# HATTON TO SILK WILLOUGHBY, LINCOLNSHIRE PROPOSED GAS PIPELINE

## Report on Archaeogeophysical Survey 2000

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## Report on Archaeogeophysical Survey 2000

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on behalf of

Mouchel Consulting Ltd
and
Transco

# Hatton to Silk Willoughby
# Proposed Gas Pipeline

## Report on Archaeogeophysical Survey, 2000


### Summary

This geophysical survey forms part of the archaeological evaluation of the route of the proposed Hatton to Silk Willoughby gas pipeline in Lincolnshire. The survey was commissioned by Network Archaeology Ltd and Mouchel Consulting Ltd on behalf of Transco.

The techniques employed for the survey were magnetic susceptibility surveying, which may indicate the presence of past settlement sites or other areas in which soil magnetic properties have been affected by human activities, and magnetometer surveying.

The magnetometer survey was arranged as a 20m wide sample strip extending along two sections of the route for which information is required at the present stage of the planning process. The survey provides a detailed record of magnetic features or disturbances intersecting the route, and allows subsurface features to be identified more reliably than would be the case for an unrecorded magnetometer scan. This detailed methodology should maximise the likelihood that at least some magnetic response will be obtained from significant archaeological sites even on the weakly magnetic clay soils which are present in some sections of the route.

The Desk Based Assessment of the route, as previously prepared by Network Archaeology [1], identified a number of areas of potential archaeological concern. These include cropmarks of possible Iron Age/Romano-British date south east of Ruskington, and enclosures and settlement sites in the vicinity of Kirkby la Thorpe. The survey has detected a number of ditches which confirm the presence of the enclosures or field systems, and has also identified areas of potentially more concentrated activity which could be given priority in any future fieldwork or trenching. It is not necessarily the case that the route intersects any major focus of ancient settlement activity, but further investigation would be needed to eliminate this possibility at locations as noted in the conclusions below.



A.D.H. Bartlett

Bartlett - Clark Consultancy


26 April 2000

## Contents



## Illustrations

The following A3 plans are included with this report:

| | | |
|---|---|---|
| Figures 1 - 6 | Survey location plans with plots of magnetic susceptibility data and summary of magnetometer findings | 1:2500 |
| Figures 7 - 10 | Magnetometer survey data plots (with selected magnetic anomalies outlined) | 1:1000 |

Field numbering follows the system used by Network Archaeology, with fields numbered from north to south from each road crossing (18/1 etc).

# Hatton to Silk Willoughby, Lincolnshire

## Proposed Gas Pipeline

## Report on Archaeogeophysical Survey 2000

### Introduction

This survey was commissioned by Network Archaeology Ltd. as part of an archaeological evaluation of the route of the proposed Hatton to Silk Willoughby pipeline, which is being undertaken for Mouchel Consultants Ltd on behalf of Transco.

The survey included recorded magnetometer coverage along two sections of the route, accompanied by magnetic susceptibility measurements. Fieldwork for the survey was carried out in April 2000.

The Proposed Route

The full route extends for some 39km from Hatton near Wragby to Silk Willoughby some 2km south east of Sleaford. The two sections covered by the present survey are areas of particular archaeological concern requiring detailed investigation in advance of the remainder of the route. They extend for some 1.7 km and 3.5 km and are located to the east of Ruskington, and from Kirkby la Thorpe to Silk Willoughby at the southern end of the route. The Archaeological Desk based Assessment, which has been prepared by Network Archaeology [1] , has identified a number of possible archaeological sites and areas of potential activity within these sections of the route.

Findings noted in the Assessment include cropmarks indicating a possible settlement and enclosures in the northern (Ruskington) section (Mon. 349273), and a nearby enclosure and trackway (Mon. 108693). In the southern (Kirkby la Thorpe - Silk Willoughby) section there are possible Iron Age settlements and a Saxon cemetery near Kirkby la Thorpe, although sites to the east of the village have been avoided by a re-route to the west. This revised route may, however, still intersect cropmark features and enclosures in areas which have now been investigated by the survey.

Geology

The areas investigated are mainly on Jurassic clays (Oxford and Ampthill clay), overlain in part by drift deposits including Boulder clay and gravel. Jurassic clays appear to have been reasonably responsive in other magnetometer surveys, although clay soils do not usually provide such a clear or complete plan of subsurface features as can sometimes be obtained

on solid chalk or limestone. Gravel soils are variable in their magnetic response, but here they gave relatively high magnetic susceptibility readings (with volume susceptibility values in the range 20 - 40 x $10^{-5}$ SI), and appear to provide favourable conditions for a magnetometer survey.

Boulder clay soils usually give low magnetic susceptibility values (as was the case here with volume susceptibility readings up to about 10 x $10^{-5}$ SI), and provide only a comparatively weak magnetic response to subsurface features. A magnetometer survey in these conditions may still respond to such intrinsically magnetic features as hearths and pits which may contain burnt material or other magnetically enhanced debris in the fill. It is therefore likely that some indication will be obtained of the presence of the more significant settlement or industrial sites, even if the overall ground plan of such sites is incomplete. Such features as ditches, enclosures or earthworks which might be detectable by magnetometer surveying on more favourable soils are in these conditions only likely to be identified if they contain extraneous magnetic debris in the fill. (Certain other categories of archaeological features, including graves and cemeteries, are difficult to detect by geophysical methods even in favourable conditions.)

Magnetometer surveys have previously, subject to these limitations, been successfully undertaken on Boulder Clay soils. Soils on such deposits may, however, contain naturally magnetic glacial erratic stones, and these can give rise to magnetic anomalies similar to those produced by silted pits at an archaeological site, although the present survey appears to be generally free of such interference.

Anomalies which are strong or narrow in profile, asymmetrical, or which have a prominent negative peak are likely to be caused by buried stones, bricks or iron objects and have been excluded as far as possible from the interpretation. The anomalies outlined on the plots are those for which an archaeological origin cannot be wholly excluded (with the exception of some possibly geological features as noted), although some could be caused by objects as noted above. The distribution and degree of clustering of the features, and correlations between magnetometer and susceptibility findings, as well as other archaeological evidence, are all relevant in reaching an interpretation.

## Survey Procedure

The survey was carried out using the two techniques of magnetometer and magnetic susceptibility surveying, which are the methods usually employed for large scale evaluation work of this kind.

The results obtainable from magnetometer and magnetic susceptibility surveys are related, but they will not necessarily detect the same features or disturbances. The magnetometer responds to cut features such as ditches and pits when they are silted with topsoil, which usually has a higher magnetic susceptibility than the underlying natural subsoil. It also detects the thermoremanent magnetism of fired materials, notably baked clay structures such as kilns or hearths. Burning associated with past human occupation enhances the

magnetic susceptibility of topsoil, increasing the magnetometer response from ditches and pits, and also making it possible to locate sites by magnetic susceptibility measurements on

the superficial topsoil. Susceptibility surveying can therefore be used to obtain a broad indication of previously occupied or disturbed areas, although the readings may be affected by a number of non-archaeological factors, including geology and land use. Areas of positive susceptibility response therefore often require further investigation, usually by detailed magnetometer surveying, before being accepted as archaeologically significant.

The magnetometer survey was arranged as a 20m wide strip, or slightly less than a 50% sample of the 42m wide pipeline easement. A continuously recorded magnetometer survey of this kind provides much more complete coverage than the alternative method of unrecorded magnetometer scanning along a limited number of transect lines. The detailed approach used here was thought to be of particular relevance to this project, given that clay soils usually produce only comparatively weak magnetic anomalies, which are difficult to identify by scanning alone. It is possible in such conditions that buried ditches or other archaeological features not containing magnetically enhanced fill may fail to respond, but that sites may still be recognizable by an increase in the noise level of the survey, or the presence of clusters of small anomalies which can only be recognized in a recorded plot. A detailed survey also offers a more secure basis for eliminating areas from further archaeological consideration than is the case for an unrecorded magnetometer scan.

The magnetometer survey was carried out using Geoscan fluxgate magnetometers, and the results are presented as graphical or x-y trace plots and as grey scale plots on figures 7 - 10. These plots show the readings after standard processing operations including adjustments to the line spacing to correct for variations in the instrument zero setting, and numerical smoothing to reduce background noise levels. Outlines and cross hatching indicating selected magnetic anomalies of potential interest have been added to the graphical plots.

The susceptibility survey was based on readings taken at 12.5m intervals using Bartington MS2 susceptibility meters with the MS2D field probe. The initial susceptibility readings are displayed as strips of shaded squares of density proportional to the readings at 1:2500 scale on figures 1 - 6. The interpretative outlines as shown on the magnetometer plots have been added in red to these drawings at reduced scale to provide a summary of the survey findings

The survey was positioned in each field by reference to OS co-ordinates measured from the 1:2500 strip maps, and located with a sub-1m accuracy GPS system. This method allowed a series of intermediate markers as needed for the magnetometer survey to be placed rapidly across each field. Details of the GPS co-ordinates of the end points of individual magnetometer survey blocks, which may be required for relocating the survey findings, can be supplied on request.

The pipeline runs from north to south, which corresponds to right - left on the plans supplied to us. The data plots as reproduced in the report are therefore also arranged across the page in the same right to left sequence.

## Results

The survey location is shown on figures 1 - 6 at 1:2500 scale. These maps are based on OS digital mapping of the route, and may not exactly match the sheet boundaries of the 1:2500 strip maps prepared by Mouchel. The magnetometer survey plots are also reproduced in sections in figures 7 - 10. Individual fields are identified by their numbers counting to the south from each road crossing. Survey blocks within a field are labeled A, B etc. The survey findings are described here for the each of the two sections of the route in turn.

### 1. Northern Section (Fields 18/1 - 18/6)

Fields 18/1-3 lie mainly on Boulder clay, and gave low susceptibility readings. (The survey alignment is offset part way across field 18/3 to bring it into line with a revision of the route. The new line is followed in fields 18/5 and 18/6, but part of 18/4 had already been surveyed on the old line).

The magnetometer survey is generally quiet in 18/1-3 except for some features in the centre of 18/3. These align with a ditch to the west, and could well represent a former field boundary. Section 18/3B takes in an area of possible cropmark enclosures and ridge and furrow cultivation, but there are few magnetometer findings. There are scattered magnetic anomalies which could represent bricks or iron, but only one possible pit-like feature is distinct enough to be outlined on the plot.

Fields 18/4 - 6 are on a gravel soil, and there are cropmarks indicating a possible settlement complex with enclosures and pits in field 18/4 (Mon. 349273). The magnetometer plot shows two distinct linear features which would be consistent with the presence of enclosures, and other smaller anomalies which could represent pits. These are not very concentrated across much of the field, although susceptibility values are high throughout. The likelihood that at least some archaeological features will be encountered in this field is therefore high, although the main focus of settlement activity may lie outside the area investigated.

Field 18/5 contains a dense tile scatter, but this corresponds to only a slight increase in susceptibility readings, and very minor magnetic anomalies. A magnetometer survey will not necessarily respond to such small scale structural features as stone wall footings, post holes or foundation trenches, and it may therefore be the case that the remains of an isolated stone or timber farm building will not create a any strong magnetic disturbances.

Field 18/6 lies close to a possible former trackway (Mon. 1080693). The field gave comparatively high magnetic susceptibility values, which could be an effect of the gravel geology, but only one possible pit-like magnetic anomaly.

## 2. Southern Section (Fields 22/1 to 24/10)

Field 22/1 is on Boulder clay and gave low susceptibility readings. One very weak possible linear feature is marked on the plans, but this is only faintly visible in the grey scale plot, and may not be reliable.

There is a very distinct increase in susceptibility readings in field 22/2, where there were also fieldwalking finds. The magnetometer findings from this field are not, however, easy to interpret. The plot shows some linear and other features which could be ditches or ridge and furrow, perhaps with some pits, but there are also broad positive magnetic anomalies which are large enough to be natural. The geological map shows clay at this point, but broad variations in magnetic response are often seen when the depth of topsoil varies above an uneven gravel subsoil. It could therefore be the case that there are both archaeological and natural contributions to the survey response in this field.

Another area of enhanced susceptibility readings associated with ditch - like linear anomalies and possible pits was detected in field 22/3, where cropmark enclosures are also recorded. Most of this area is free of the possibly geological features noted in 22/2, although there is one large anomaly at the north of the field. The survey follows a revised route alignment in 22/3.

Field 22/4 produced only marginal findings, but in 22/5 and 23/1 there are distinct linear anomalies which could well indicate traces of a former field system. There may also be rather inconclusive pit - like features and a probable geological anomaly in 23/1, where Roman finds were noted in fieldwalking.

In field 24/1 there is a linear anomaly marking the former boundary with 24/2. Field 24/2 contains at least one pit-like magnetic anomaly, but its significance is not very clear in isolation, and much of this area is obscured by magnetic interference from a piece of farm machinery.

There are high susceptibility values in fields 24/3 and 24/4. The linear feature marked in 24/3 could relate to a nearby rectilinear enclosure (Mon. 1049484), although it does also align with a change in cultivation.

Field 24/4 contains cropmark enclosures, and gave particularly high susceptibility readings, together with a significant increase in magnetometer activity. Individual significant features are less easy to identify, perhaps in part because the field was ridged for potatoes at the time of the survey, but the variations in response seen here could well be archaeologically significant.

There are generally low susceptibility readings and minimal magnetic findings in fields 24/5 and 24/6, although there may be some small magnetic anomalies in 24/7, where there is a tile scatter. There are high susceptibility readings on the line of the former railway at the south end of 24/8.

Fields 24/9 and 24/10 contain scattered small magnetic anomalies (not outlined on the plots), but there is no significant susceptibility variation. These fields lie close to a Roman road (Mon. 1044205), but the small but strong magnetic anomalies are more likely to be caused by modern debris (scattered brick or iron) than to be archaeologically significant.

## Conclusions

The survey has produced positive archaeological findings at a number of locations. Some of these are likely to be ditches associated with ancient field systems, which were detected particularly in the vicinity of Kirkby la Thorpe (e.g. in fields 22/3, 22/5, 23/1). Ditches or enclosures were also detected in the Ruskington section of the survey in field 18/4, where they appear to be associated with pits and other features.

Other areas of potential archaeological concern include fields 22/2 - 3 where there are magnetic anomalies and a strong susceptibility response. Some of the larger magnetic anomalies could, however be natural, and it may the case that the detected features include a combination of geological effects and ridge and furrow, together perhaps with other archaeological features.

Field 22/4 contains magnetic disturbances and high susceptibility readings in an area of cropmark enclosures. Some pits may have been detected, but further investigation would be needed to test whether this is in fact a significant ancient settlement site. Priority in any future trenching or watching brief should therefore perhaps be given to fields 18/4-5, 22/2-3 and 24/4, together perhaps with 22/5 and 23/1.

**Report by:**

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26 April 2000

J. Cox assisted with this survey.

**Reference**

[1] Hatton to Silk Willoughby Proposed Gas Pipeline . Archaeological Desk Based Assessment. Report No. 147, December 1999. Prepared by Network Archaeology Ltd.

# Hatton to Silk Willoughby

## Geophysical Survey 2000: Summary of Findings

This list notes the more significant findings from the magnetometer survey of this pipeline route. The grading (1-4) given alongside each entry refers to the reliability of the geophysical evidence rather than the archaeological significance of the findings.

| | |
|---|---|
| Grade 1: | Distinct magnetic anomalies of probable archaeological origin. |
| Grade 2: | Magnetic anomalies possibly including natural or recent disturbances, but which could in part be archaeologically significant. |
| Grade 3: | Weak or isolated features; not necessarily archaeologically significant. |
| Grade 4: | Strong magnetic anomalies of probably recent or natural origin. |

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| Field | | Grade |
|---|---|---|
| 18/3 | Magnetic anomalies possibly representing former field boundary. | 2 |
| 18/4 | Linear magnetic anomalies (enclosures ?) and possible pits. | 1 |
| 22/1 | Very faint possible linear feature. | 3 |
| 22/2 | High susceptibility values with linear magnetic anomalies (ridge and furrow ?) and possible pits. | 1-2 |
| | Strong magnetic anomalies may be geological. | 4 |
| 22/3 | Possible ditches and (few) pits in area of cropmark enclosures. | 1-2 |
| 22/5 | Ditches: possible field system ? | 1 |
| 23/1 | Possible ditch and pits in field with Roman finds. | 1-2 |

cont./

| Field | | Grade |
|---|---|---|
| 24/1-2 | Former boundary and possible pit. | 3 |
| 24/3 | Linear feature near cropmark enclosure. | 3 |
| 24/4 | High susceptibility readings and possible pits in area of cropmark enclosures. | 1-2 |
| 24/7 | Small magnetic anomalies in field with tile scatter. | 3 |

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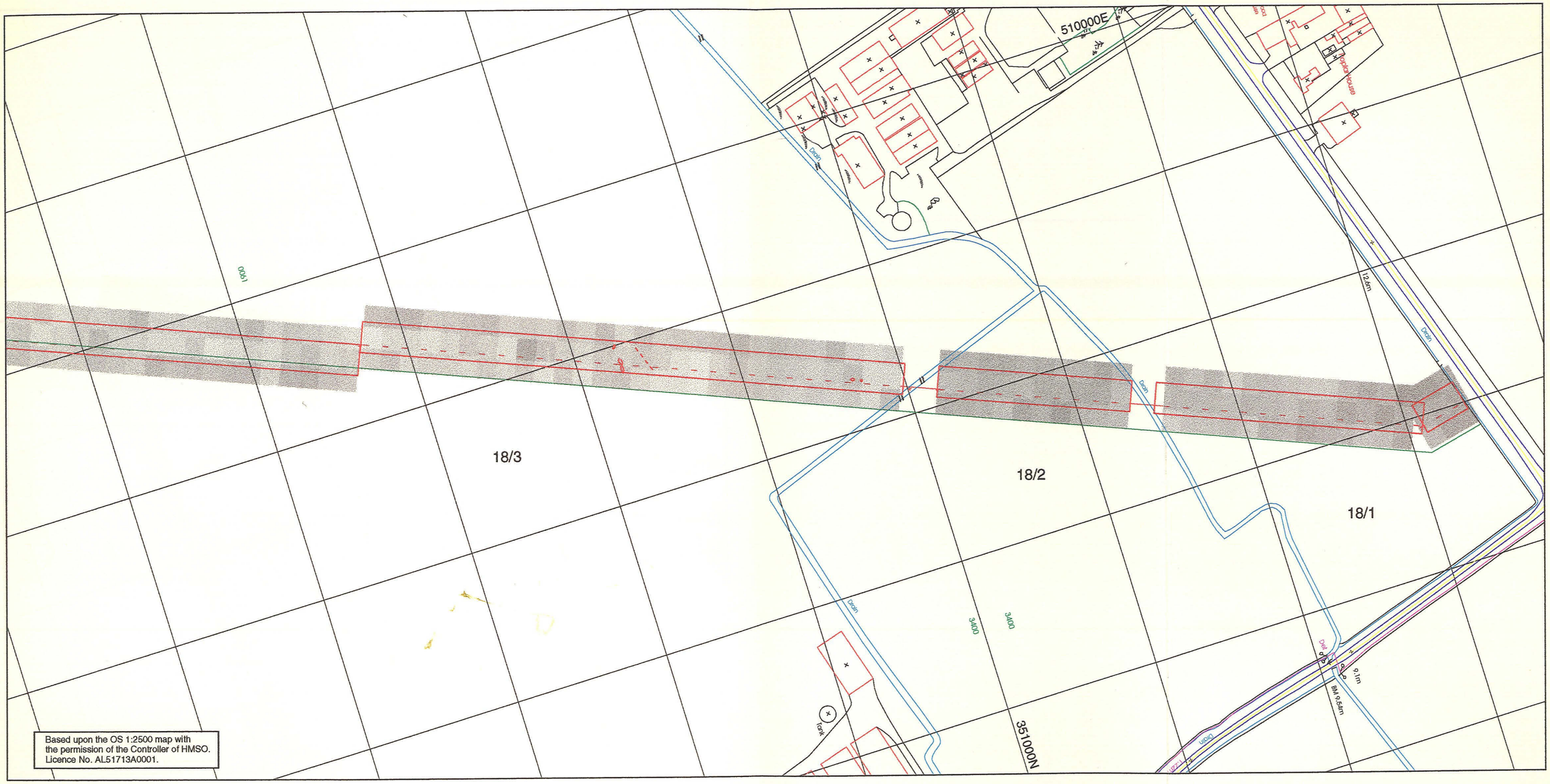
N




40 x $10^{-5}$ SI (volume susceptibility)

0

magnetometer survey (with interpretation)

pipe alignment

revised alignment

1:2500

0 100m

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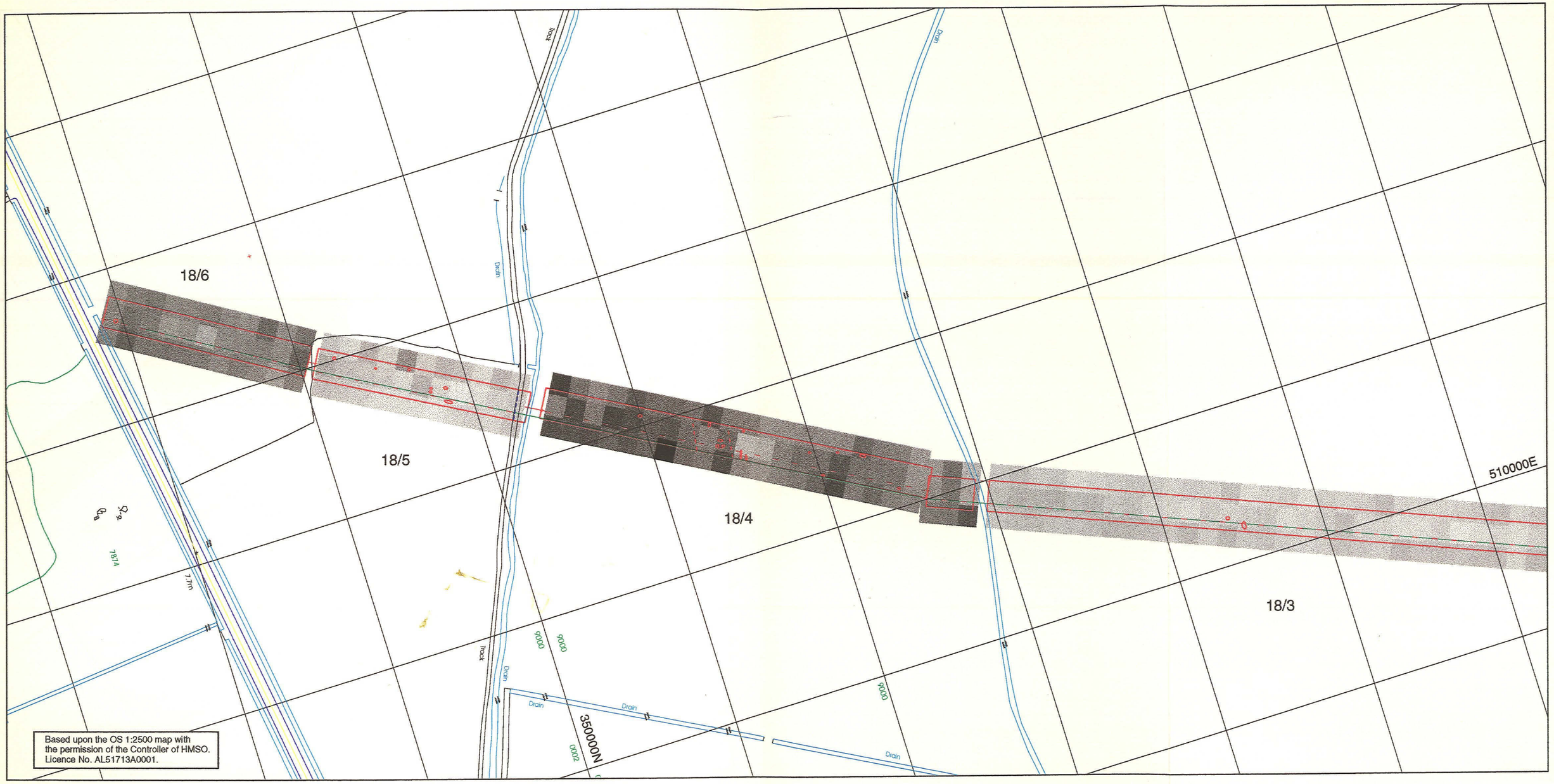
**Hatton to Silk Willoughby, Lincolnshire**
**Geophysical Survey of Gas Pipeline 2000**

**Figure 1: Magnetic Susceptibility Survey**
**Fields 18/1 to 18/3**




40 x $10^{-5}$ SI (volume susceptibility)

0

magnetometer survey (with interpretation)

pipe alignment

revised alignment

1:2500

0 100m

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**Hatton to Silk Willoughby, Lincolnshire**
**Geophysical Survey of Gas Pipeline 2000**

**Figure 2: Magnetic Susceptibility Survey**
**Fields 18/3 to 18/6**

N

347000N

22/1

22/2

22/3

22/4

Pond

Track

Ditch

7500

10.8m

6559

510000E



40 x $10^{-5}$ SI (volume susceptibility)

0

magnetometer survey (with interpretation)

pipe alignment

revised alignment

1:2500

0 100m

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**Hatton to Silk Willoughby, Lincolnshire**
**Geophysical Survey of Gas Pipeline 2000**

**Figure 3: Magnetic Susceptibility Survey Fields 22/1 to 22/4**

N

509000E

24/3

24/2

24/1

23/1

22/5

22/4

345000N

Based upon the OS 1:2500 map with the permission of the Controller of HMSO. Licence No. AL51713A0001.

40 x $10^{-5}$ SI (volume susceptibility)

0

magnetometer survey (with interpretation)

pipe alignment

1:2500

0 100m

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**Hatton to Silk Willoughby, Lincolnshire**
**Geophysical Survey of Gas Pipeline 2000**

**Figure 4: Magnetic Susceptibility Survey**
**Fields 22/4 to 24/3**

N


40 x $10^{-5}$ SI (volume susceptibility)

0

magnetometer survey (with interpretation)

pipe alignment

1:2500

0 100m

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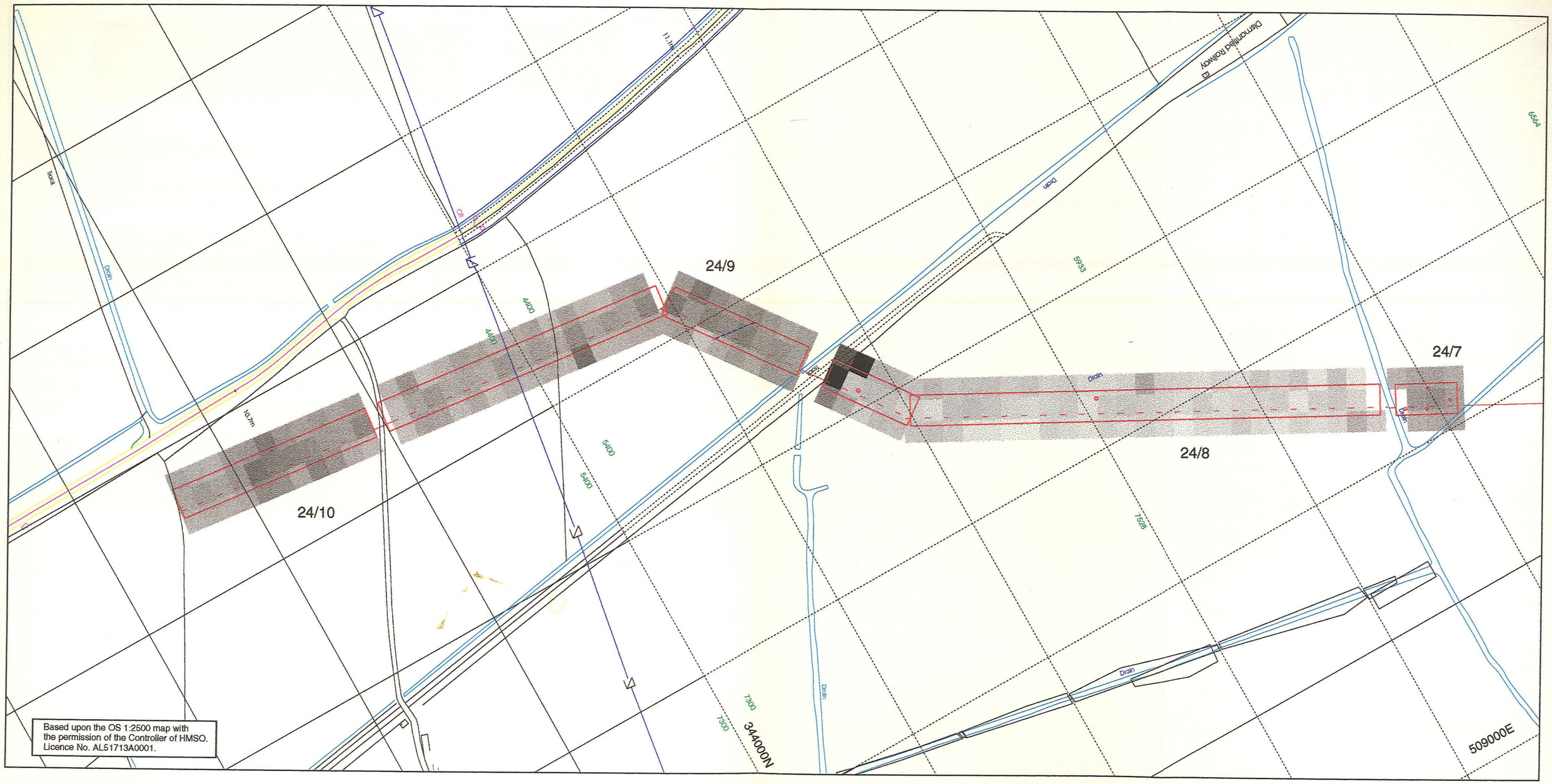
**Hatton to Silk Willoughby, Lincolnshire**
**Geophysical Survey of Gas Pipeline 2000**

**Figure 5: Magnetic Susceptibility Survey Fields 24/3 to 24/6**




Based upon the OS 1:2500 map with the permission of the Controller of HMSO. Licence No. AL51713A0001.

40 x $10^{-5}$ SI (volume susceptibility)

0

magnetometer survey (with interpretation)

pipe alignment

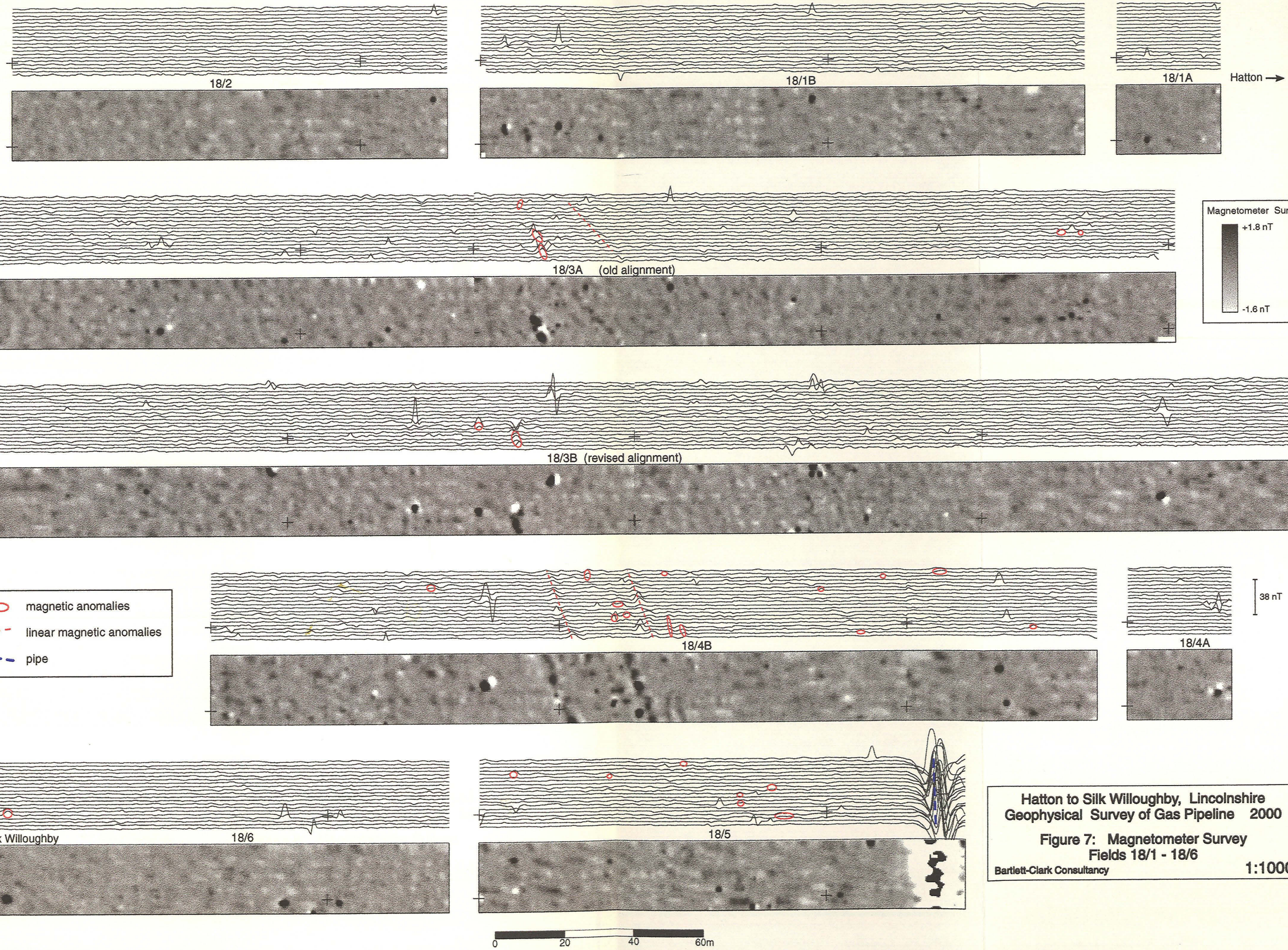
1:2500

0 100m

**Hatton to Silk Willoughby, Lincolnshire**
**Geophysical Survey of Gas Pipeline 2000**

**Figure 6: Magnetic Susceptibility Survey**
**Fields 24/7 to 24/10**

Bartlett-Clark Consultancy




**Hatton to Silk Willoughby, Lincolnshire**
**Geophysical Survey of Gas Pipeline 2000**

**Figure 7: Magnetometer Survey**
**Fields 18/1 - 18/6**

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**1:1000**

magnetic anomalies
magnetic anomalies (geological ?)
linear magnetic anomalies
pipe

22/1

Hatton →

22/2

Magnetometer Survey
+1.8 nT
-1.6 nT

22/3C

22/3B

22/3A

38 nT

22/5B

22/5A

22/4

← Silk Willoughby

23/1B

23/1A

0 20 40 60m

Hatton to Silk Willoughby, Lincolnshire
Geophysical Survey of Gas Pipeline 2000

Figure 8: Magnetometer Survey
Fields 22/1 - 23/1

Bartlett-Clark Consultancy

1:1000

Magnetometer Survey
+1.8 nT
-1.6 nT

24/1-2

machine

Hatton →

24/3

24/4

38 nT

24/6

24/5

magnetic anomalies
linear magnetic anomalies
pipe

← Silk Willoughby

24/7

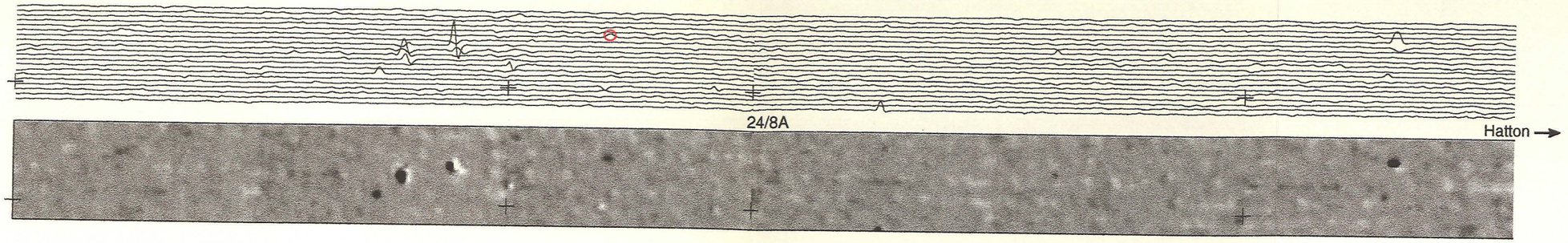
0 20 40 60m

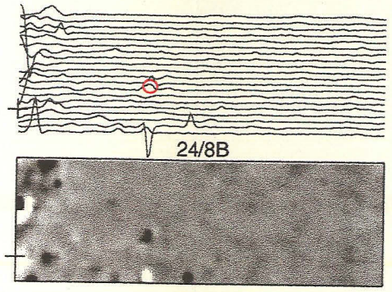
**Hatton to Silk Willoughby, Lincolnshire**
**Geophysical Survey of Gas Pipeline 2000**

**Figure 9: Magnetometer Survey**
**Fields 24/1 - 24/7**

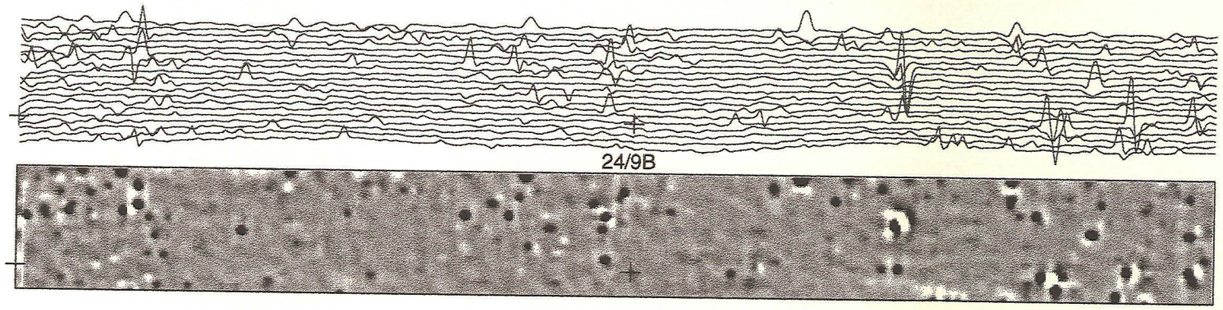
Bartlett-Clark Consultancy

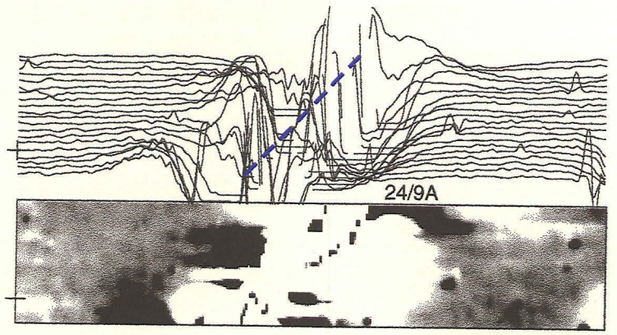
1:1000



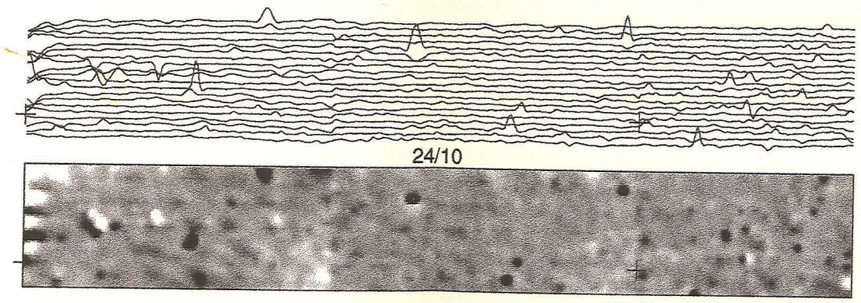

Magnetometer Survey
+1.8 nT
-1.6 nT




38 nT

Silk Willoughby




magnetic anomalies
linear magnetic anomalies
pipe

0 20 40 60m

**Hatton to Silk Willoughby, Lincolnshire**
**Geophysical Survey of Gas Pipeline 2000**

**Figure 10: Magnetometer Survey**
**Fields 24/8 - 24/10**

Bartlett-Clark Consultancy

**1:1000**