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# Engineering Consultancy Services

## MEMORANDUM



TO: Recreational Services Dept  
Archaeology Section

Our Ref: ECS/SJW/E0541/160/JP

Your Ref:

For further information please contact

Mr S J Wiles

Ext: 2916 Fax. 2925

10 April 1995

### A16 FOTHERBY BYPASS

Further to your recent discussions with the Highways Agency and ECS regarding the above scheme, I enclose for your information copies of the relevant sections of the Environmental Statement Volumes 1 and 2 and the Geophysical Survey along the route of the proposed A16 Fotherby Bypass.

If you require further information of discussions regarding this aspect then please contact my Engineer on the above telephone number.

for Chief Engineer ECS

LINCOLNSHIRE  
COUNTY COUNCIL  
19 APR  
CITY AND COUNTY  
MUSEUM

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SLI 4558

PRN 4190

ELI 418 465



THE DEPARTMENT  
OF TRANSPORT

**A16 FOTHERBY BYPASS  
ENVIRONMENTAL STATEMENT**

**VOLUME I**

DEPARTMENT OF TRANSPORT  
EAST MIDLANDS NETWORK MANAGEMENT DIVISION  
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September 1992

**DEPARTMENT OF TRANSPORT  
A16 FOTHERBY BYPASS  
ENVIRONMENTAL STATEMENT**

**VOLUME I**

This Environmental Statement is issued in accordance with EC Directive 85/337/EEC as applied by Section 105A of the Highways Act 1980.

This Environmental Statement is placed on deposit with the draft Orders for the scheme and may be inspected at the locations shown on the last page of this document.

Comments on this Environmental Statement should be sent to the Director of Transport, Department of Transport, East Midlands Regional Office, Cranbrook House, Cranbrook Street, Nottingham by 17th December 1992.

Further copies of the Non Technical Summary included in this Statement are available, free of charge from the Department at the above address.

**September 1992**

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## 1.0 INTRODUCTION

- 1.1 The village of Fotherby lies on the eastern edge of the Lincolnshire Wolds on the A16(T), Norman Cross to Grimsby Trunk Road, about 4 km north of the market town of Louth. The A16(T) is a principal north-south route through Lincolnshire, for long distance traffic, forming the strategic route from Humberside to Stamford. The general location of the village on the trunk road network is shown on Figure 1.
- 1.2 The purpose of the proposed new road is to provide a single carriageway bypass for the A16(T), to the west of the village. The objectives for the new road are consistent with the Government's general objectives for the improvement of trunk roads which are:-
- a) to assist economic growth by reducing transport costs;
  - b) to improve the environment by removing through traffic from unsuitable roads in towns and villages;
  - c) to enhance road safety.
- 1.3 In 1975 the Secretary of State for Transport announced that the A16(T) should be considered for improvement along its entire length from Norman Cross, on the A1 near Stamford, to Grimsby. A bypass for the village of Fotherby was included as part of a Route Assessment Report prepared by the Lincolnshire County Council on behalf of the Department of Transport in 1976.
- 1.4 The Department included a bypass for Fotherby in the East Midlands Trunk Road Regional Programme in 1986. An interim signing and road marking scheme was carried out in 1987/88 at the junction of the A16(T) and North Elkington Lane. The bypass scheme is included in the National Trunk Road Programme and Draft Orders for the route accompany this Environmental Statement.
- 1.5 The main environmental advantages of the scheme arise from the removal of trunk road traffic from the village. This would lead to a reduction in the effects of severance, noise, atmospheric pollution, vibration, and dust and dirt. In particular, the bypass will relieve many dwellings and other occupied buildings, including six buildings Listed for their Architectural and Historic Interest, of the adverse environmental effects of trunk road traffic.
- 1.6 The bypass would not adversely affect any site or feature of special ecological, historical or archaeological interest. No buildings would need to be demolished to construct the bypass. The main environmental disadvantage of the scheme would be its effect on the landscape of the Lincolnshire Wolds Area of Outstanding Natural Beauty. Special attention has been paid to minimising the effects on the landscape. It is considered that the bypass would not have a significant effect on the AONB and surrounding landscape. Some increase in the costs of the scheme have been accepted in order to achieve the optimum balance between engineering and environmental considerations. These are explained in more detail in Sections 5 and 6 and in the Landscape Report in Volume II of this Statement. Public consultation has also played an important part in route planning and design.

## 2.0 THE SCHEME

### 2.1 The Current Situation

2.1.1 The existing A16 trunk road passes through the village of Fotherby in a north-south direction. It carries some 9,500 vehicles per day of which around 12% are heavy goods vehicles. The A16 through Fotherby is one of the busiest routes for commercial traffic in Lincolnshire.

2.1.2 The road through the village has a number of changes in direction and level. Various parts of the existing trunk road are sub-standard or seriously sub-standard in respect of one or more of the following features:

- a) width;
- b) vertical and/or horizontal alignment;
- c) stopping site distance;
- d) junctions (radii and visibility);
- e) accesses (visibility);
- f) footway width and verge width.

There are six side roads taking access to the trunk road via seven priority junctions. Thirty five residential properties front onto the A16(T), all having individual private accesses. Other accesses serve seven farmsteads, a riding school, a post office and a petrol filling station. Houses and other buildings are situated on both sides of the road.

2.1.3 The heavy traffic travelling through the village brings noise, vibration, dust, dirt, atmospheric pollution and danger to residents and visitors. It causes severance to the community and the large heavy goods vehicles have an intimidating effect on pedestrians and cyclists in the village.

### 2.2 Description of the Published Route

2.2.1 The Published Route would be a single carriageway 7.3 metres wide with 1.0 metre wide hard strips and, generally, 2.5 metre wide grass verges.

2.2.2 It would leave the existing trunk road at a point approximately 150 metres south of Cordeaux Corner and rejoin the existing trunk road at a point approximately 425 metres north-west of the garage at the corner of Allenby Crescent, in the vicinity of Mill Farm. A plan of the route is shown on Figure 2. The total length of the Published Route is 2.5 kilometres.

2.2.3 Upon leaving the line of the existing A16(T), south of the village, the Published Route would head to the north-west over low lying land, partly on a shallow embankment (ranging from 0.5 m to 1.5 m where it crosses Yarburgh Beck which would be culverted at this point) and then into a cutting as it approaches North Elkington Lane. The depth of the cutting where the route would cross the existing line of North Elkington Lane is approximately 2.2 metres. North Elkington Lane would be formed into a cul-de-sac with no direct vehicular access to the trunk road from the east. There would be a priority junction on

the west side of North Elkington Lane, some 18 metres north of the existing lane.

- 2.2.4 The route would then head in a generally northerly direction through arable farmland, broadly parallel with the existing A16(T). Between North Elkington Lane and Short Lane the route would be located some 85 metres to the west of the edge of Fotherby village and between 65 and 330 metres to the east of Barton Street. Much of this length of road would be in a shallow cutting varying from 0.5 to 2 metres deep.
- 2.2.5 Where the Published Route crosses Short Lane a cul-de-sac would be formed. Short Lane would have no direct vehicular access to the trunk road from the east or the west. However, a route for pedestrians, riders and cyclists would be maintained along the line of the existing lane from the cul-de-sac head, west of Wold View, to Barton Street and thence up to Fotherby Common.
- 2.2.6 North of Short Lane the route would pass into a cutting of 2.5 m opposite Hill Crest and then onto a shallow embankment between 0.9m and 1.2m high as it passed northwards to rejoin the existing trunk road in the vicinity of Mill Farm. The route would pass approximately 125 metres east of Manor Farm, 72 metres west of Hill Crest and 75 metres west of Longacre. The design of the Published Route incorporates extensive ground modelling to the cutting slopes and adjacent land, including land to the west of Wold View.
- 2.2.7 Three priority or 'T' junctions are proposed on the Published Route. At each end of the scheme there would be a connection to provide access to the village. These junctions would include local carriageway widening of the proposed trunk road to accommodate 'ghost islands' to shelter right-turning traffic. The third junction would link the proposed trunk road to North Elkington Lane as described in paragraph 2.2.3.
- 2.2.8 The proposed road would not be provided with street lighting except at the northern and southern junctions. No lay-bys are proposed along the bypass but lay-by provision would be made to the south of Cordeaux Corner and near Utterby on the existing A16(T).
- 2.2.9 It is anticipated that the bypass would remove 93% of all traffic on the existing trunk road in the village. It is anticipated that traffic flows on the proposed bypass would be about 9,500 vehicles per day in the opening year and would rise to between 12,000 and 14,400 within 15 years (see Figure 7).
- 2.2.10 Manual classified counts carried out on the A16 and on the minor roads within the village have been supplemented by data obtained from automatic traffic counts permanently situated on the A16 to provide information on the amount of local, or through traffic, seasonal variations and traffic growth. All surveys, and subsequent assessments were carried out fully in accordance with the procedures contained within the Department of Transport's Traffic Appraisal Manual (TAM).

### 3.6 Flora and Fauna

- 3.6.1 There are no statutorily or non-statutorily designated sites of nature conservation interest affected by the Published Route. (Figure 6).
- 3.6.2 The Ecology Report (section 9 Volume II) identified existing hedgerows as the only significant habitats affected. Where these are continuous and overgrown, or well maintained to a height exceeding 1.2 m, they provide habitat for communities of plants and animals on the open farmland. They also provide corridors which assist in the movement of plants and animals between habitats.

### 3.7 The Cultural Heritage

- 3.7.1 There are no Scheduled Ancient Monuments, Conservation Areas or Listed Buildings on or close to the Published Route.
- 3.7.2 The Cultural Heritage Report (section 10 Volume II) identifies the sites and features of cultural heritage value in the general area. Sites of potential archaeological interest are located around the village (Figure 6). Barton Street is part of a Roman Road from Barton-on-Humber to Louth. The Published Route lies close to this feature but would not affect it. Aerial photographs have revealed the presence of cropmarks to the south of Short Lane and to the west of the Published Route (Figure 6). The bypass would not affect these features. Buildings of importance are confined to the built-up area of Fotherby. There are historic parklands and an ancient woodland near to the village but none are affected by the Published Route (Figure 6).

### 3.8 Land Use

- 3.8.1 Within the village of Fotherby the predominant land uses are residential and agricultural with a church, a garage a post office and a meeting room. (Figure 5).
- 3.8.2 Outside the main built-up areas the surrounding land is almost exclusively in agricultural use with the exception of the disused former railway line, a few woodlands, a riding school and scattered residential properties. Fotherby Common is planted with trees and is a small area of recreational amenity land. (Figure 5).
- 3.8.3 A survey of farmholdings potentially affected by a proposed western bypass was undertaken by the Agricultural Development Advisory Service of the Ministry of Agriculture Fisheries and Food (MAFF) in October 1991. Detailed information about individual farmholdings is necessarily confidential but the main findings of the report, based on aggregated information, are set out in paragraphs 3.8.4 to 3.8.6.
- 3.8.4 Seven agricultural holdings were surveyed in detail covering a total of 1,525 hectares of land from Utterby to the south of Fotherby. The survey concentrated on farmland to the west of the existing A16(T) but some holdings also farmed land to the east of the trunk road. Of the 1,525 hectares surveyed 1,320 hectares were cultivated as arable land and temporary grass ley; 205 hectares were maintained as permanent grassland. 3 farm holdings involved the keeping of

#### 4.5 Effects on Flora and Fauna

- 4.5.1 No statutory or non-statutory site of nature conservation interest would be affected by the proposed scheme. The proposed road would require the removal of some 9 hedgerow trees, some 370 linear metres of hedgerow and 800 square metres of roadside verge. None of these habitats are of special significance.
- 4.5.2 Habitats lost to the scheme are commonly found in Lincolnshire and comprise replaceable communities of ubiquitous species of flora and fauna. The loss and severance of habitat is not significant and new planting and landscaping proposals would in time provide a significant net increase in woody cover and managed grass verges. The English Nature reply to consultation is included in Appendix B, Volume II.

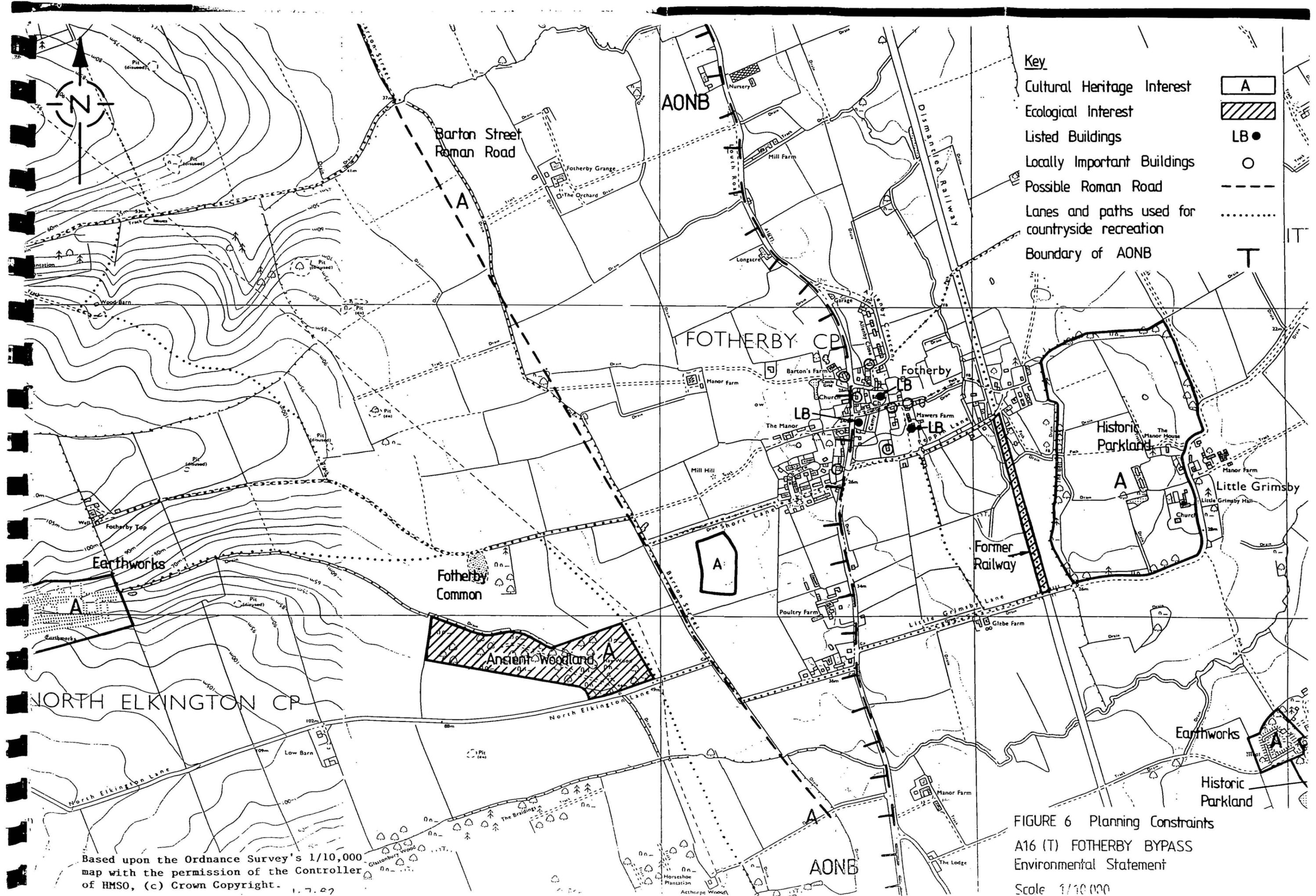
#### 4.6 Effects on the Cultural Heritage

- 4.6.1 The effects of the proposed bypass would be beneficial in reducing the effects of trunk road traffic on 6 Listed Buildings and three other buildings of local importance. No sites or features of archaeological or cultural heritage interest would be adversely affected by the scheme. A watching brief, by a qualified archaeologist, would be undertaken during construction works along the whole route. The English Heritage reply to consultation is included in Appendix B, Volume II.

#### 4.7 Effects on Land Use

- 4.7.1 Apart from highways, agriculture is the only land use which is directly affected by landtake. There would be no adverse effects on any other land use.
- 4.7.2 Seven farmholdings would be affected by landtake for the Published Route. 2.3 hectares of Grade 3a and 7.1 hectares of Grade 3b agricultural land would be required by the scheme. 11 fields would be affected. Of these, 5 fields would be severed but the remaining parts would be of a size, shape and location such as to allow continued farming operations. Access to the severed areas would be provided.
- 4.7.3 5 of the other fields would be severed in such a way as to leave small or awkwardly shaped or located fragments of the field which would not be suitable for modern farming operations. Where field amalgamation was impractical the Department would consider acquiring the severed areas for planting. 5 such areas have been identified extending to some 0.9 hectares. The remaining field would not be severed by the land take for the proposed road.
- 4.7.4 It is anticipated that the Published Route scheme, together with accommodation works to be agreed with individual land owners and occupiers, would provide for the continued access to and operation of all other agricultural land. However, The Manor Farm, Fotherby would experience significant severance of access. In the case of all seven landholdings the effects on field access and journeys between constituent parts of holdings would be capable of mitigation.





- Key**
- Cultural Heritage Interest A
  - Ecological Interest
  - Listed Buildings LB ●
  - Locally Important Buildings ○
  - Possible Roman Road
  - Lanes and paths used for countryside recreation
  - Boundary of AONB

Based upon the Ordnance Survey's 1/10,000 map with the permission of the Controller of HMSO, (c) Crown Copyright.

FIGURE 6 Planning Constraints  
A16 (T) FOTHERBY BYPASS  
Environmental Statement  
Scale 1/10,000



**THE DEPARTMENT  
OF TRANSPORT**

**A16 FOTHERBY BYPASS  
ENVIRONMENTAL STATEMENT  
VOLUME II  
ACCOMPANYING REPORTS**

**DEPARTMENT OF TRANSPORT  
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September 1992

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NB. All Figures referred to in this Volume are contained in Volume I of this Environmental Statement together with the Framework Analysis and The Landscape Proposals Plan.

## 10.0 CULTURAL HERITAGE REPORT

### 10.1 Areas, Sites and Features of Cultural Heritage Interest

10.1.1 There are no Scheduled Ancient Monuments in the vicinity of Fotherby or the Published Route. There are no areas or features identified for their known or potential archaeological interest on the line of the proposed road. The nearest sites of archaeological interest are:-

- a) cropmarks of enclosures to the south of Short Lane and to the east of Barton Street;
- b) earthworks to the south of Fotherby Top; and
- c) a moat and earthworks at Brackenborough Hall.

These features are shown on Figure 6. Barton Street is probably part of a pre-Roman Road running north-south along the eastern edge of the Wolds. Various chalk, sand and gravel pits potentially may contain some archaeological interest but none have been investigated and none would be affected by the Published Route.

10.1.2 There is no designated Conservation Area in Fotherby.

10.1.3 Within the village the eight buildings Listed by the Secretary of State for the Environment as of Architectural or Historic Interest are the most important buildings. They are identified in paragraph 10.1.4. and Figure 6. Six are located on the existing A16(T). In addition to the Listed Buildings there are a variety of other houses, farmbuildings etc which contribute to the amenity and heritage value of the village. Fotherby is an historic community and its cultural heritage is represented by the clusters of buildings which together form the village. The Listed and locally important buildings, identified in paragraph 10.1.4 and 10.1.5, alone cannot create the character and identity of the village. Most buildings within the village, with their gardens and open spaces, play a part in the community's heritage.

10.1.4 The Listed Buildings are:-

1. The 13th Century Church of St. Mary, Church Lane, (Grade II);
- 2-7 6 No. terraced cottages built as almshouses in the 19th Century on Louth Road, fronting the existing A16(T), Grade II;
8. The late 18th Century house at Mawers Farm on Peppin Lane, Grade II.

10.1.5 The locally important buildings, some of which were previously listed as Grade III before the Department of Environment regraded all Listed Buildings into Grades I, II or II\*, are concentrated in the main body of the village. The principal buildings of local interest are: The Manor House, The Yews, and Westholme (on the A16(T)); Barton Farmhouse on Allenby Crescent; Holly House and the Old Sunday School on Church Lane; and Southwold and The Vicarage on Peppin Lane.

- 10.1.6 There are attractive examples of historic parklands at Little Grimsby and at Brackenborough Hall.
- 10.1.7 The woodland at The Dales and May Wood, in the valley of the Beck north of North Elkington Lane (Figure 6) is considered to be ancient woodland (of natural origin or originating before 1600 AD). It is coincidental with the parish boundaries and is probably a remnant of a large block of woodland on the steep slopes of the Wolds historically associated with the villages of Fotherby, North Elkington and Ackthorpe/South Elkington.
- 10.1.8 The historic settlement pattern of Fotherby was originally based on a relatively compact linear village on the Louth Road (A16(T)). Nineteenth and twentieth century development has formed two detached clusters of buildings; one to the south based on the A16(T) and North Elkington Lane, and one to the east around the former railway station. Wold View has consolidated development on the slope between the upper and lower glacial terraces. Like Utterby, Ludborough and North Thoresby, on the A16(T) to the north, Fotherby developed as a settlement on the edge of the coastal plain and was not directly related historically to the villages on the Wolds to the west.
- 10.1.9 Following a desk-top analysis of known information from archaeological records (the Sites and Monuments Records) and an examination of aerial photographs a field investigation was undertaken in February and March 1992. This consisted of two phases:-
- a) a visual inspection of the general area; and
  - b) a detailed fieldwalking survey.
- Both field surveys were undertaken by a qualified Field Archaeologist.
- 10.1.10 The initial inspection of the general area revealed some fragments of ridge and furrow lying close to the existing A16(T) in the village which would not be affected by the Published Route. The Route would lie close to the presumed line of Barton Street a pre-Roman trackway which runs along the east side of the Wolds linking Barton-in-Humber with Louth. The Street forms the western boundaries of fields where there is a slight bank beneath the hedge. This may indicate the presence of the street but could equally be associated with the hedge itself. It would not be affected by the Published Route but the realignment of North Elkington Lane may affect a small part of any remains of the street.
- 10.1.11 In addition to the aerial photographs held by the Lincolnshire Sites and Monuments Record a search was made of the National Photographic Records of the RCHM at Swindon. The Cambridge University Collection Aerial Photographic Unit hold two photographs of crop marks at TF311 912. These lie in field 0800, south of Short Lane, east of Barton Street and to the west of the proposed road. They comprise two sub-rectangular enclosures, probably iron age in date.
- 10.1.12 The detailed fieldwalking survey consisted of four traverses along the bypass route, including the junctions, within a 50m wide corridor. Techniques in fieldwalking as a method of locating archaeological

remains have been developed and refined over many years (Haselgrove et al 1985). Whilst only a small proportion of artefacts in the ploughsoil will be exposed at any one time it is generally accepted that a large enough sample will be seen to indicate the presence (or absence) of human activity. The spacing of each traverse affects the reliability of the sample collected but experience has shown that a 20m interval is adequate to give a rough indication of artefact concentrations. To increase the reliability of the survey, traverses were spaced c.12m apart.

- 10.1.13 The whole of the route was arable land and was under crop, mainly brassicas or cereal. One field was freshly ploughed. Conditions in 3 fields were poor because of the advanced crop growth. One field was covered in straw and had probably been direct-drilled. Visibility on the ground in the remaining eight fields was mainly good.
- 10.1.14 There was remarkably little material of any period in the fields. Given the proximity of the southern half of the route to the village of Fotherby larger quantities of medieval and later pottery had been anticipated.
- 10.1.15 Six pieces of pottery were retrieved within the 50m wide corridor, five of which were medieval and one 17th century in date. Six pieces of struck flint were also retrieved, only one of which was a recognisable tool. This came from a field at the southern end of the route and was a small scraper dating to the late Neolithic/early Bronze Age. One small piece of green stone, found at the northern end, may be a fragment from a Neolithic stone axe. Large numbers of polished stone axes made from this material were imported into Lincolnshire from the Lake District.
- 10.1.16 Ground conditions were poor in Field 0800 where nothing relating to the enclosure ditches shown on the aerial photographs was found.

## **10.2 Changes in the Cultural Heritage Resource**

- 10.2.1 No significant changes to the features or sites of cultural heritage interest are anticipated. However, the Listed Buildings and buildings of interest on the A16(T) would suffer increased adverse effects from trunk road traffic if a bypass is not constructed.

## **10.3 Mitigation Requirements and Proposals for the Cultural Heritage**

- 10.3.1 The construction of the Published Route would not significantly affect any sites or features of cultural heritage interest.
- 10.3.2 However, a watching brief would be kept by a qualified archaeologist during construction along the whole of the route.

## 10.4

### Effects of the Scheme on the Cultural Heritage

#### 10.4.1

The effects of the proposed bypass would be beneficial in reducing the effects of trunk road traffic on the village generally and particularly on 6 Listed Buildings and three other Buildings of local interest. No disadvantages to the cultural heritage are expected to arise as a result of the scheme.

**GEOPHYSICAL SURVEY ALONG  
ROUTE OF PROPOSED A16  
FOTHERBY BYPASS, LINCS.**

A PROGRAMME OF RESEARCH CARRIED OUT  
ON BEHALF OF

**ENGINEERING CONSULTANCY SERVICES**

By

**GeoQuest Associates**

## **INTRODUCTION**

This report presents the results of a geophysical survey along part of the proposed route of the A16 Fotherby bypass in Lincolnshire. The archaeological potential of this section of the road has been highlighted by the detection of two possible Iron Age enclosures as cropmarks to the south of Short Lane at TF312912 (Figure 1).

This report contributes to an archaeological assessment being carried out by Lincolnshire County Council. The aims of the work were as follows:

- 1 Use geophysical methods to test for the presence of Iron Age or other archaeological features within the road corridor.
- 2 Map pipes and other buried services.

## **LOCATION AND ENVIRONMENT**

The study area is situated immediately south of Short Lane in the village of Fotherby which is located on the A16 between Louth and Grimsby. A 300m long strip, 50m wide, was specified for the archaeological geophysical survey (Figure 1). Despite proximity to the cropmark features, fieldwalking has failed to locate any artifacts in this vicinity.

The solid geology is thought to be Cretaceous Chalk overlain by glacial tills, glacial sands and gravels. The topography is subdued and there are no surface outcrops. At the time of survey the field had recently been under arable cultivation.

## **THE GEOPHYSICAL SURVEYS**

The geophysical survey explored an area 50m wide centred along the midline of the proposed bypass (Figure 1). The survey employed a Geoscan FM36 fluxgate gradiometer with ST1 sample trigger to detect variations of magnetic susceptibility and thermoremanence which might be associated with ditches and other archaeological features in the subsoil. Details of the underlying physical principles of this method are given in Appendix A. Measurements were made in 20x20m grid units with a sampling interval of 1.0x0.5m which enabled geophysical anomalies and archaeological features to be resolved on a scale of approximately 1.0-2.0m. A zig-zag traverse scheme was employed as described in Appendix A.

The geophysical data were processed into a grey-scale image showing residual geomagnetic anomalies within the transect (Appendix B) and this is presented on a basemap digitised from the 1:2500 O.S. sheet in Figure 2.

## RESULTS

Geomagnetic anomalies were found to be extremely weak throughout the study area (standard deviation  $\sim 1.2\text{nT/m}$ ) with significant anomalies being close to the noise level of the fluxgate gradiometer. It was unfortunately not possible to apply a spatial filter to the data without blurring subtle features of possible archaeological interest. Surface iron debris has also contributed random noise within parts of the study area.

Figure 3 classifies the geomagnetic map into two styles of terrain:

- 1 Significant regions of anomalously *high magnetic field gradient* which might be associated with high susceptibility soil-filled structures such as *ditches and tile drains*.
- 3 Strong *dipolar anomalies* (paired positive-negative) whose likely source in this context are iron objects with permanent magnetisation and high susceptibility, for example *horseshoes, ploughshares and other debris*.

A key to the symbols used is given in Figure 3.

## DISCUSSION

Figure 4 presents an interpretation of the features seen in the geophysical data, together with a key. A coordinate scheme is given on the diagram for ease of reference. The following features have been identified:

- 1 **Field Drains.** A prominent network of intersecting, positive magnetic anomalies can be seen traversing the entire road corridor. These probably represent sets of tile field drains. Over part of the study area these anomalies are more diffuse suggesting that the drains are more deeply buried. Iron objects are present in these drainage trenches, for example in the area centred on E1.5.
- 2 **Iron Debris.** The large number of small magnetic dipoles (paired positive-negative anomalies) indicates that surface iron objects (eg. machine parts) are abundant. This is a frequent characteristic of fields which have undergone a long period of mechanical cultivation.
- 2 **Disturbed Area.** A zone of relatively strong and irregular geophysical anomalies has been detected at CD1 and this has obscured the trace of one of the field drains mentioned above. A strong variation in bedrock topography, or a change to an area of deeper ploughing are possible explanations.

- 3 Possible Ditches. Geophysical features of possible archaeological interest are seen here as several areas of compact, positive magnetic anomalies (Figure 2). These are highlighted by the green shaded symbols in Figure 3 while the most distinct examples are interpreted as possible ditches in Figure 4. However, the significance of these features is unclear owing to the very weak geophysical response from the subsoil.

## CONCLUSIONS

The following conclusions can be drawn from this study:

- 1 A network of tile drains, at varying depths, appears to traverse the study area.
- 2 Surface iron objects are abundant, particularly in the east central part of the study area.
- 3 A number of 'ditch' features, of possible archaeological interest, have been detected which may warrant further investigation.

## CREDITS

*Field Survey:* L. Johnson, R. Hinds

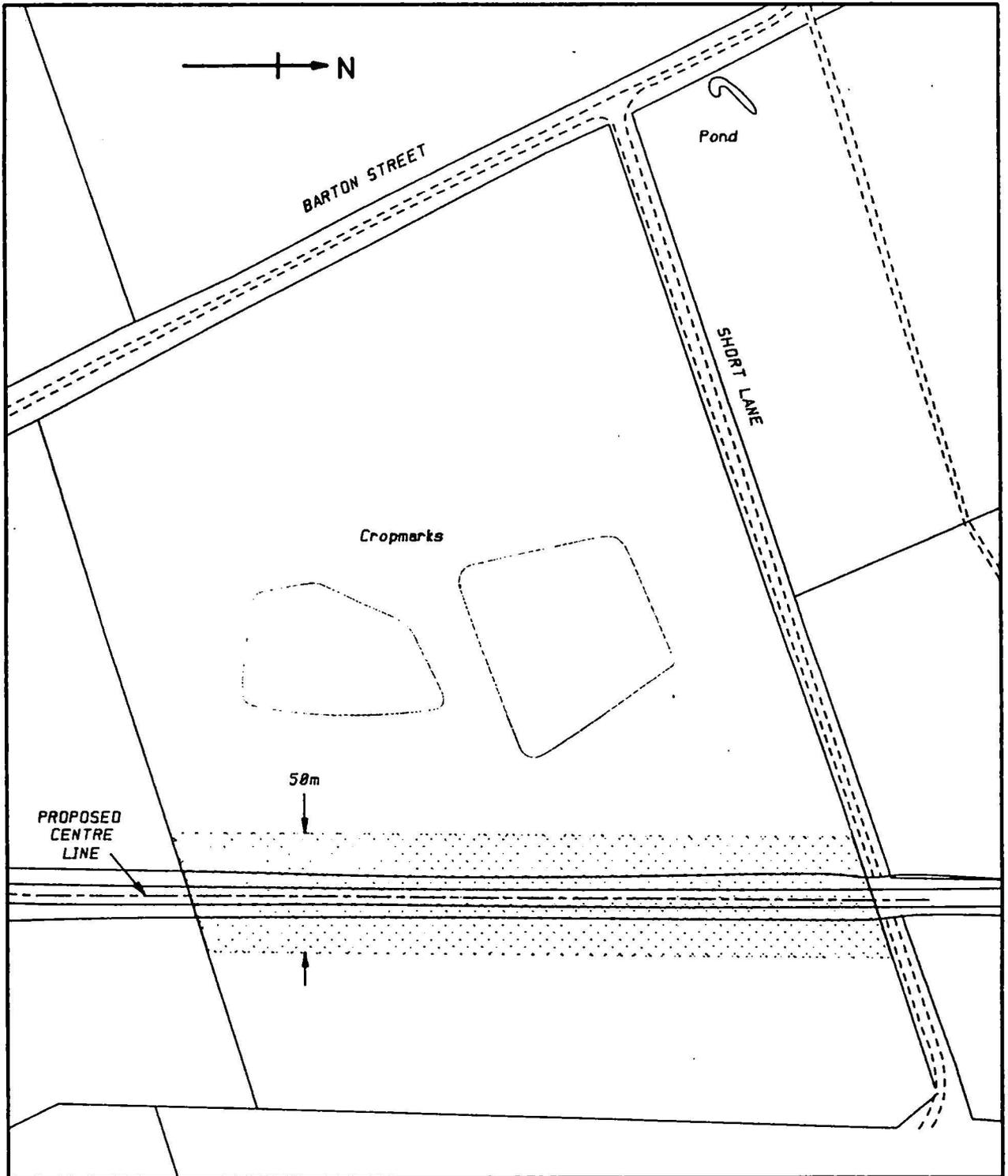
*Report:* M.J. Noel, L. Johnson

*Date:* 22nd September 1993

**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 artifacts.

**FIGURE 1**

Map showing the location of the area surveyed at Fotherby. The Centre line of the proposed bypass is indicated by the dashed line.



A16 FOTHERBY BYPASS  
SURVEY LOCATION

SURVEY BY:

**GeoQuest**  
ASSOCIATES

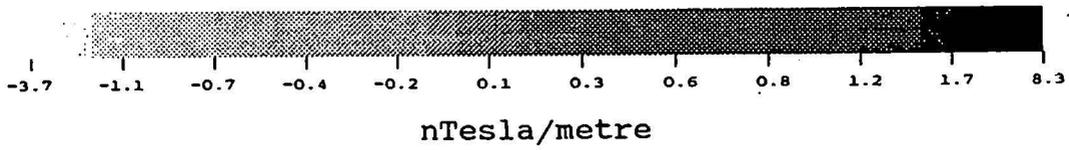
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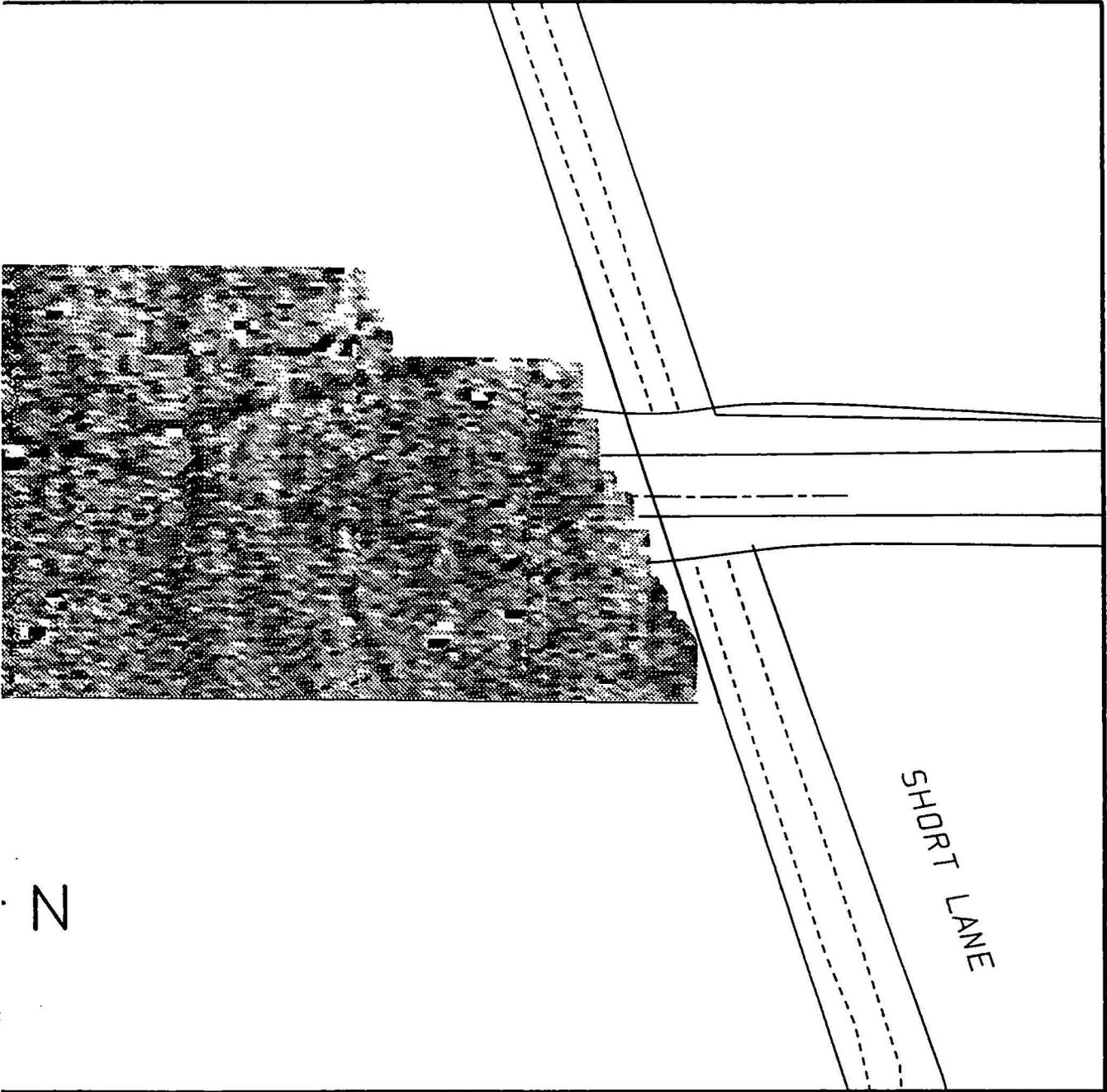
**EGS**

0 1:2500 100m

**FIGURE 2**

Results of the geomagnetic survey at Fotherby. Refer to the scale below for absolute values.



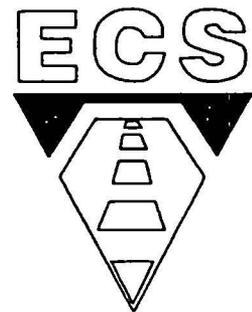


N

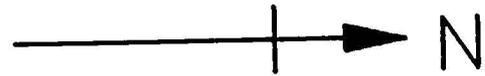
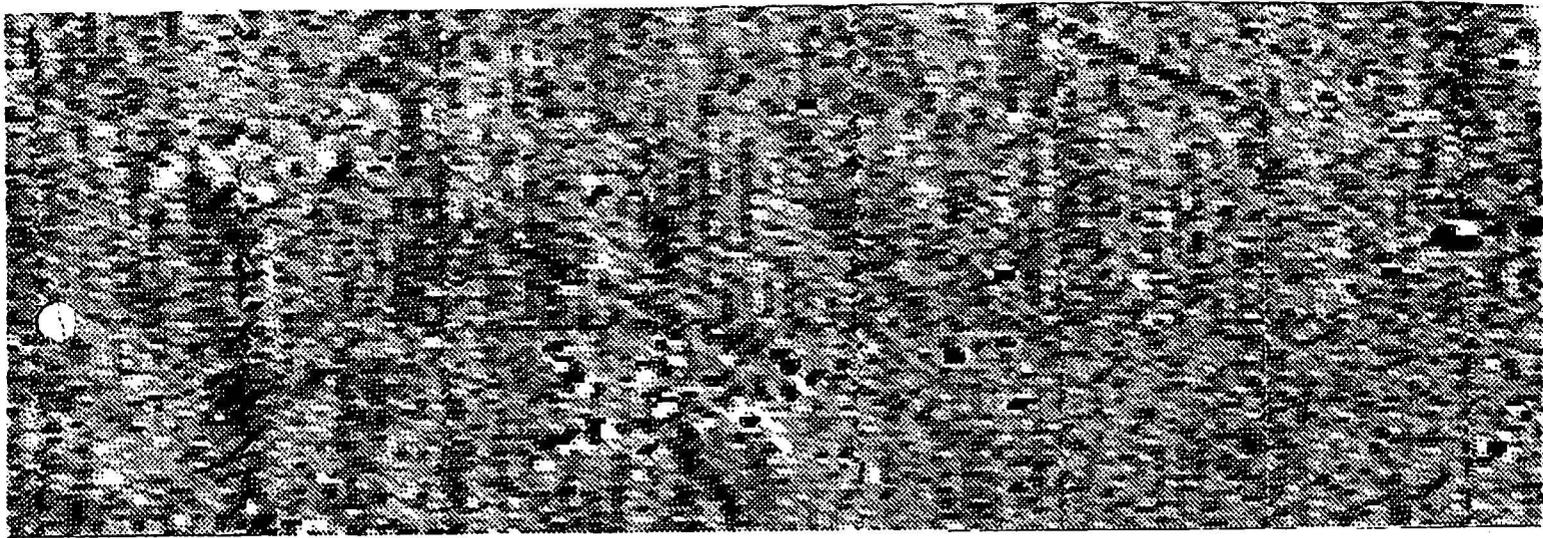
SHORT LANE

**st**  
CIATES

ON BEHALF OF:



Right of 3 (Fig 2)



S

SURVEY BY:

**GeoQuest**  
ASSOCIAT

Middle of 3 (Fig 2)

PROPOSED  
CENTRE  
LINE



A16 FOTHERBY BYPASS  
SURVEY RESULTS

0

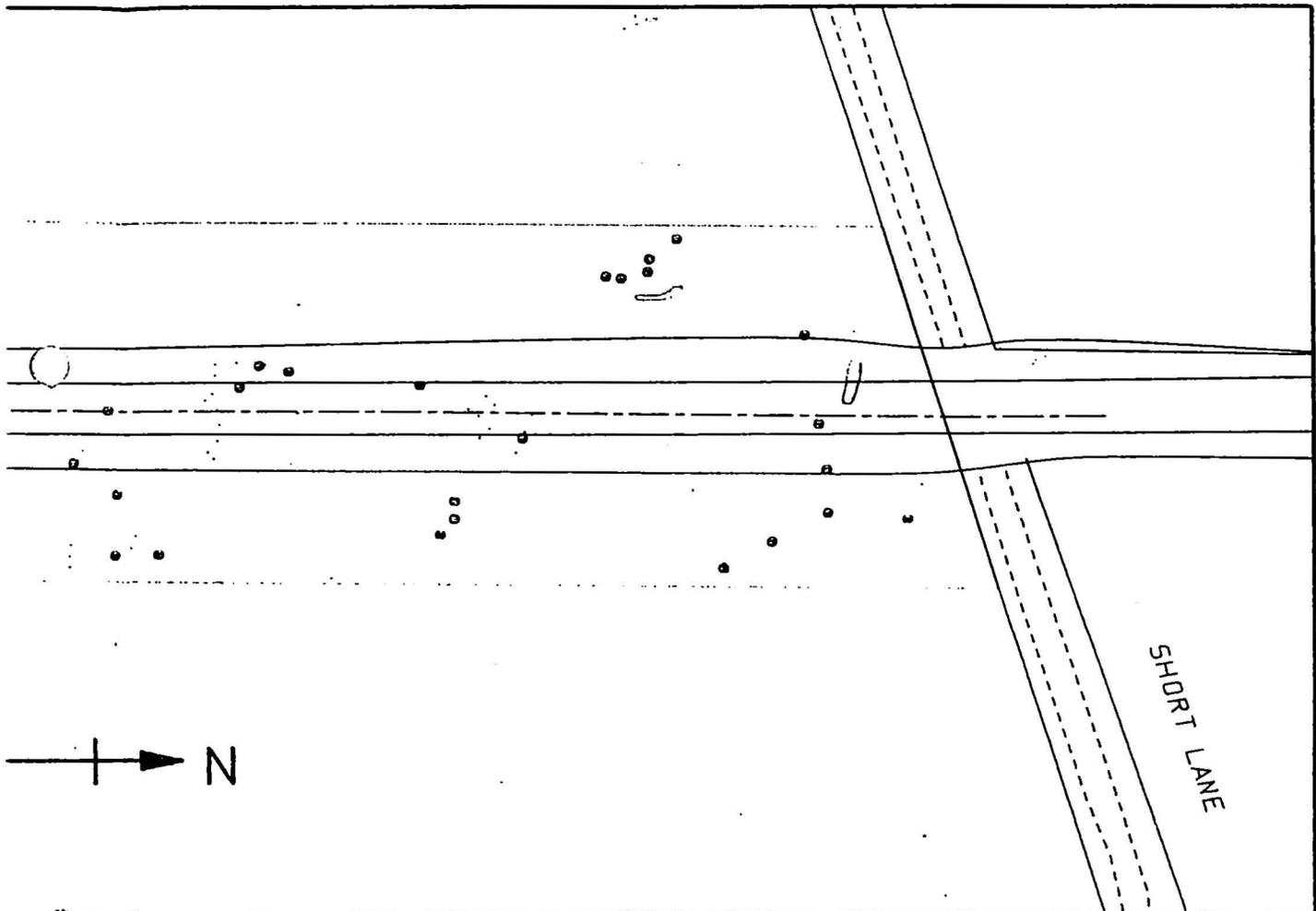
1:740

100m



**FIGURE 3**

Geophysical interpretation of the survey results obtained at Fotherby.  
Refer to the key for an explanation of the symbols used.



ANOMALIES

Positive area

Positive lineation

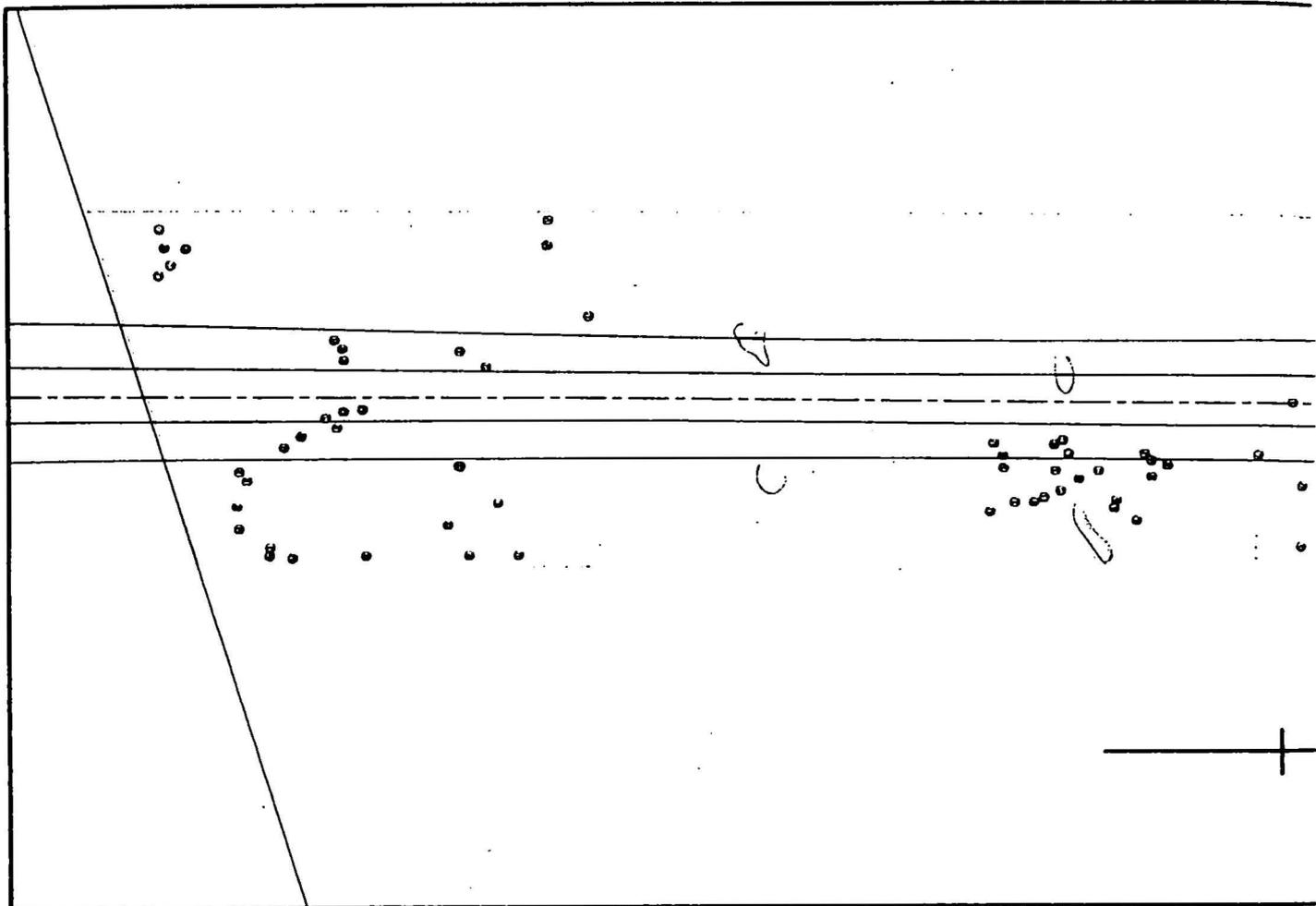
Magnetic dipole

SURVEY BY:

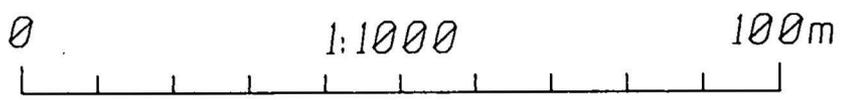
ON BEHALF OF:

**GeoQuest**  
ASSOCIATES

**ECS**



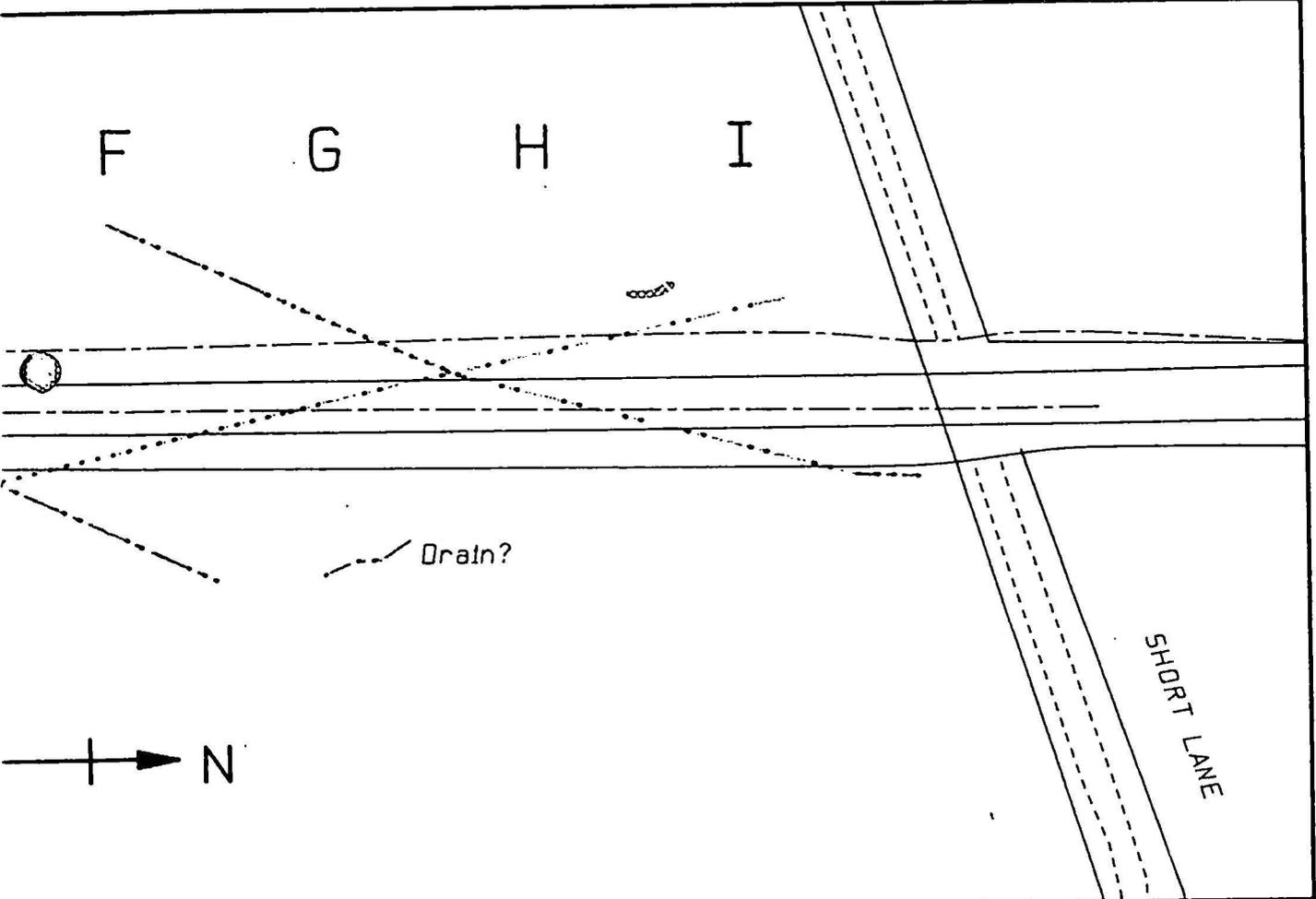
A16 FOTHERBY BYPASS  
 GEOPHYSICAL INTERPRETATION



- ANOM.
- Positive
- Positive
- Magnetic

**FIGURE 4**

An interpretation of the geophysical survey results from Fotherby.



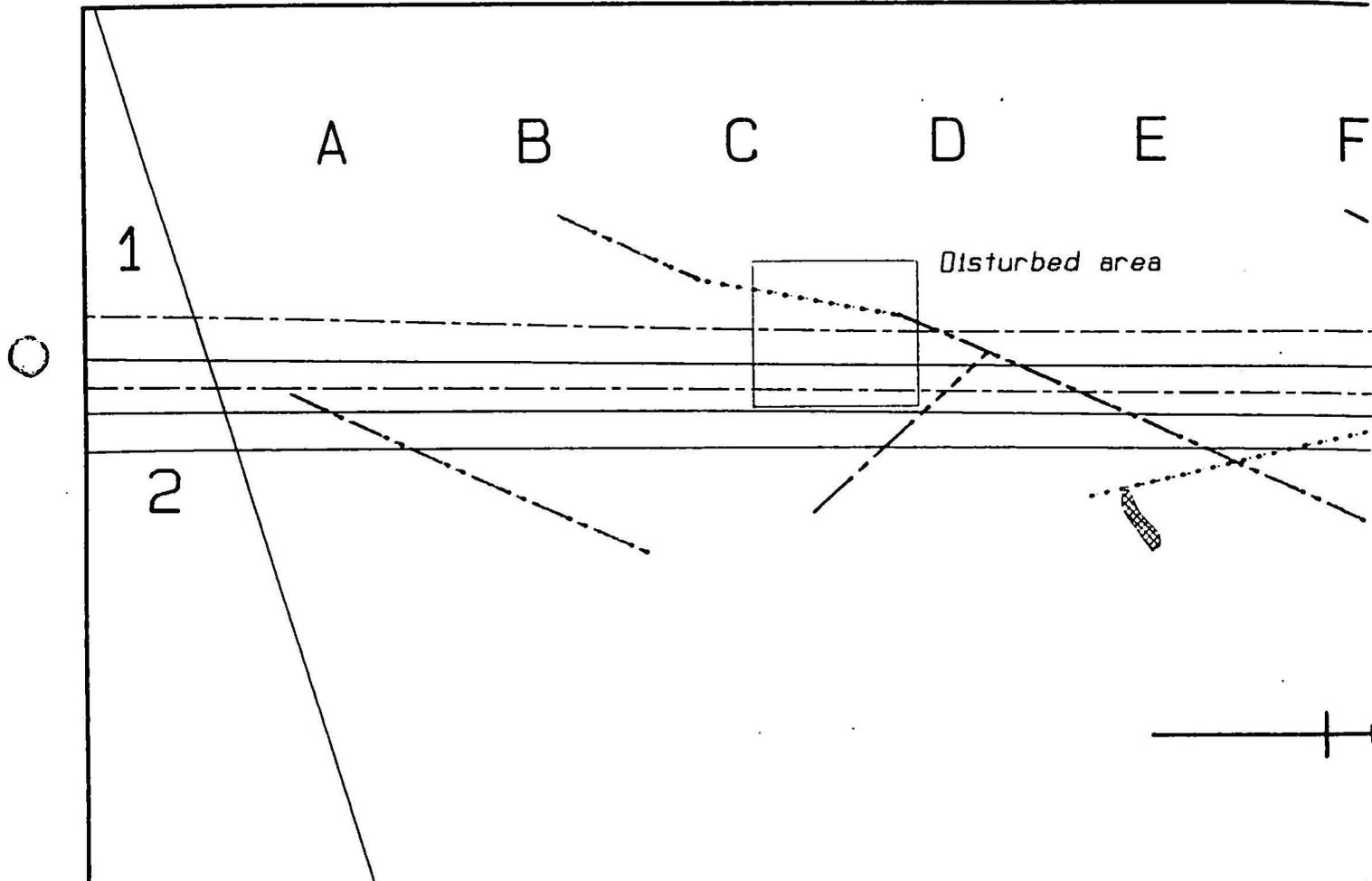
<p>FEATURES</p> <p>Possible ditches</p> <p>Drains</p>
---

SURVEY BY:

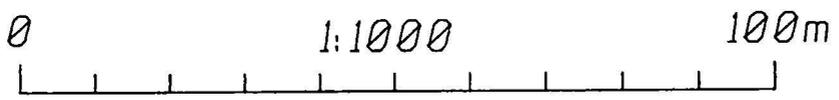
ON BEHALF OF:

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ASSOCIATES

**ECS**



A16 FOTHERBY BYPASS  
 PHYSICAL INTERPRETATION



FEAT

 Possible

 Drains

# APPENDIX A

## *Principles of Geomagnetic Surveying*

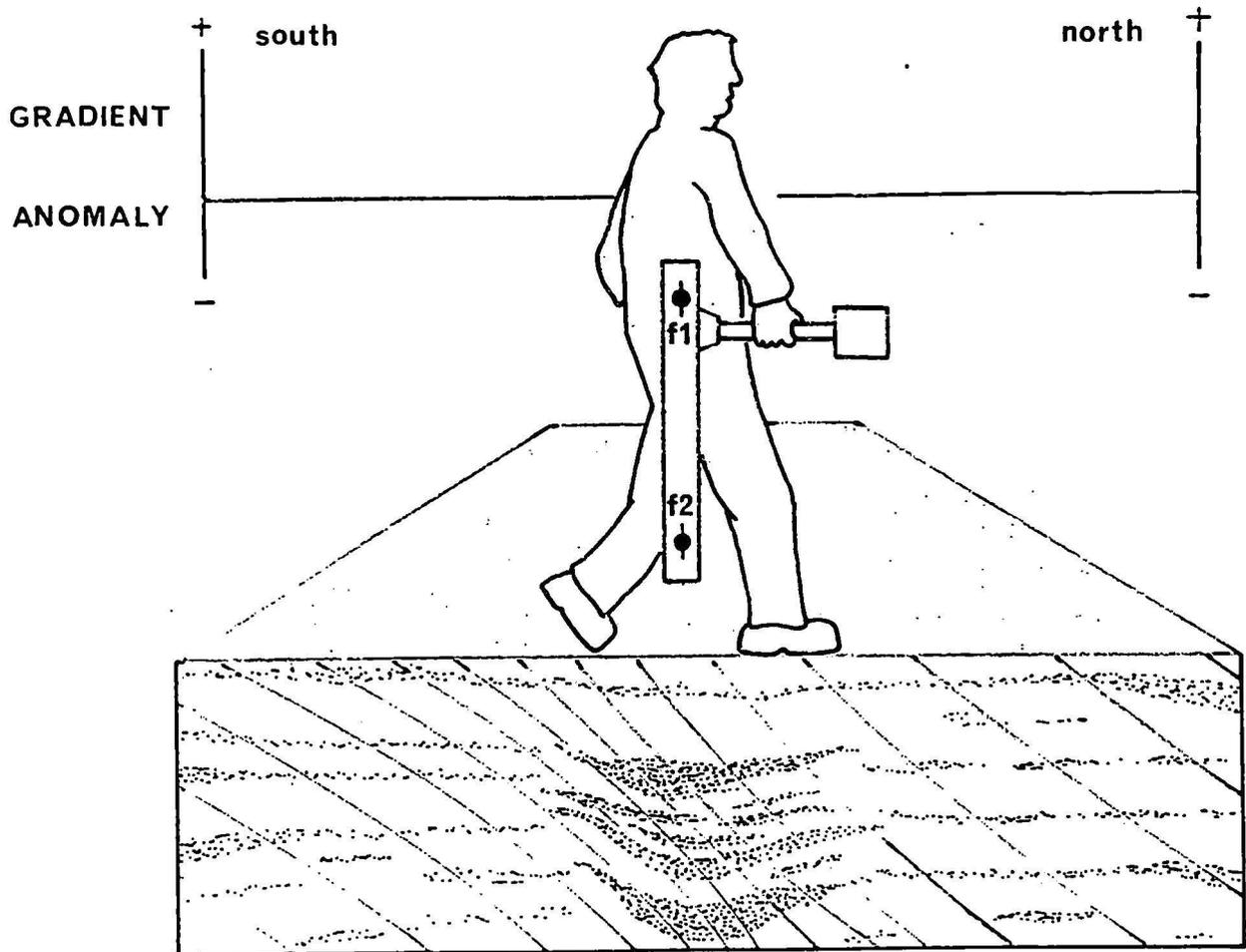
Geomagnetic prospecting detects subsurface features in terms of the perturbations or 'anomalies' that they induce in the Earth's magnetic field. In contrast to resistivity, seismic or electromagnetic surveying, no energy is injected into the subsoil and hence this is one of a class of *passive* geophysical techniques that includes gravity and thermal surveying. In an archaeological setting two types of magnetic anomalies can be distinguished:

- 1 Anomalies arising from variations in *magnetic susceptibility* which will modulate the component of magnetisation *induced* in the subsurface by the Earth's magnetic field. For most archaeological sites, this is the dominant factor giving rise to geomagnetic anomalies. In general, susceptibility is relatively weak in sediments, such as sandstones and enhanced in igneous rocks and soils, especially those which have been burnt or stratified with organic material.
- 2 Anomalies due to large, *permanently magnetised* structures. Such permanent magnetisation or 'remanence' arises when earth materials are heated to above  $\sim 600^{\circ}\text{C}$  and cooled in the geomagnetic field. Thus kilns and hearths are often detected as strong permanent magnets causing highly localised anomalies that dominate effects due to background susceptibility variations. Remanence can result from other physical and chemical processes but these give rise to anomalies that are usually unimportant for geophysical prospecting.

There are several approaches towards the practical measurement of geomagnetic anomalies. In this study measurements were made using a Geoscan FM36 fluxgate gradiometer which records the change with height in the vertical component of the Earth's magnetic field, as shown overleaf. This method has the advantage of being insensitive to diurnal variations while the Geoscan instrument also benefits from an integrated data logger. Note that in mid northern latitudes the magnetic anomaly will be asymmetric with the main peak displaced to the south of the archaeological feature. Thus, a ditch filled with a soil of enhanced susceptibility, for example, will generate a positive anomaly to the south, mirrored by a weak negative anomaly north of the feature. When portrayed as an area map of grey tones this gives rise to a 'shadowing' or pseudo relief effect which must be borne in mind when making an archaeological interpretation.

Two techniques can be used to survey gridded areas using the fluxgate magnetometer. In the parallel method the instrument is used to scan the area along traverses which are always in the same direction. This method minimises 'heading errors' due to operator and instrument magnetisation but is time consuming. The alternative zig-zag method is significantly faster and suitable for areas where anomalies are large compared to these and other sources of error.

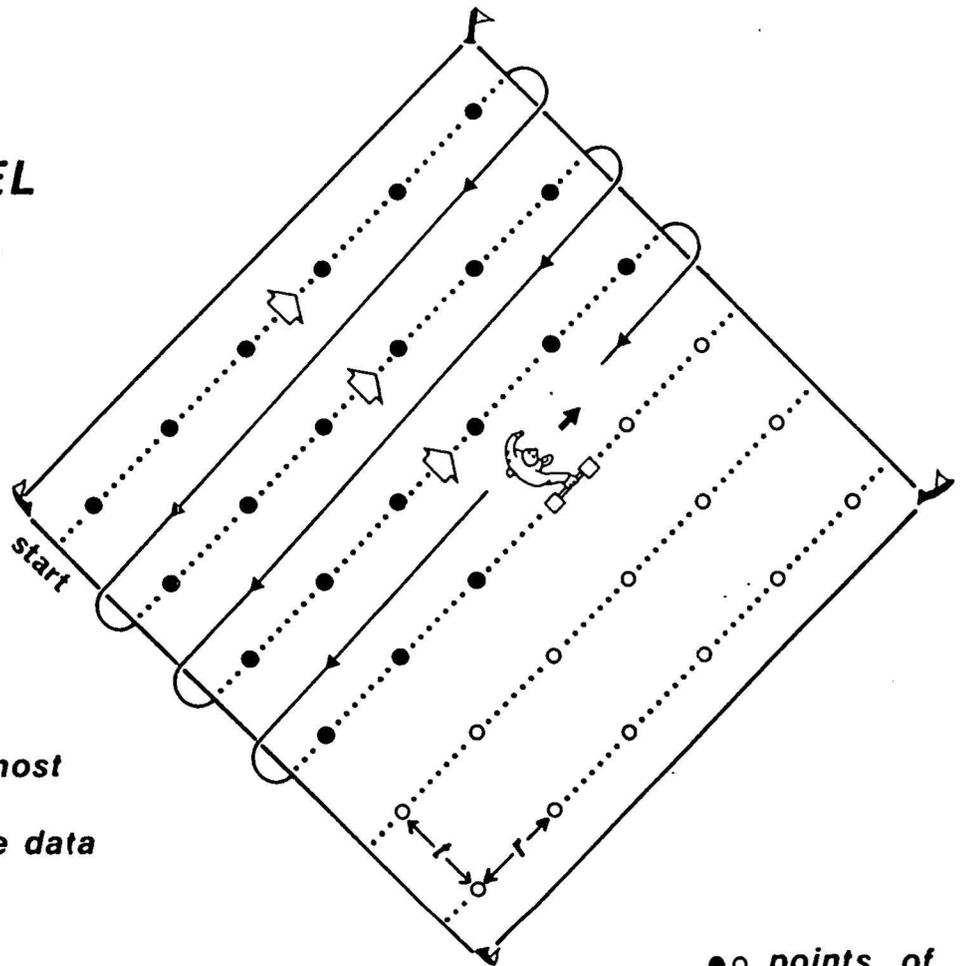
# MAGNETIC SURVEYING



# SURVEY SCHEMES

## PARALLEL METHOD

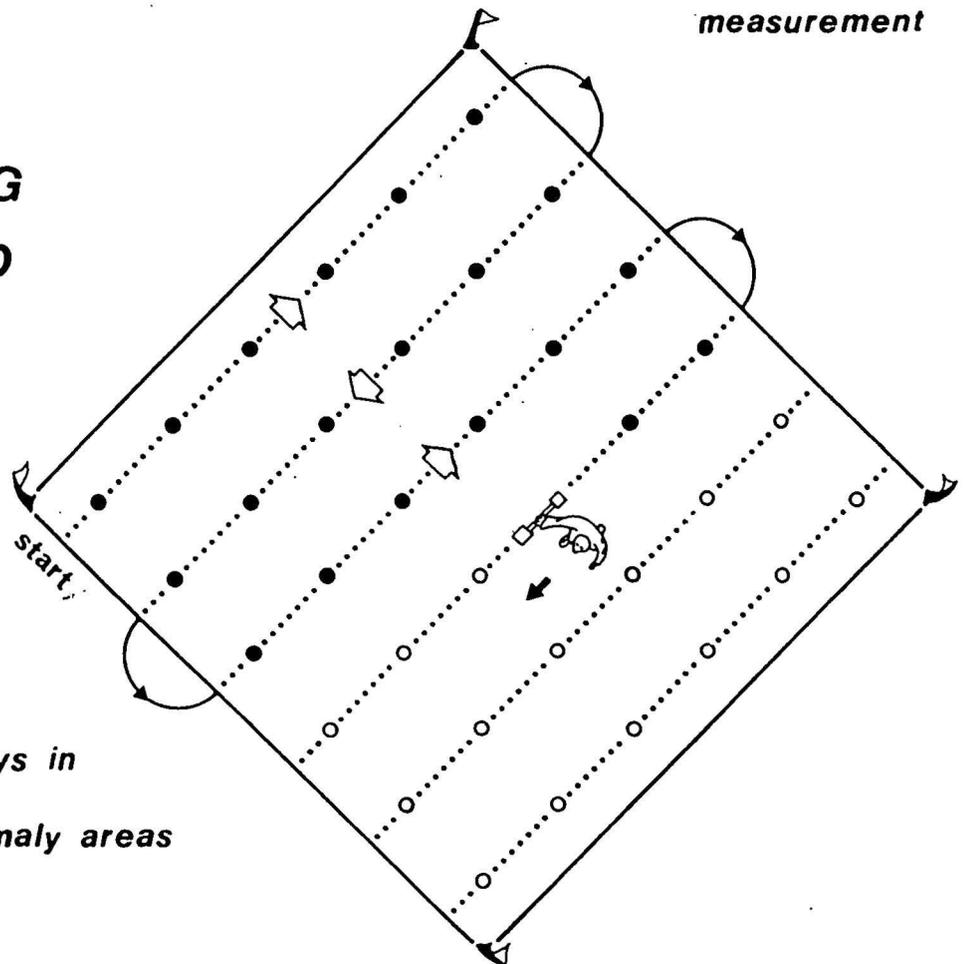
*slower but  
minimises most  
errors in the data*



●○ points of measurement

## ZIG-ZAG METHOD

*suitable for  
rapid surveys in  
strong anomaly areas*



## APPENDIX B

### *Data Processing Procedure*

The various stages involved in gathering and manipulating the field measurements are summarised in the flow diagram overleaf. Data are downloaded from the magnetometer or resistivity meter to a portable computer, via a serial cable, inspected graphically and then stored on disc. Once the survey is completed, the data from individual grids are corrected for instrument drift (typically a few % per hour for the magnetometer) and then their dynamic range reduced if they contain highly variable values. This is often necessary where an area contains strong dipole sources if one is to make the best use of the grey scales available from the printer. Next, the area image is constructed by 'tiling' together adjacent grids. To achieve this, a special graphical technique is applied that minimises 'seams' in the image which would otherwise mask the anomalies of archaeological interest. If enlargement of a selected area is required, then this is achieved by expanding the data with bicubic splines; an approach which helps to reduce blurring. Finally, the data are numerically mapped to a set of 33 grey levels (true half tones) which are programmed to have a normal distribution in the printed image. From experience, it has been found that such a distribution is pleasing to the eye and by adjusting the mean density and variance the appearance of the anomalies can be optimised. All processing is carried out by proprietary GeoQuest software.

# DATA PROCESSING

