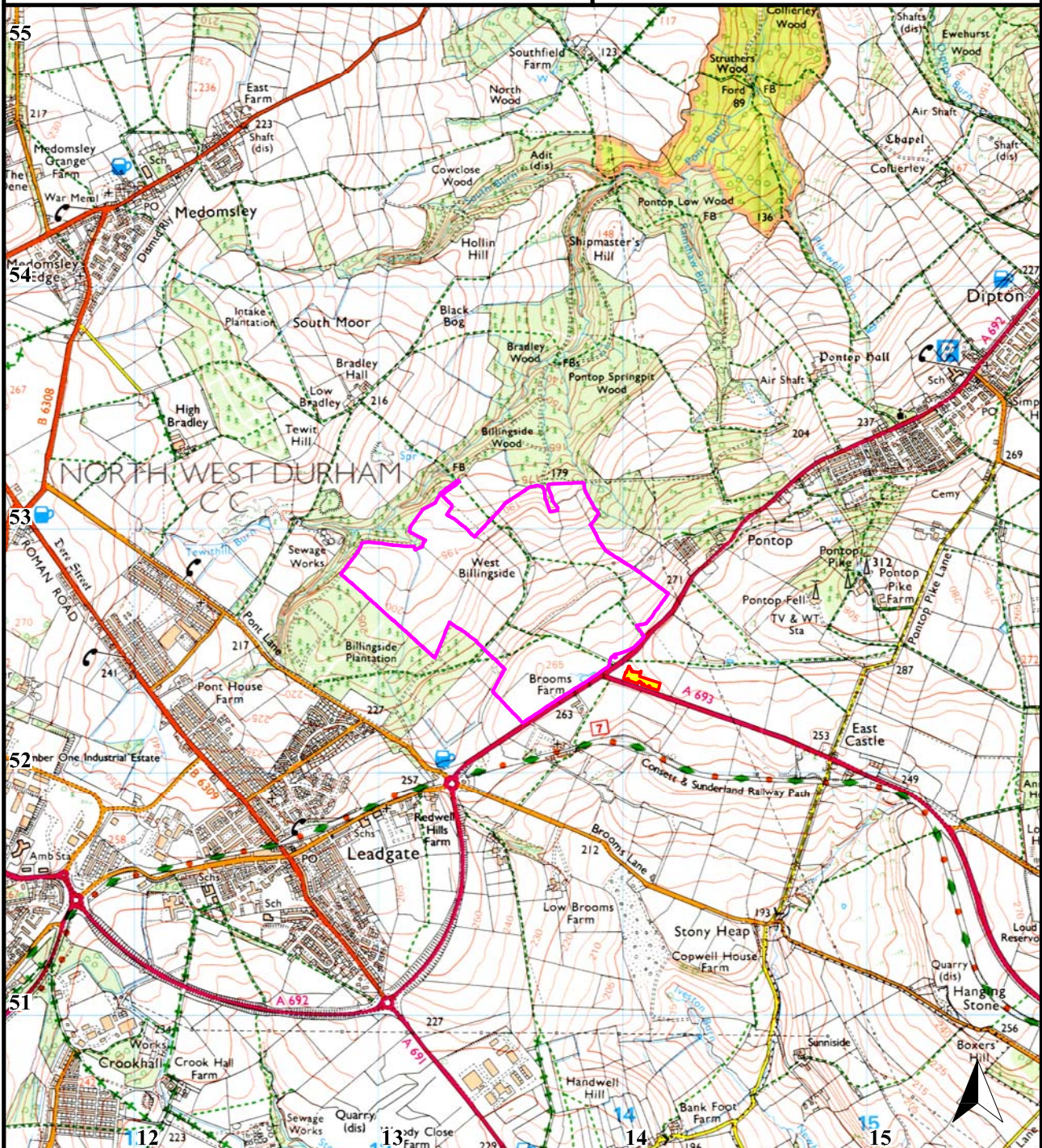
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Figure 1

Location of survey

on behalf of
UK Coal Mining Ltd

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survey



previous study area



scale 1:25 000 - for A4 plot

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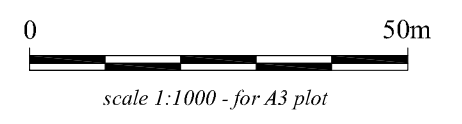
**Bradley Surface Mining Scheme,
Leadgate, County Durham**


geophysical survey phase 2 (highways)

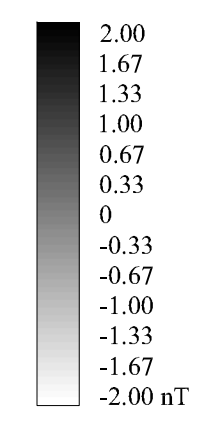
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Figure 2

Geophysical survey



 outline of survey area

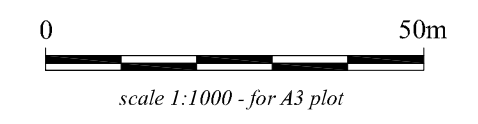






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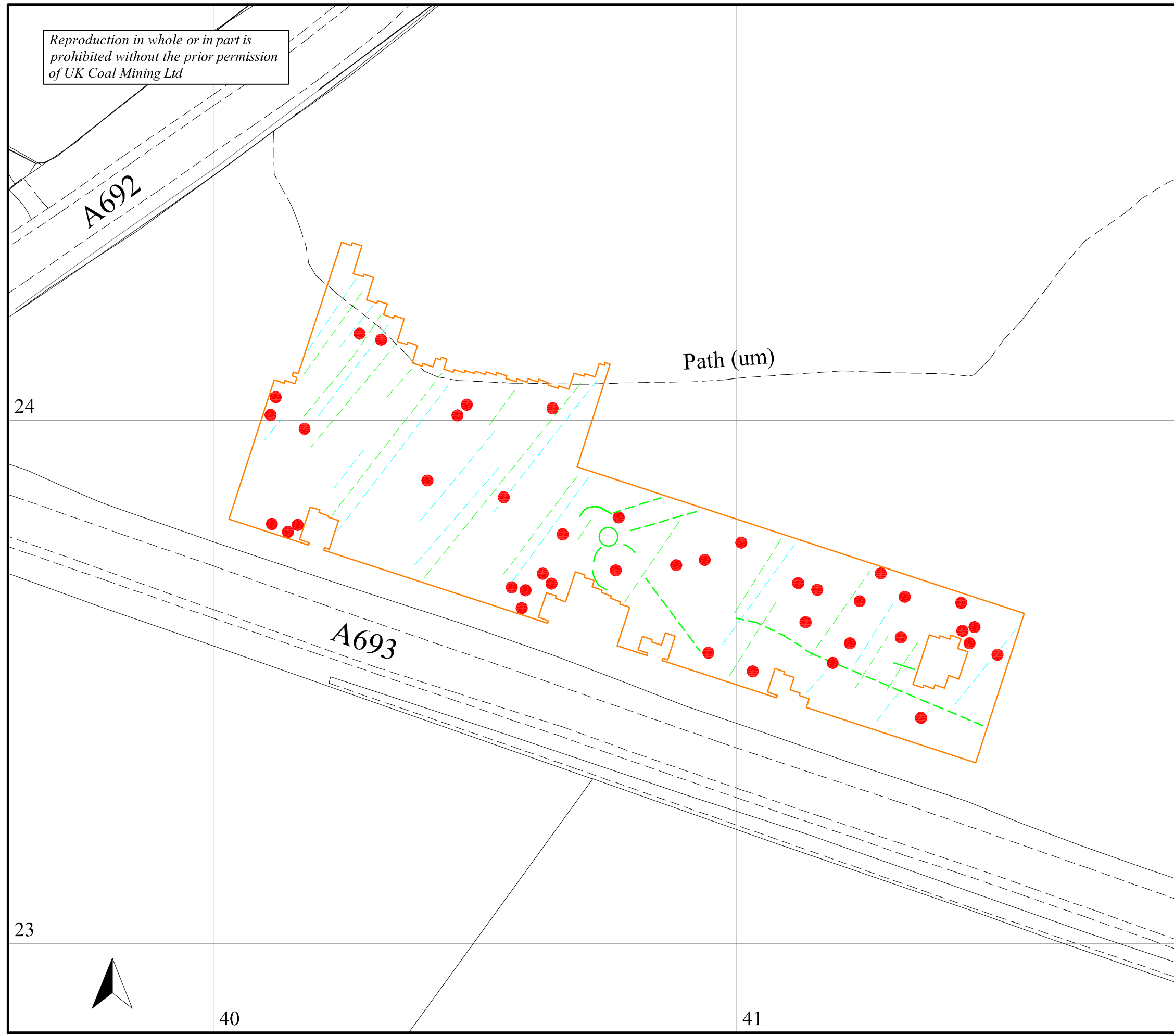
Figure 3

Geophysical interpretation

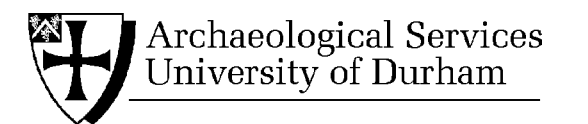
on behalf of
UK Coal Mining Ltd



-  outline of survey area
-  positive magnetic anomalies
-  negative magnetic anomalies
-  dipolar magnetic anomalies



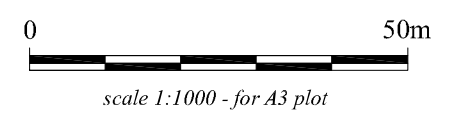
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Figure 4
Archaeological interpretation

on behalf of
UK Coal Mining Ltd



- outline of survey area
- soil-filled features
- orientation of ridge and furrow

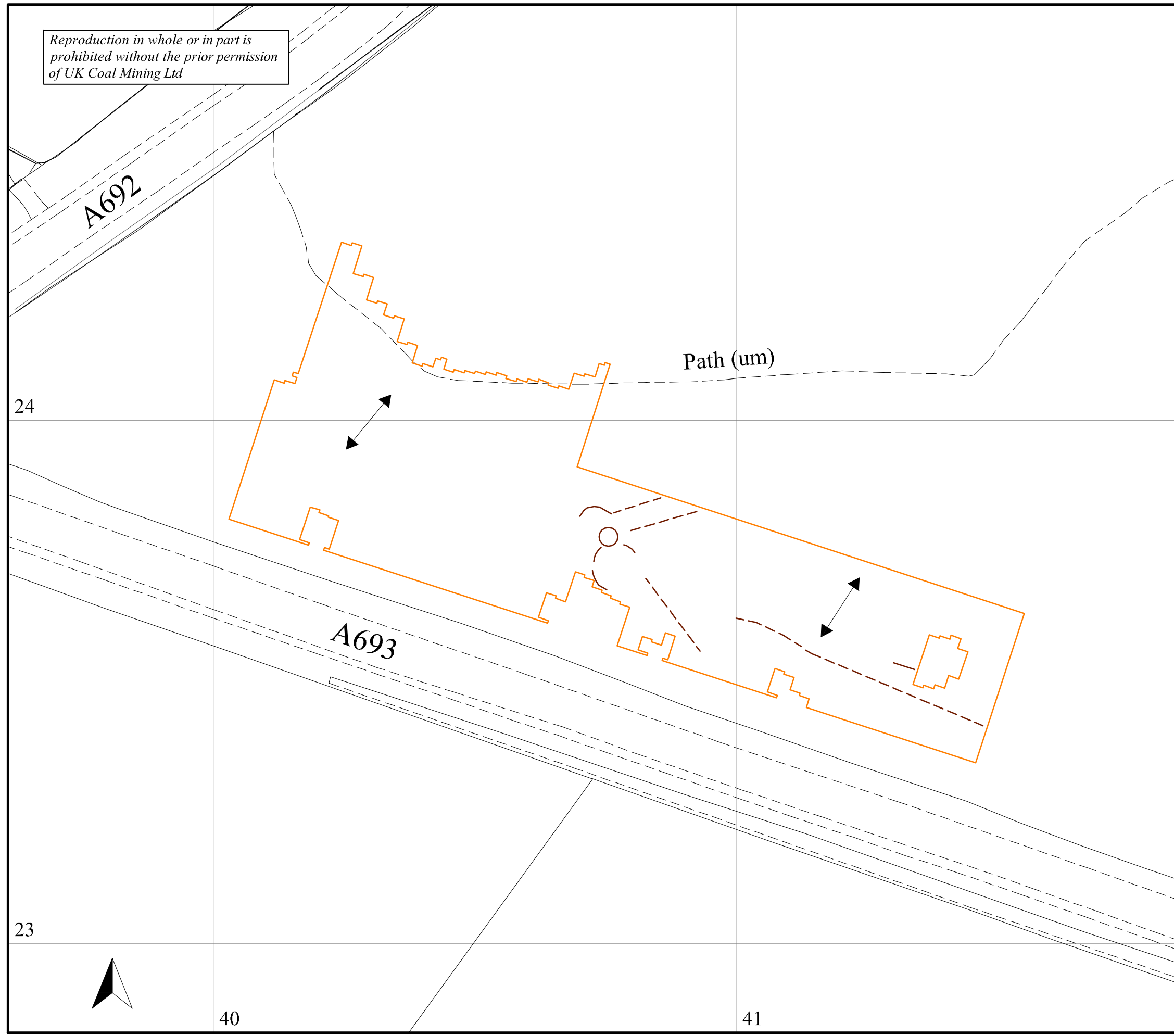


Figure 5: Trace plot of geophysical data

Area 1

