RPS Planning, Transport and Environment

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A63 MELTON GRADE SEPARATED JUNCTION
GEOPHYSICAL INVESTIGATION

at

MELTON
HUMBERSIDE

for
DEPARTMENT OF TRANSPORT
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R17 42

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1. *INTRODUCTION*

Geo-Services International (UK) Limited was commissioned to undertake an archaeological geophysical survey of three field areas (Geophysical Survey Areas A, B and C of *MAP 1*) near Melton, Humberside.

The objective of the survey was to investigate the variability of the magnetic field gradient across the sites and the electrical resistivity of the subsurface (Area A only) in order to identify possible near-surface archaeological features. Aerial photographs of Area A have revealed crop mark patterns attributed to archaeological features.

The geophysical survey was carried out over a 9 day period from 30 January 1993 to 10 February 1993.

FIGURE 1 shows the location of the survey areas.

2. *SURVEY METHODOLOGY*

2.1 Fluxgate Magnetic Gradiometer

Comprehensive coverage of all three areas (Geophysical Survey Areas A, B and C) was carried out using a Geoscan FM36 Fluxgate Magnetometer in the gradiometer mode. This system provides a rapid and cost effective means of identifying fired structures, such as kilns, furnaces, hearths and ovens (which have a remnant magnetization) and areas of subsoil with an enhanced or depleted magnetic susceptibility (eg. pits and ditches of hill forts, enclosures, field systems and barrows etc.).

In the gradiometer mode the FM36 utilizes two separate fluxgates, positioned one above the other, to provide a direct measure of extremely small variations in the local vertical magnetic field gradient (resolution of +/- 1nT). The method is particularly favoured for magnetic surveys in archaeological site investigations as it tends to resolve composite or complex anomalies into their individual components and automatically removes the regional magnetic gradient to better define shallow anomalies. Time dependant magnetic field variations such as magnetic storms are also effectively minimised.

The FM36 is equipped with an integral data-logger, capable of storing up to 16,000 readings, and a powerful survey tracking facility which provides both audible and visual indications of the survey position. This enables fast and efficient surveying of approximately 40 points/minute.

Instrument drift resulting from gradual misalignment of the fluxgate sensors (due to thermal expansion/contraction of the instrument) and diurnal variation of the total field was checked and rectified after completion of each grid (approximately every 15-20 minutes) by reference to one of a number of control stations established in each survey area. Control stations were set up in areas having a negligible vertical field

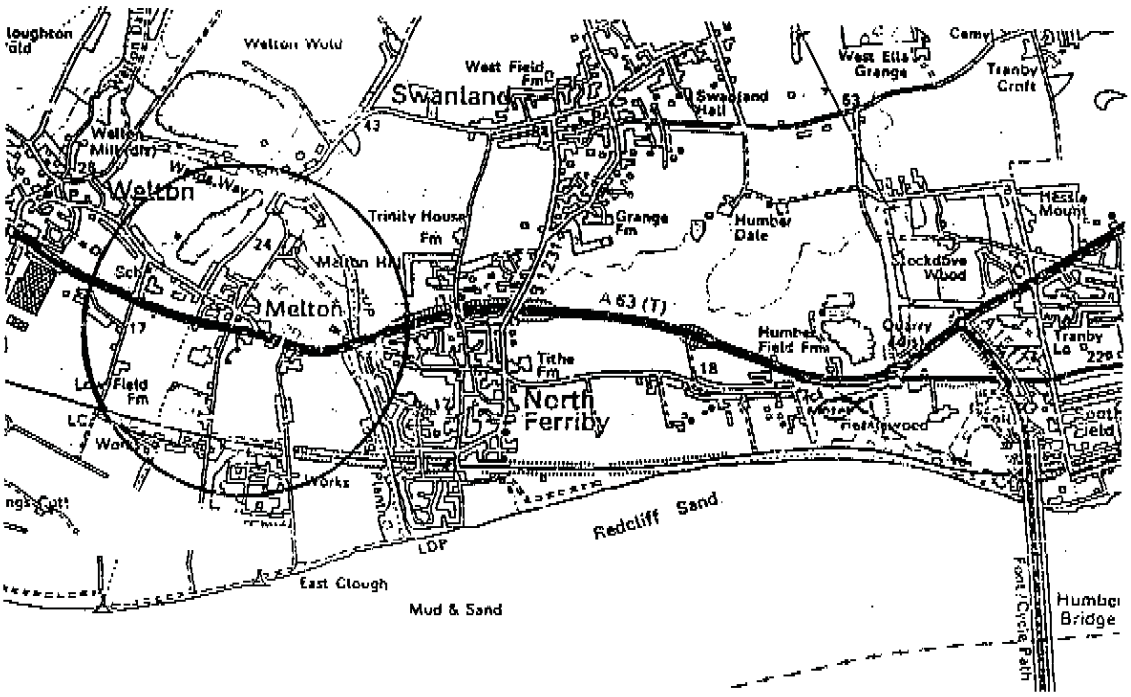

FIGURE 1 Location Map – Melton Site

gradient (ie no buried features and a low top soil magnetic susceptibility). The tight control on drift provided in this way facilitated a high quality data set with limited instrument noise. Frequent monitoring of drift is particularly critical during early morning and late afternoon when magnetospheric activity is high and temperature fluctuations are more pronounced.

Cultural, geological, topographic and hydrogeological factors can all affect magnetometer surveys. These factors were considered when the data was interpreted.

2.1 Electrical Resistivity

Electrical resistivity surveying was performed in Geophysical Survey Area A only using a Geoscan RM4 Resistivity Meter with a Twin Electrode Array (PA1) and DL10 data logger. This equipment is designed for rapid, detailed area surveys to investigate depths in the near surface of up to 1m. The Twin configuration consists of two current and two potential probes one each of which are mounted on a mobile frame and the other two positioned remote from the survey. The placement, orientation and insertion depth of the probes is not critical and allows relatively quick surveys to be carried. This is an advantage over more traditional electrode configurations such as the Schlumberger or Wenner Arrays. A control station outside the survey area was established and revisited at least 3 times a day to verify the repeatability of data measurements.

Archaeological features result from relative changes in resistivity across survey areas, and hence, absolute resistivity levels are not important. However, in order to provide compatibility between sampling grids following movement of the remote probes, the background level was always reset to its pre-existing value. Cultural, geological, topographical and hydrogeological factors can all affect electrical resistivity surveys and these were considered when the data was interpreted.

3. *SURVEY SPECIFICATIONS*

The base survey for Geophysical Survey Areas A, B and C (*MAP 1*) was carried out by Anthony Walker Land Surveys using a 20m x 20m grid system. Readings were acquired on 20m x 20m subgrids which were later combined to provide complete coverage of each area. This grid system was further subdivided to provide a grid with 1m line spacing and 0.5m sample interval providing an effective 800 data points per grid. The resistivity survey was carried out on a 1m line spacing and 1m sample interval in areas shown on *MAP 1.*

It was recommended that the survey lines in Geophysical Survey Areas A and C be orientated northeast-southwest, while those in Geophysical Survey Area B be orientated north-south. This recommendation was accepted by Acer Consultants Ltd the Consulting Engineers for the project. The survey was carried out using the grid numbers taken from the pegs and sketch maps provided by the surveyors, the grids geophysically surveyed were as follows:

Geophysical Survey Area A:

Fluxgate Magnetometer Survey: 125 grids were completed in this survey area.

A004–A005=1	B003–B007=4	C001–C008=7	D001–D008=7
E002–E008=6	F002–F008=6	G003–G008=5	H003–H009=6
J003–J011=8	K004–K011=7	L005–L012=7	M005–M012=7
N006–N012=6	P006–P014=8	Q007–Q015=8	R008–R016=8
S009–S016=7	T010–T017=7	U010–U016=6	V011–V015=4
W013–W014=1			

Resistivity Survey: 27 grids were completed in this survey area.

B003–B004=1	C003–C004=2	D001–D004=3	E001–E004=3
L007–L011=4	M007–M011=4	N007–M011=4	P007–P011=4
P012–P013=1	Q013–Q014=1		

Geophysical Survey Area B:

A009–A013=4	B001–B026=25	C008–C013=5	C019–C021=2

A total of 36 grids were completed in this survey area.

Geophysical Survey Area C:

U004–U006=2	V004–V007=3	W004–W008=4	X006–X009=3
Y007–Y009=2			

A total of 14 grids were completed in this survey area.

4. *DATA CAPTURE AND PROCESSING*

The magnetic gradiometer data was measured and then stored in digital memory using a Geoscan FM36 autologger in gradiometer mode. Electrical resistivity was measured using a Geoscan RM4/DL10 system in autolog mode. The results were monitored with respect to selected control points in order that any drift could be accounted for.

Magnetic gradient and electrical resistivity data was periodically down–loaded to a field computer for immediate quality control and storage on magnetic disk. This forms part of a Quality Assurance procedure which provides for the early recognition of poor data sets that can be immediately resurveyed.

Preliminary data processing using GEOPLOT software was carried out at the end of each day in order to provide hardcopy output of the data. This enabled an initial assessment of the quality of the data and identification of possible anomalies which

may have required further, more detailed coverage. The data was also available for viewing by the Engineer's Representative.

Final data processing was carried out using GEOSOFT. Image processing and spatial domain filtering were used to enhance the signal to noise ratio.

5. *SURVEY RESULTS*

Magnetic Gradiometer Survey Results

A number of features indicated by variations in the magnetic field gradient are present in Geophysical Survey Area A, B and C. These are shown in *FIGURES* 2,3 and 4 respectively. Linear features described by magnetic 'highs' are generally indicative of ditch systems. These have been separated into 5 main categories (see *MAP 2*) based on morphology and are described as follows:

1. Trans-Linear Ditch Features:

Geophysical Survey Area A

Ditch Feature A: A number of parallel linear ditch features (2-4) run approximately east-west across the whole of the survey area. These represent ditches dug along the outline of an old road or trackway and adjacent field boundaries. The orientation of these ditches indicates that they may probably represent the earlier course of the present Melton Old Road from Melton (west), to the Melton Road in North Ferriby (east).

Ditch Feature B: This is represented by three parallel linear ditch features which are orientated approximately north-south in the centre of the survey area. This feature has been previously identified from crop markings observed on aerial photographs and are thought to be of Romano-British age.

Geophysical Survey Area B and C

Ditch Feature C: Four parallel linear ditch features with a northwest-southeast orientation are present in the central part of Survey Area B. These probably represent the location of a old road or trackway.

Ditch Features D: Two single linear ditch features occur in the central and east area of Survey Area B. They have an orientation approximately north-south and northwest-southeast, respectively.

2. Ditch Enclosures:

Geophysical Survey Area A

There are a number of rectangular ditch defined enclosure features in the west, central and eastern sectors of the survey area. Some of these features are orientated perpendicular to Linear Features A and B. However, a feature to the far southwest corner of the survey area appears to bear no relationship to the dominant linear features described above. Immediately to the southeast of the junction of Ditch Feature A and B appears a large enclosure approximately 50 x 50m which is surrounded on its southern and eastern sides by a number of smaller enclosures.

Geophysical Survey Area B and C

No enclosures are immediately evident in these Survey Areas.

3. ' Ridge and Furrow ' Features:

Geophysical Survey Area A

Probable Medieval 'ridge and furrow' features are represented by approximately 10m wide north-south trending linear strips. These appear most prominent within the central and western sectors of the survey area.

Geophysical Survey Area B and C

A number of regular parallel linear features are represented in Survey Area C which could be related to ' Ridge and Furrow '.

4. Isolated Anomalies:

Geophysical Survey Area A

a) Anomalous magnetic highs: A number of isolated magnetic highs have been mapped. These could represent the locations of ancient kilns, hearths or burials.

b) Anomalous magnetic lows: Two isolated lows have been observed, one of which falls inside an enclosure feature. These could represent the location of a deep pit, water well or burial site.

Geophysical Survey Area B and C

A number of small and isolated magnetic 'lows' and 'highs' appear in both areas under investigation. However, only one in Survey Area B appears to warrant any further investigation at this time.

5. Magnetic Background:

Geophysical Survey Area A

The general magnetic background levels measured within the area where less than 1nT. However, close to the A63 trunk road and wire fences, higher backgrounds were experienced which may have masked possible features. Within the western sector of the area a distinct change in the background level is observed, this is delineated by an irregular east-west line of change. To the north the background has a lower magnetic background than to the south. This probably represents a geological phenomena such as a change in soil or rock type. A similar change in background magnetic response in observed to the north which parallels this phenomena.

Geophysical Survey Area B and C

Small variations appear to be present in both area's but none of any significance.

Resistivity Survey Results

The resistivity method was applied in selected areas of interest in consultation with and with permission from the Consulting Engineers for the project. The application of the method was only deemed necessary in Survey Area A where significant archaeological features required better definition. Sub-surface features could be further enhanced and the method may be able to distinguish features such as the remains of building masonry and mounds. This would be particularly useful to better define the interior of particular enclosures described. The technique was also used to better define the sub-surface in areas displaying anomalous magnetic highs described previously.

Resistivity Survey Area A-A: This survey area, to the west of Area A (*MAP 1*), was done over nine 20m x 20m grids to cover an area defining an enclosure. The survey revealed little other than confirming the orientation of ridge and furrow and a ditch defining the southern part of the enclosure (*FIGURE 5a and 5b*). Some faint internal structure can be observed with a resistivity 'high' located in the central part of the enclosure.

Resistivity Survey Area A-B: This survey area, in the central part of Area A (*MAP 1*), was done over sixteen 20m x 20m grids to cover an area defining a road or trackway intersection and an enclosure. The survey confirmed the presence of the ditches and 'ridge and furrow' with resistivity 'lows' (*FIGURES 6a and 6b*). Some structure may be present in the interior of this enclosure but this is complicated by the presence of the afore-mentioned features.

Resistivity Survey Area A-C and A-D:

These were selected to better define the cause of magnetic anomaly highs in the parts of Area A indicated in *MAP 1.* Several resistivity highs in *FIGURE 7* are significant and may correspond to subsurface mounds.

6. *CONCLUSIONS*

The geophysical survey has revealed significant archaeological features in the Melton area. Geophysical Survey Area A appeared to provide the most significant indication of archaeological activity as evidenced by the geophysical methods utilised.

Geophysical Survey Area A revealed the evidence of ditches which outlined two ancient roads or trackways, and also delineated adjacent enclosures. The chronology of these features is difficult to deduce without the evidence provided by a detailed archaeological investigation in areas highlighted by geophysics.

The geophysical survey has been successful in describing a complex archaeological history for Geophysical Survey Area A. It has extended the limited amount of information gained from crop marks observed on aerial photographs. The methods have confirmed the presence of a north-south and an east-west linear road or trackway across South Lawn and a number of adjacent enclosures. The method has also confirmed the presence of 'ridge and furrow' features, probably of Medieval age.

The geophysical survey suggests that the east-west road or trackway predates that with a north-south orientation. This is reinforced by some adjacent enclosures which clearly predate others. The assumption underlying this hypothesis is that a stronger geophysical response indicates more recent archaeological phenomena, which in general may be true but again requires direct field evidence for confirmation. If these features are of Romano-British date, then several periods are represented.

A number of strong isolated magnetic 'highs' appear in some enclosures, in fact one of these appears in a central position in one enclosure. The resistivity surveys provided a resistivity 'high' over magnetic 'highs' which may indicate the location of an ancient mound. Such features require further field investigation as they may indicate the location of ancient burial sites.

In Geophysical Survey Area B one prominent ancient road or trackway and two ditches have been indicated by the survey, which has also highlighted a isolated magnetic 'high'. In Geophysical Survey Area C only 'ridge and furrow' features have been indicated by the survey.

It is recommended that a detailed field evaluation be carried out on the various features discussed. This should aim to confirm and determine the chronology of the archaeological features surveyed and to investigate the possibility of there being buried kilns, furnaces or burial mounds.

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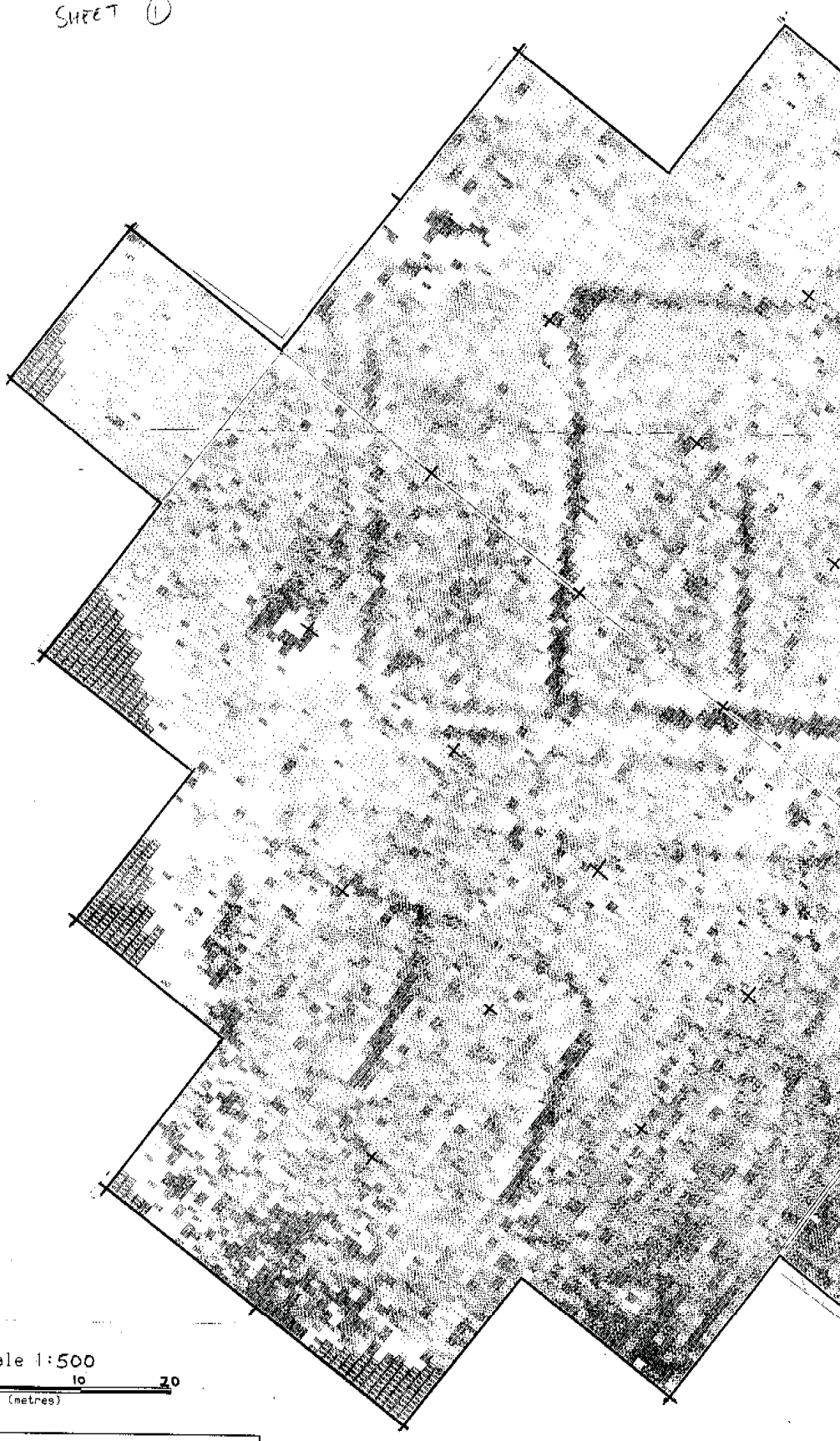
A



Scale 1:500

10 0 10 20

(metres)

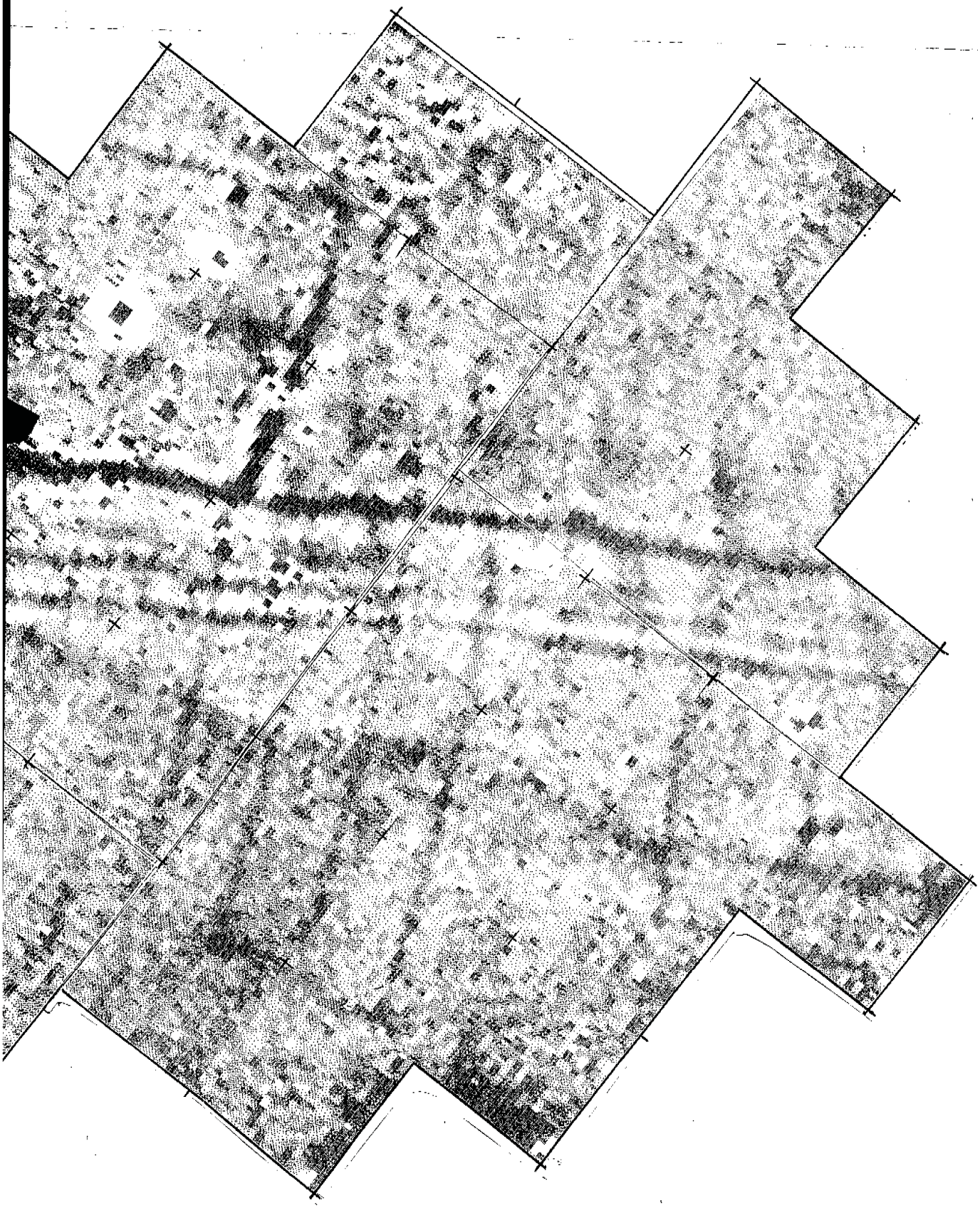
Client: DEPARTMENT OF TRANSPORT
Magnetic Gradiometery Dot Density Image Light Tones = Low, Dark Tones = High Geophysical Survey Area A Melton, Humberside Scale 1:500
FIGURE 2a
GSI (UK) LTD.

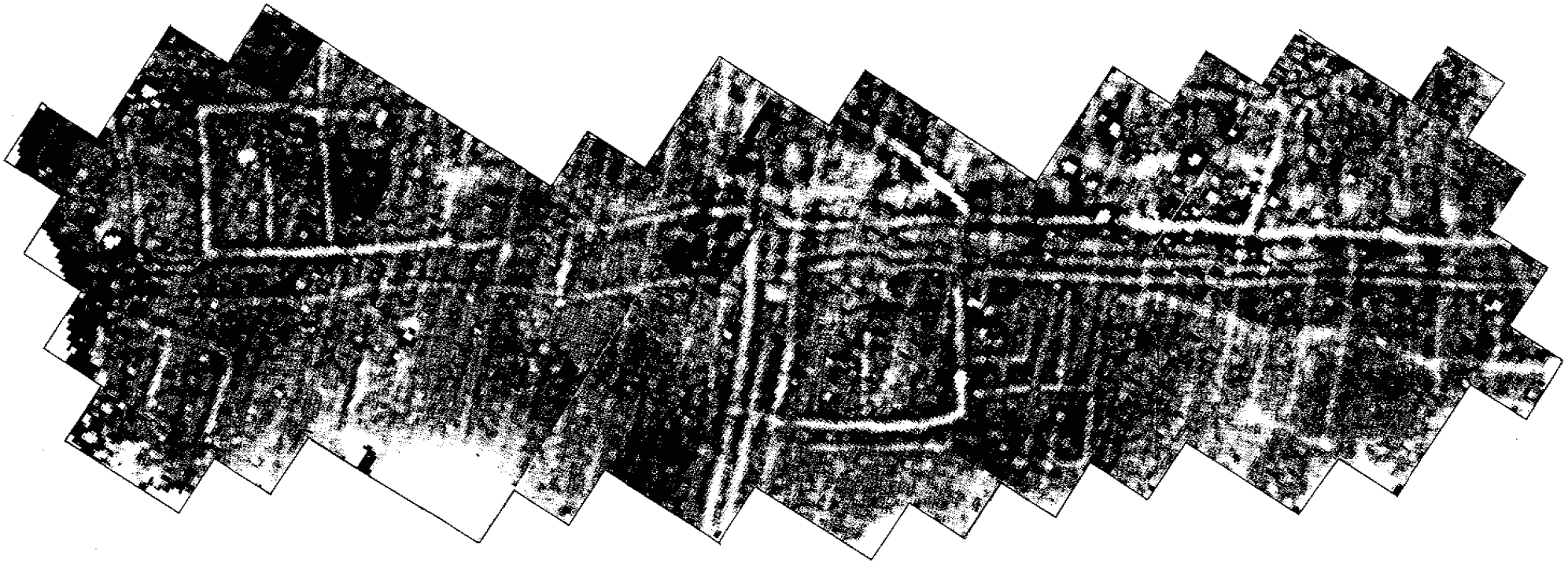
SHEET (2)

C

SHEET (4)

D





Scale 1:1250

25 0 25 50

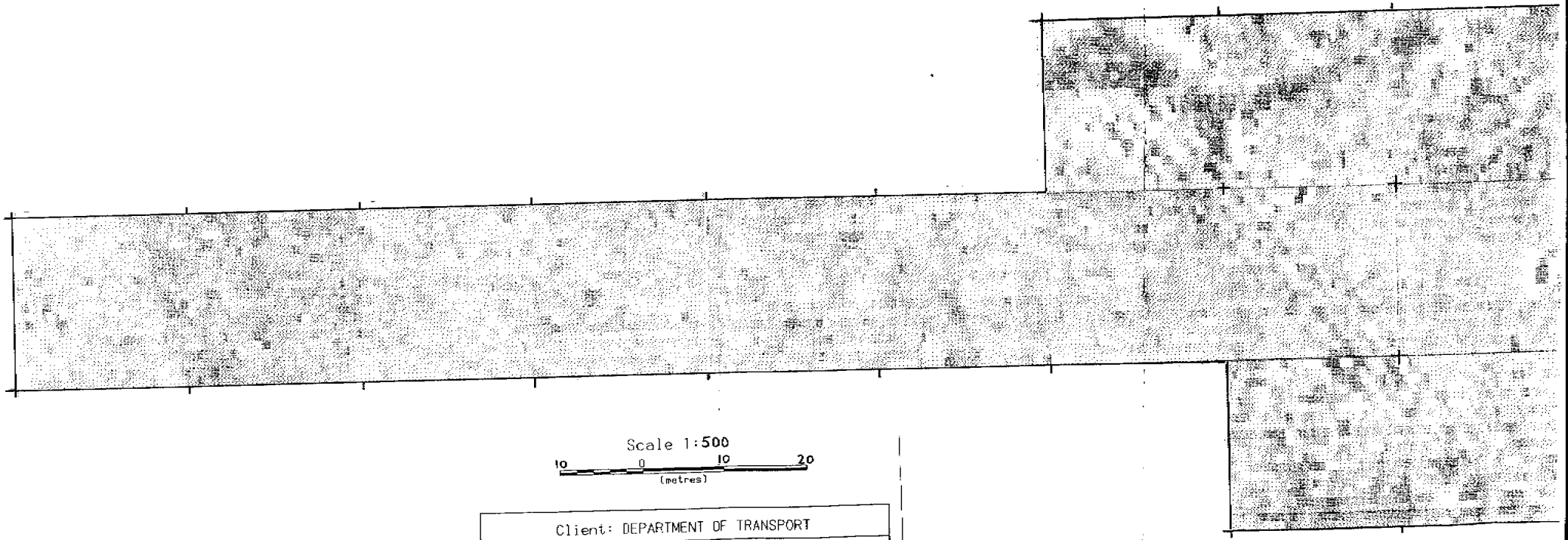
(metres)

Client: DEPARTMENT OF TRANSPORT

Magnetic Gradiometery Greyscale Image
Light Tones = High, Dark Tones = Low
Geophysical Survey Area A
Melton, Humberside
Scale 1:1250

FIGURE 2b

SS (UK) LTD.



Scale 1:500

10 0 10 20

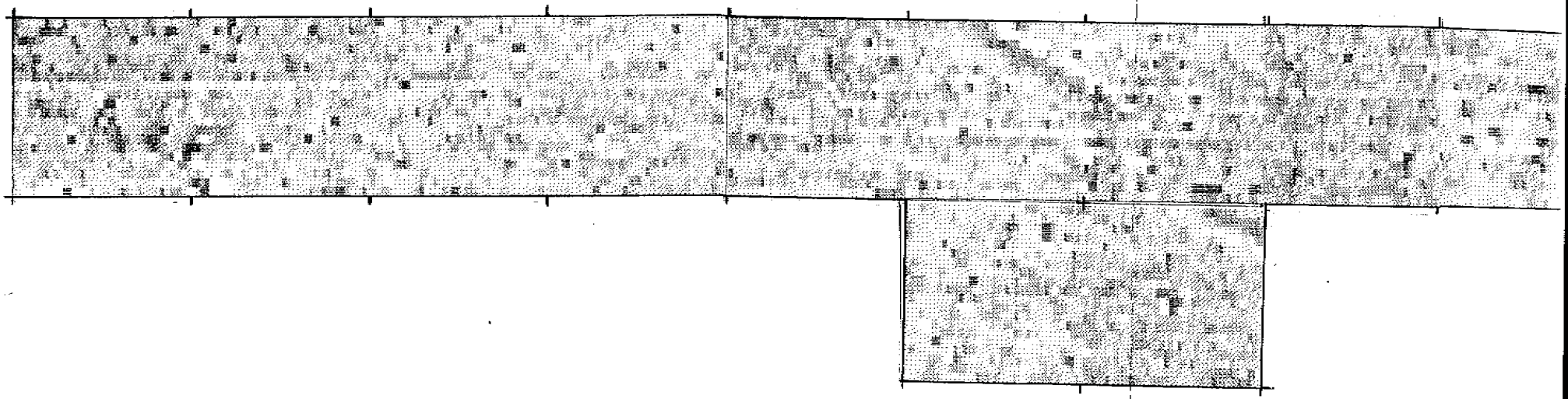
(metres)

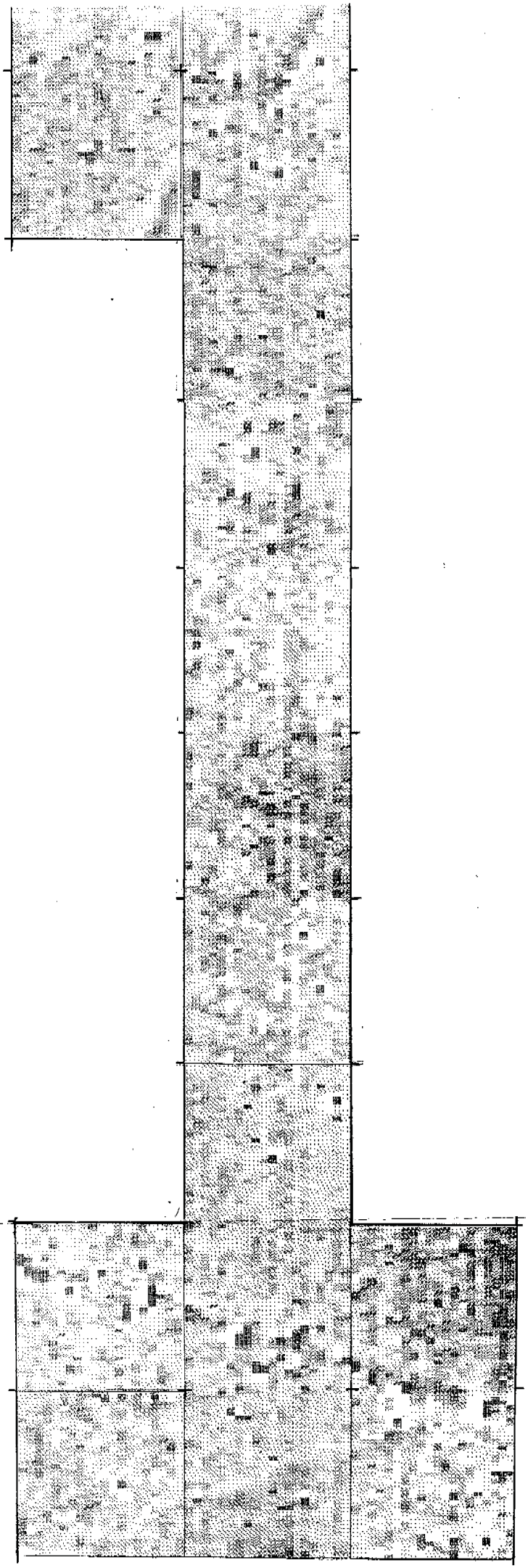
Client: DEPARTMENT OF TRANSPORT

Magnetic Gradiometery Dot Density Image
Light Tones = Low, Dark Tones = High
Geophysical Survey Area B
Melton, Humberside
Scale 1:500

FIGURE 3a

GSI (UK) LTD.





Scale 1:1250

25 0 25 50

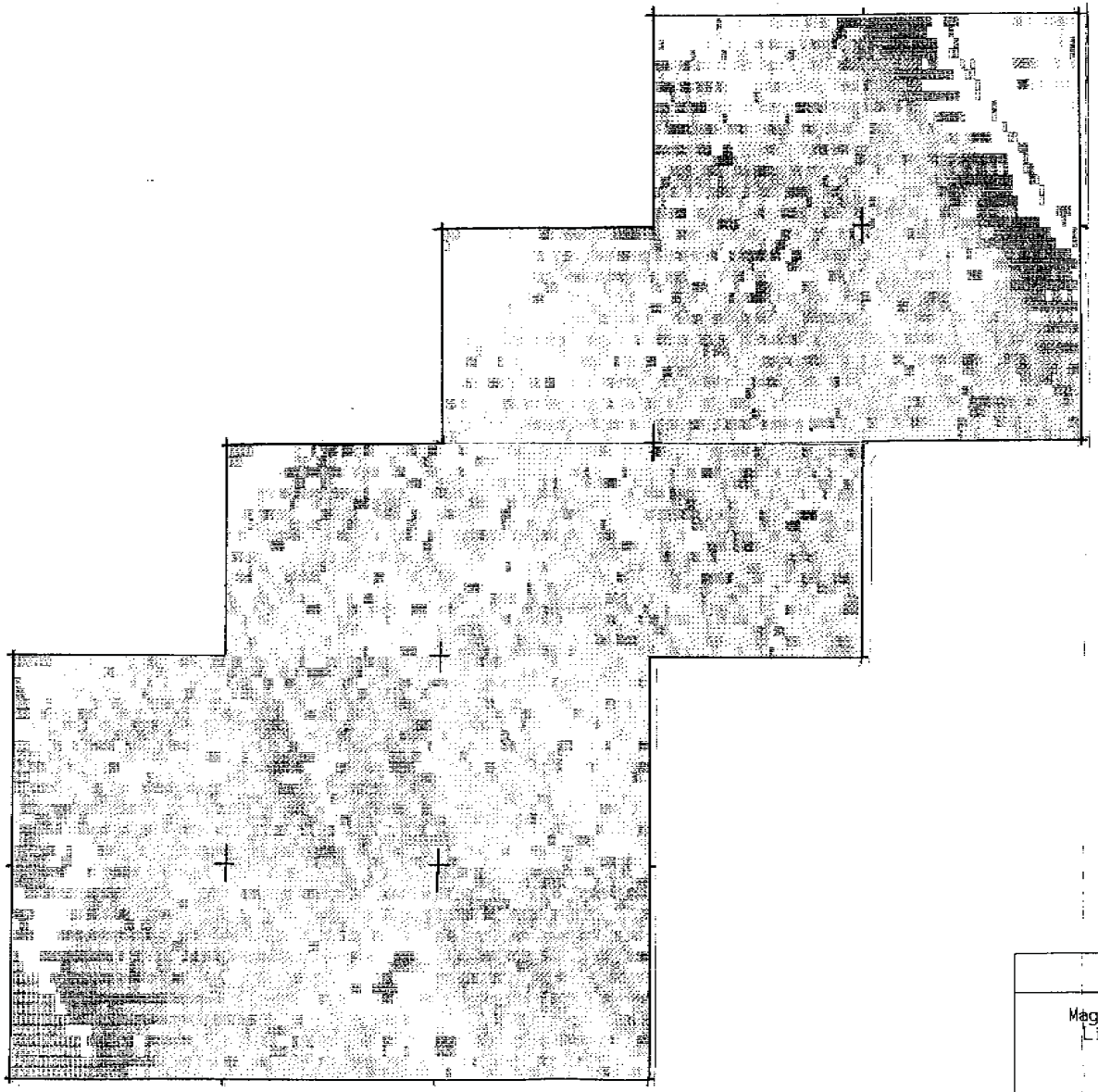
(metres)

Client: DEPARTMENT OF TRANSPORT

Magnetic Gradiometery Greyscale Image
Light Tones = High, Dark Tones = Low
Geophysical Survey Area B
Melton, Humberside
Scale 1:1250

FIGURE 3b

GSI (UK) LTD.



Scale 1:500

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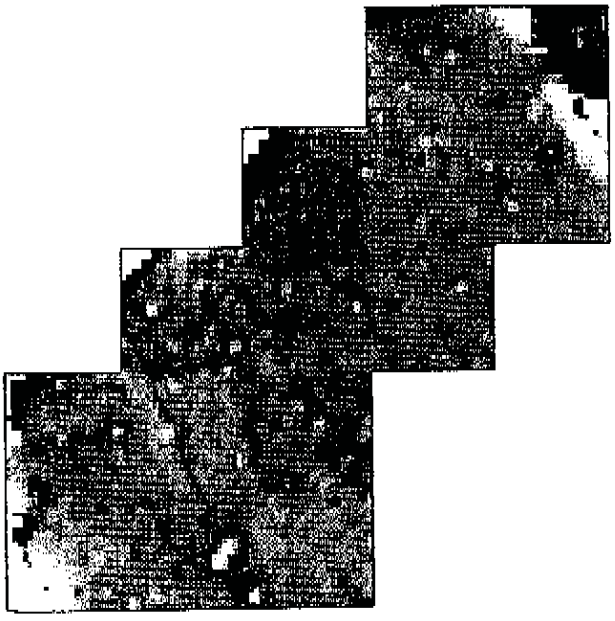
(metres)

Client: DEPARTMENT OF TRANSPORT

Magnetic Gradiometery Dot Density Image
Light Tones = Low, Dark Tones = High
Geophysical Survey Area C
Melton, Humberside
Scale 1:500

FIGURE 4a

GSI (UK) LTD.



Scale 1:1250

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(metres)

Client: DEPARTMENT OF TRANSPORT

Magnetic Gradiometery Greyscale Image
Light Tones = High, Dark Tones = Low
Geophysical Survey Area C
Melton, Humberside
Scale 1:1250

FIGURE 4c

GSI (UK) LTD.

Scale 1:500

10 0 10 20

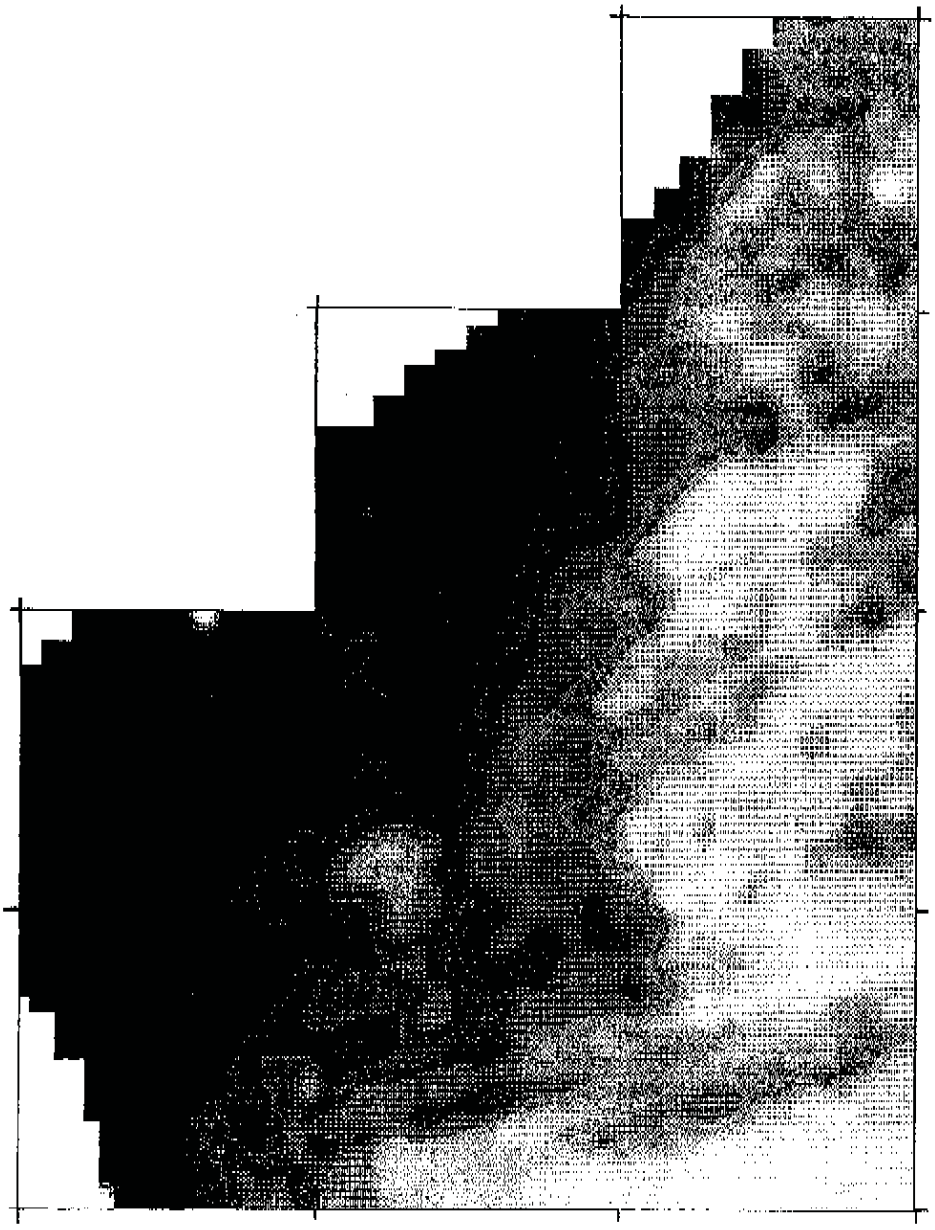
(metres)

Client: DEPARTMENT OF TRANSPORT

Resistivity Dot Density Image
Light Tones = Low, Dark Tones = High
Geophysical Survey Area A-A
Melton, Humberside
Scale 1:500

FIGURE 5a

GSI (UK) LTD.



Scale 1: 500

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(metres)

Client: DEPARTMENT OF TRANSPORT

Resistivity Greyscale Image
Light Tones = High, Dark Tones = Low
Geophysical Survey Area A-A
Melton, Humberside
Scale 1:500

FIGURE 5b

GSI (UK) LTD.

Scale 1: 500

10 0 10 20

(metres)

Client: DEPARTMENT OF TRANSPORT

Resistivity Dot Density Image
Light Tones = Low, Dark Tones = High
Geophysical Survey Area A-B
Melton, Humberside
Scale 1:500

FIGURE 6a

GSI (UK) LTD.

Scale 1:500

10 0 10 20

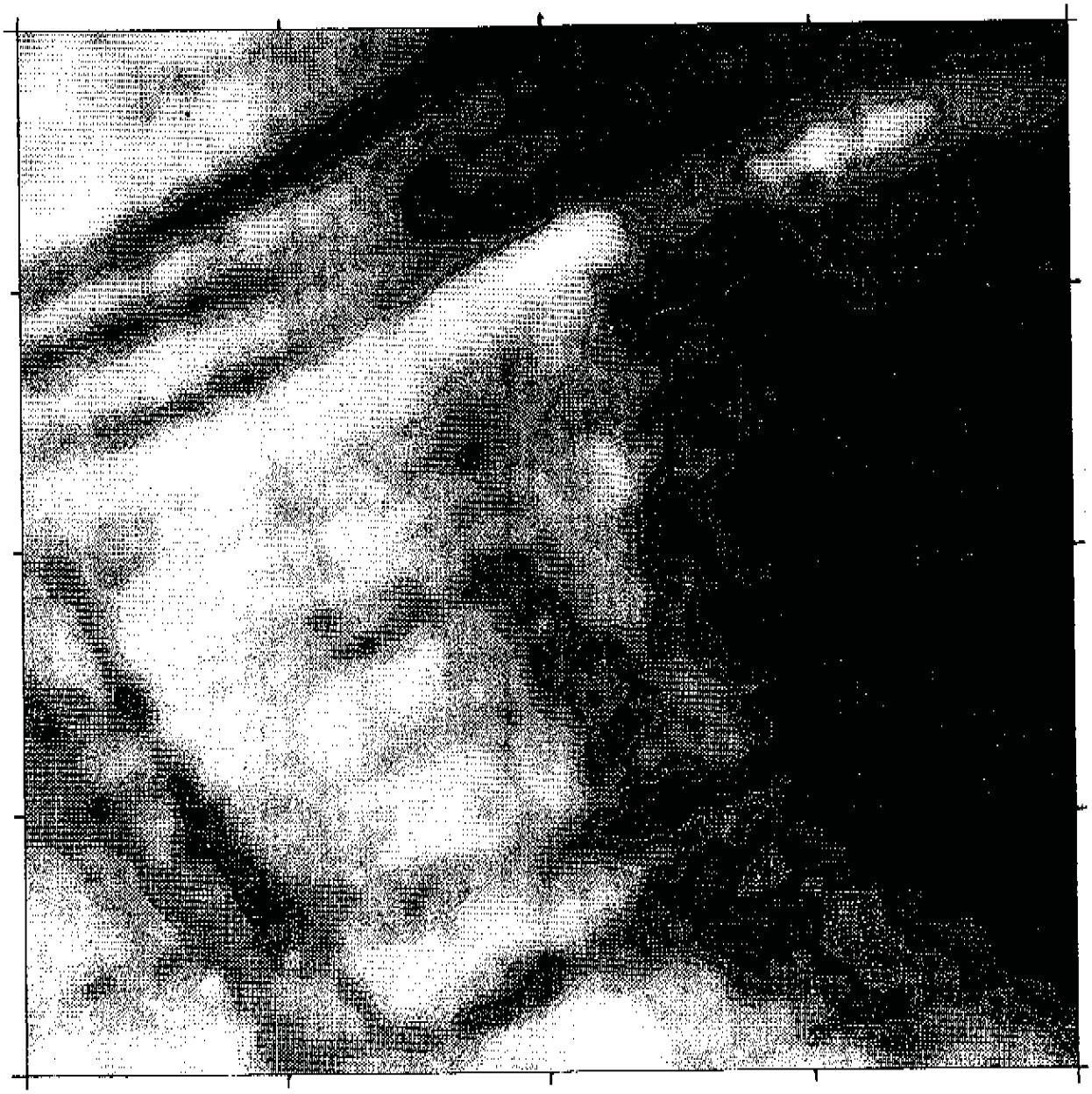
(metres)

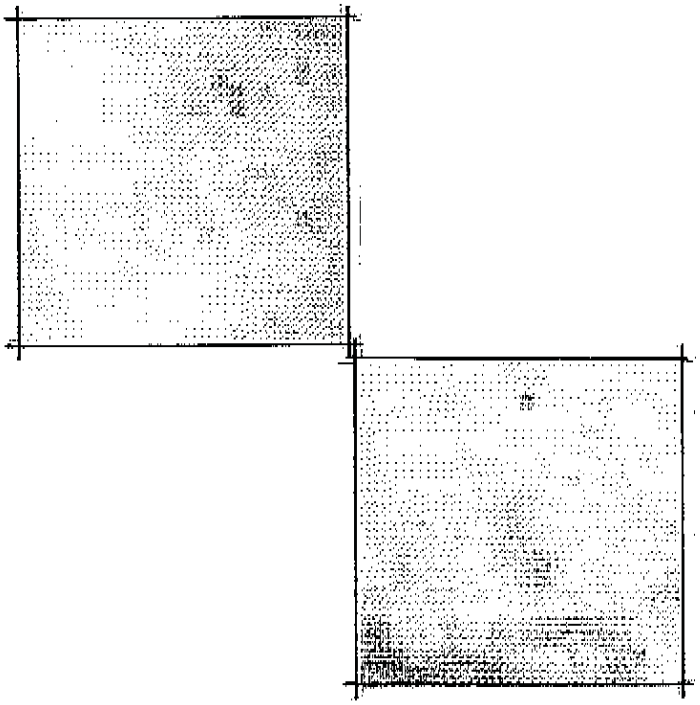
Client: DEPARTMENT OF TRANSPORT

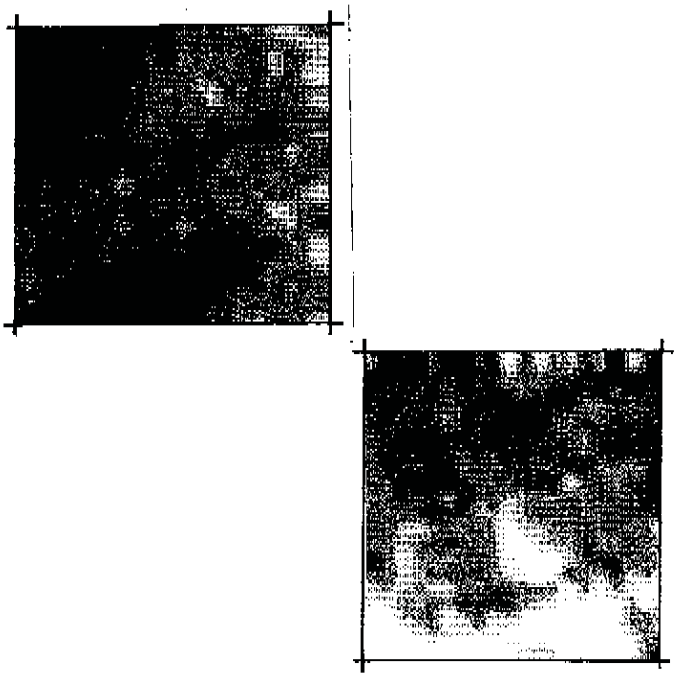
Resistivity Greyscale Image
Light Tones = High, Dark Tones = Low
Geophysical Survey Area A-B
Melton, Humberside
Scale 1:500

FIGURE 6b

GSI (UK) LTD.







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(metres)

Client: DEPARTMENT OF TRANSPORT
Resitivity Dot Density Image Resistivity Greyscale Image Geophysical Survey Area A-C & A-D Melton, Humberside
Scale 1:500 FIGURE 7
GSI (UK) LTD.