KING'S LYNN TO WISBECH

Report on
Archaeogeophysical Survey of
Proposed Gas Pipeline 2006-7

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for

Network Archaeology Ltd

on behalf of:

Murphy Pipelines Ltd

King's Lynn to Wisbech

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Summary

This report describes findings from a geophysical survey which was carried out as part of the archaeological evaluation of a proposed pipeline route between King's Lynn, Norfolk, and Wisbech in Cambridgeshire. The sections of the route which were surveyed amount to some 3.5km near to Wisbech, and 850m near King's Lynn.

The magnetometer survey detected a large number of subsurface magnetic features and disturbances, some of which (particularly in field 118) are of clear archaeological significance. Others may require further investigation to establish their significance, or eliminate them from archaeological consideration. Other findings appear to be either of natural origin, or of limited archaeological interest. These include diffuse magnetic disturbances probably representing variations in the depth or composition of silting on drained or reclaimed land, and broad curving linear features which appear to indicate former ditches or drainage channels. These are evident particularly in the areas investigated at the western (Wisbech) end of the route.

Findings at the eastern (King's Lynn) end include strong irregular magnetic anomalies and areas of disturbed readings which appear to relate to the presence of a strongly magnetic glacial gravel subsoil. Some small magnetic anomalies may require further investigation, but only minimal findings of potential archaeological relevance could be identified in this part of the survey.

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Bartlett - Clark Consultancy 6 March 2006

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Illustrations

A3 plans at the following scales are included in this report:

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Figures 2 - 11	Survey location plans with grey scale plots of magnetometer data (alongside interpretative plans also showing magnetic susceptibility data).	1:1250
Figures A1 – A5	Data archive: graphical plots of magnetometer survey data.	1:1000

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Introduction

This report describes findings from a magnetometer survey carried out on sections of the route of the proposed King's Lynn to Wisbech pipeline. The survey forms part of an archaeological evaluation of the route, and was commissioned by Network Archaeology Ltd on behalf of Murphy Pipelines Ltd and National Grid.

Fieldwork on one section of the route which was of particular archaeological concern (field 118) was undertaken in December 2006, and the remainder of the work was done in January 2007. Initial data plots with an interpretation and summary of findings have previously been supplied, and a full presentation of the results is now assembled in this report.

The Route: Geology and Archaeology

The route is 30km in length, and extends from a compressor station near West Bilney some 10km SE of King's Lynn (TF 721162) to an Above Ground Installation on the west bank of the Nene 4km north of Wisbech (TF 456139).

The two sections of the route for which magnetometer coverage was required amount to some 850m near to the compressor station at the eastern end of the route (fields 3-6), and 3.5km at a separate location to the NE of Wisbech, and near to the western end of the route (fields 112-126).

Ground conditions appear to differ between these two sites, although both are in low lying areas with substantial nearby drainage ditches. Geological and other conditions are described in the Written Scheme of Investigation for the project (prepared by Network Archaeology for Murphy Pipelines, and dated June 2006).

The eastern section (fields 3-6) appears to be located on Upper Greensand bedrock at an elevation of c. 15m OD, with drift deposits of glacial sand and gravel, and a peaty topsoil (listed in the WSI as Isleham 2).

The greater part of the remainder of the route crosses an area of low lying reclaimed marshland and fenland, with a geology of marine alluvium on a bedrock of Ampthill and Kimmeridge Clay. The western survey area lies within this landscape at an elevation of 1-3m OD near to the villages of West Walton and Walton Highway. This location near to established settlements presumably means that the route here is on relatively habitable

ground. There may therefore be a greater likelihood of finding archaeologically significant settlement remains here than in nearby fenland which is unlikely to have been occupied prior to modern drainage and reclamation. The fact that a moated site is indicated on the OS map some 300m east of the survey near field 122 supports this possibility.

Survey Procedure

The survey followed standard procedures for a linear project of this kind, but with the variation that readings were collected from some of the fields using caesium vapour rather than fluxgate magnetometers.

The usual methodology, as described in the WSI, is for readings to be collected along transects 1m apart using Bartington Grad 601 magnetometers. This was done here in fields 117 – 126 at the western end of the survey area. Readings here were recorded usually in a strip 45m wide, and centred on the proposed pipe alignment. This is equivalent to a full survey of the 44m working width. Variations to this coverage included the survey in field 124, where a widened 50m strip offset to the north of the pipe alignment was surveyed. We were asked also to extend the survey to take in the full surveyable width of fields 117-118.

The remaining areas (fields 112-115 SE of the A47 in the western section of the survey, and fields 3-6 at the eastern end) were surveyed (at 45m and 30m width) as specified using caesium magnetometers. This was done using a pair of Scintrex Smartmag SM-4 magnetometers (supplied to us by Allied Associates Geophysical Ltd). These magnetometers in principle are more sensitive than fluxgate instruments (with a stated resolution of 0.01nT compared with > 0.1nT for the Bartington fluxgate). This additional sensitivity means there is should be an improved likelihood of detecting weak magnetic anomalies which may result from archaeological features buried at depth beneath alluvial deposits. The caesium magnetometers are also capable of measuring total magnetic field values, and therefore should have a greater detection range than fluxgates, which can be used only in a gradiometer configuration. [A vertical gradiometer measures the difference in readings at the upper and lower detectors. This eliminates extraneous background magnetic field variations, but means that only nearby targets which affect one detector significantly more than the other are detected.]

It remains unclear to us whether the theoretically improved sensitivity and range of the (relatively slow and heavy) caesium instruments had any practical bearing on the outcome of the survey. The glacial soils in fields 3-6 gave high magnetic susceptibility readings (where they are exposed), and gave rise to strong (natural ?) magnetic anomalies. Sensitivity to an additional decimal place is of little concern when anomalies of 50-100nT are being recorded. One initial sample block in field 3 was surveyed using both fluxgate and caesium instruments for the purpose of comparison, and gave closely similar plots (as shown in the data archive plans: figure A5). Fields 112-115 at the west end of the route did give a particularly quiet response, and the readings here were plotted at greater sensitivity than for other sections of the survey (figure A4). Some limited findings have been identified here, as noted below, but they do not appear to fall below the sensitivity of the fluxgate magnetometer, and so would have been detected with either type of

instrument.

The caesium magnetometer data was collected following a similar procedure to the fluxgate survey with readings recorded along transects 1m apart at a rate of 4 values a metre between position markers. File conversion software as used for the fluxgate surveys had to be modified to convert the files from the Scintrex logger to a suitable format for subsequent processing. The first stage of this involved using a zero-mean baseline calculation to reduce the absolute field readings (c. 49000nT) to local anomaly values. [A similar calculation is routinely done on fluxgate data, but with the slightly different purpose of removing fluxgate heading errors.] Subsequent processing and presentation was then similar for data sets from both types of instrument.

The results are presented as grey scale plots at 1;1250 scale on figures 2-11, and as graphical or x-y trace plots in the data archive, which is also included in this report (figures A1 to A5). These plots show the readings after standard processing operations including slight numerical smoothing to reduce background noise levels.

The interpretation of the magnetometer survey which is shown in the lower half of each survey plan includes a selection of magnetic anomalies, but not all the features as indicated are archaeologically significant. The interpretation as marked is intended to be schematic and illustrative, and not to reproduce the detail of the grey scale plots. Features are indicated by broken lines, continuous outlines, or cross hatching. Broken lines are used to permit a simplified representation of complex features, or to represent features which are too fragmented to form a satisfactory outline. The interpretation is selective; 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 are not generally outlined in the interpretation, unless they form a group of features requiring comment.

Colour coding has been used to try and distinguish different effects. Magnetic anomalies of possible archaeological, or at least non-geological origin are outlined in red, with potential geological disturbances in orange. (Possible cultivation effects are shown in green, and pipes in blue.) This survey also detected an unusual number of distinct, but large and irregular, linear features. These may well represent former ditches or watercourses predating the present pattern of drainage ditches. Features of this kind, and possible land drains, are shown in different shades of blue.

Magnetic susceptibility readings form a useful component of the survey. They provide evidence of local magnetic conditions, as determined by geology and soil type, and therefore inform the interpretation of the magnetometer survey. It is rarely possible, however, particularly in an extensive survey across a varying geological background, to identify archaeological findings directly from the susceptibility data. A magnetometer survey provides direct evidence for the existence and location of subsurface archaeological features, whereas their presence can only be inferred indirectly from susceptibility readings, which are also affected by numerous non-archaeological variables. The susceptibility readings, as measured with a Bartington meter, are presented in the form of shaded squares of density proportional to each reading on the survey location plans.

The survey was positioned in each field by reference to OS co-ordinates measured from

the digital mapping supplied by the client, and located with a sub-1m accuracy differential GPS system

Results

The survey plans and data plots in this report are arranged in sequence from west to east. This means the plans can be read consecutively from left to right, but also that they run in the negative pipe direction. The field or land parcel numbers (which follow the system as used by Murphy Pipelines) therefore decrease from field 126 at the west end of the survey to field 3 at the east.

The findings from the survey, as discussed below, are summarised in the Appendix to this report. An initial version of this list, mentioning findings of potential archaeological significance, has previously been supplied. A number of additional items, none of which appear to be of definite archaeological relevance, have now been added to this list for the record.

Fields 126 to 125

One potentially significant finding here is a cluster of magnetic anomalies (labeled A on figure 2) in field 126. The disturbances here could represent silted pits of a kind which could be associated with ancient settlement remains, but the features are small and isolated, and there is no clearly associated increase in susceptibility values.

Field 126 also provides initial examples of other magnetic anomalies of types which recur throughout the survey. The linear features at B could perhaps represent former ditches (a number of which have appear to have been detected elsewhere), or could be minor furrows or depressions filled with magnetically responsive silt. Effects of this kind could also account for many of the magnetic anomalies (usually indicated in orange) in other fields.

Strong natural magnetic anomalies have frequently been encountered in previous surveys of wetland areas, and are often found when pipeline surveys cross alluvial ground near rivers. Such features probably relate to the presence of naturally silted hollows in the subsoil, or other variations in the depth of topsoil cover. The difficulty in the present survey is that such features are widespread, and so may be less clearly distinguishable from archaeological findings than is usually the case.

A narrow linear disturbance at C in field 126 could perhaps be a modern land drain (as appears to be likely for narrow parallel linear features in other fields).

Other individual pit-like features are visible in field 125 (e.g. around D), but they are larger and less concentrated than at A, and so may well be natural.

Field 124

Some of the magnetic anomalies here, especially the groups at E and F, are perhaps of a suitable size and strength to represent archaeological features. The susceptibility readings also show some increase in these areas.

The more dispersed magnetic anomalies in the centre of the field are less conclusively significant, but the field as a whole may be a suitable target for further investigation.

Fields 123a – 121

There are distinct magnetic anomalies throughout these fields, but they may well all be of non-archaeological origin. The strong curving ditch-like linear feature with possible branching side channels at G has the appearance of a drainage system, and is therefore coloured blue to indicate a possible former watercourse. The smaller parallel linear features (H) in this field have the appearance of (possibly recent) land drains.

The broad irregular magnetic anomalies as outlined in 123 are characteristic of the (presumably natural) disturbances mentioned previously which are often seen on wetlands.

Additional features in each of these categories are seen also in 122 and 121. The strong curving anomalies at J are similar to G in 122, and could again be former ditches or streams. There are other narrow linear features suggesting land drains at K in 122 and L in 121. K lies within a group of raised susceptibility values. These do not appear to be associated with archaeological features, and so may relate to current land use. Other magnetic anomalies in both fields, including the branching group of linear features at M in 121, are broad and weak, and unlikely to be archaeologically significant.

Fields 118 – 117

These fields contain a variety of findings, of which some are of clear archaeological significance, but others may be of non-archaeological origin as proposed in the fields above.

The clusters of magnetic anomalies indicated in red at N, O, P can be seen on the graphical plot (figure A3) to be relatively strong and narrow, as would be expected for ditched enclosures or other features of archaeological dimensions, and which may contain a magnetically enhanced fill. There is also an increase in susceptibility values in the southern part of field 118 around O and P. Various smaller magnetic anomalies in the vicinity of these groups of features could indicate pits, or other individual archaeological findings. These results are consistent with the presence of a surface scatter of Roman and Iron Age pottery seen during the fieldwork in the south of field 118, although modern broken pipes also appear to be present.

The interpretation of other findings in these fields is a little more problematic. Some of the magnetic anomalies (perhaps including weaker linear features indicated by orange broken lines) could perhaps indicate enclosures associated with the archaeological features, but others are probably unrelated to the archaeology. The linear anomaly Q cuts through O and P, and probably therefore indicates a ditch or channel of different date. Q forms part of a system of ditch-like linear features extending across much of the two fields. These features appear to be both too large in scale and irregular in plan to be of direct archaeological significance, but further investigation might be needed to fully assess this question.

A strong single magnetic anomaly at R in field 117 could be recent.

The fields as listed above were all surveyed using fluxgate magnetometers. The remaining fields as described below were surveyed with caesium magnetometers. The width of the survey was specified as 45m for fields 112-115, and 30m for fields 3-6.

Fields 115 - 112

The findings from these fields include various diffuse and irregular magnetic anomalies, many of which again appear to be natural or non-archaeological. The pattern of curving linear magnetic anomalies at S in 115 is perhaps comparable to the features noted above at M in 121.

Other weak and irregular magnetic anomalies (as outlined in orange) also appear to be natural. A difficulty remains that deeply buried archaeological features, if detected by the caesium magnetometer, would also give rise to broad and weak anomalies. Such features could therefore only be identified as significant if they displayed archaeological characteristics in terms of their distribution, dimensions, or plan, for which there is little evidence in these fields.

Some linear disturbances are present in 112 (as indicated by blue broken lines, U), but they are probably land drains. No survey coverage was required in field 113.

The only magnetic anomalies in these fields which resemble others previously noted as of archaeological interest are the small features outlined in red at T in 112. These could well be insignificant, but could perhaps be comparable in origin to the groups of small pit-like features noted above at A and F in fields 126 and 124. A strong disturbance at the south end of 112 may be caused by nearby pipe or boundary.

Fields 3 – 6

The high magnetic susceptibility values seen in field 5 and nearby are probably an effect of the glacial gravel subsoil which is stated to be present here. The very much lower susceptibility readings in much of field 3 are consistent with the presence of a peat topsoil covering the gravel, but strong magnetic anomalies were detected throughout this eastern

section of the route. The ground here remains low lying, with extensive water logging at the time of the survey.

Many of the magnetic anomalies take the form of broad irregular variations in the readings, and most are highly irregular in plan. They are stronger than at the Wisbech end of the survey, presumably because of the glacial subsoil, but again in most cases appear to be of natural origin.

It is difficult to identify any features of potential archaeological significance. The particularly strong magnetic disturbances in field 5 (e.g. V) show no regularity of plan. Areas containing strong narrow magnetic anomalies are marked by cross hatching (W, X in 5 and 3), but these could well be caused by natural magnetic stones in the underlying gravel.

A cluster of smaller individual magnetic anomalies is indicated by red outlines at Y in field 3, but this group could be a weaker version of the probably natural disturbances nearby at X. Other individual pit-like anomalies are outlined towards the north of the field (Z), but they are too isolated to be of any conclusive significance.

Conclusions

This survey has produced an unusual variety of magnetic responses, many of which appear to relate to the presence of former drains or channels, or to variable depths of silting on drained or reclaimed wetlands. There do, however, appear to be clear archaeological findings in field 118, and there is perhaps also a possibility of archaeological features at locations including fields 124 and 126.

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King's Lynn to Wisbech Pipeline: Geophysical Survey

Appendix: Inventory of Selected 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:	Magnetic anomalies of probably non-archaeological origin.

Field / Feature		Grade
126 A	Small cluster of possible pit-like magnetic anomalies.	2-3
126 B	Linear features: possible cultivation effects, or silted channels.	3
126 C	Weak linear disturbance.	3-4
125 D	Broad weak magnetic anomalies (natural ?)	3-4
124 E, F	Clusters of distinct pit-like and other magnetic anomalies.	1-2
123a H	Narrow linear disturbances: land drains ?	4
123a G	Distinct curving and branching linear anomalies: former watercourses ?	3

122 J	Similar to G ?	3
122 K	Similar to H.	4
121 L	Similar to H.	4
121 M	Broad, weak magnetic anomalies: silted channels, furrows, or natural variations in topsoil depth ?	3-4
118 N, O, P	Clusters of distinct linear and other magnetic anomalies, possibly representing a settlement site.	1
118 Q (etc.)	Broad curving linear features (similar to G and others above) - silted watercourses ?	3
117 R	Strong isolated magnetic anomaly: recent ?	4
115 S	Broad weak magnetic anomalies similar to M: natural ?	3
112 T	Small group of pit-like magnetic anomalies (as at A ?)	2-3
112 U	Parallel linear disturbances: land drains ?	3-4
5 V	Strong irregular magnetic anomalies – probably geological.	3-4
5 W, 3 X	Clusters of strong narrow individual magnetic anomalies: magnetic stones in gravel ?	3-4
3 Y, Z	Individual (pit-like ?) magnetic anomalies. Sparsely distributed, but generally rather large for archaeological features, and close to other (natural ?) disturbances.	2-3