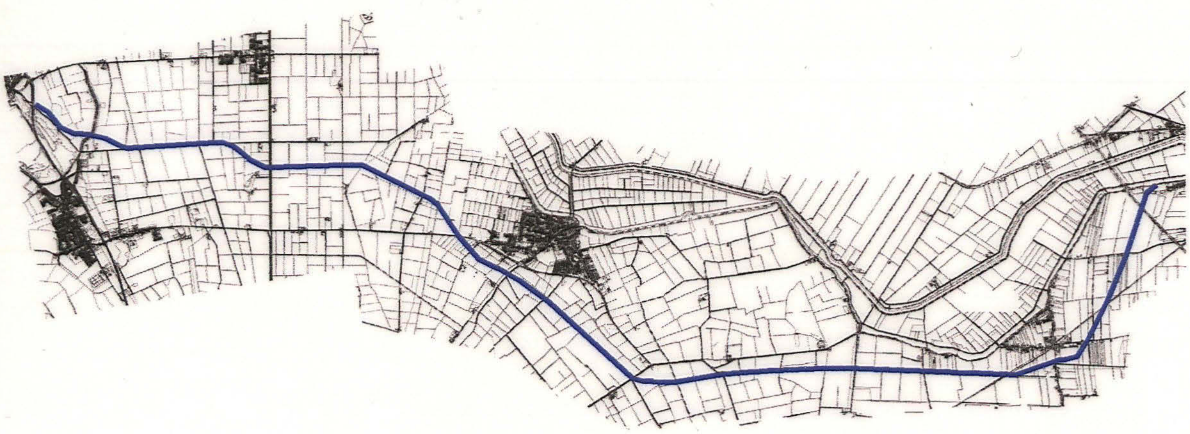
Babtie

A1073 PETERBOROUGH TO SPALDING IMPROVEMENT SCHEME

FLUXGATE GRADIOMETER AND RESISTANCE SURVEYS

VOLUME I (OF II)



Report prepared for Babtie Group
By David Bunn & Colin Palmer-Brown

PRE-CONSTRUCT GEOPHYSICS

July 2002

PRN 23891 – 23917

Event L13257
Event L13258
Source L17988

Contents

Illustrations

Volume II

PRE-CONSTRUCT GEOPHYSICS

61, High Street
Newton on Trent
Lincoln
LN1 2JP

Tel: 01777228129/155

Summary

- *Fluxgate Gradiometer and Resistivity surveys were undertaken along the proposed route of the A1073 Peterborough to Spalding relief road*
- *The survey detected a range of magnetic anomalies, some of which appear to reflect past human activities; for example, field boundaries and medieval farming systems*
- *In isolated areas, a number of magnetically strong anomalies may represent the remains of industrial activities such as salt making*
- *A limited programme of resistivity survey identified an area of relatively high electrical resistance at the site of a medieval grange. Some of this variation may represent stone building remains. Similar features may have been detected by gradiometry on land to the north of Cowbit*
- *The magnetic signature of some natural features appear to conceal, or superficially resolve as, archaeological features: similarly, post-glacial alluvial deposits may have masked traces of occupation and activity in some areas*

1.0 Introduction

Babtie Group, acting on behalf of Lincolnshire County Council, commissioned Pre-Construct Geophysics to undertake fluxgate gradiometer and resistivity surveys on land in south Lincolnshire and north Cambridgeshire, along the proposed route of the A1073 Spalding to Peterborough improvement scheme. This work was carried out as part of an archaeological evaluation of the area.

2.0 Location and description

The proposed route, which comprises eight sections (Figs. 1-41), extends approximately 21.5km northwards from the A47 at Eye in Cambridgeshire to the A16/B1173 junction at Cowbit in Lincolnshire.

The 1km study corridor, which is predominantly level and lies almost entirely below 10m OD, includes drained fenland, the original fen edge, and an elevated gravel ridge at Crowland.

Current land use is predominately arable.

3.0 Geology and soils

The solid geology of the area was formed during the Jurassic period, and comprises Oxford Clay (B.G.S., 1984, 1992).

The southern section of the route occupies an area at the fen edge, where the drift geology comprises River Terrace gravels deposited by the Rivers Nene and Welland. These gravels extend eastwards beneath Flandrian deposits of alluvium and are exposed as Abbey Gravels, which create slightly higher ground at Crowland. To the south of the village, in Section E and the southern edge of Section D, the route crosses young beds of Nordelph Peat (2000-3000 years B.P.), laid down in bogs during a temporary regression of the salt marshes.

Beyond Crowland, widespread deposits of alluvium form the Barroway Drove and (later) Terrington Beds. These include the remains of silt filled tidal creeks or roddons, many of which have been identified by aerial photography. Roddons often appear at the surface as slight ridges.

All of the soils along the route derive naturally from the underlying drift deposits (S.S.L.R.C., 1983, 1989). In Section H they comprise the Shabbington Series, a deep fine loam over sandy soils. Along the remainder of the route, deep stoneless clayey soils deriving from marine alluvium, predominate. In Sections D-G, over the older Barroway Drove Beds, these are, for the most part, non-calcareous (Wallasea Series); in Sections A-C, over the Terrington Beds, they are younger and more calcareous (Stockwith and Agney Series).

4.0 Archaeological and historical background

Sections 4 and 5 include archaeological information extracted from a specification and additional maps (Figs. 3-7) provided by Babtie Group (Babtie Group, 2001).

The extent and nature of past human activity within the study area has been closely associated with changes in the landscape. A succession of drainage and reclamation activities has transformed large tracts of tidal marshes into fertile and cultivatable land. This transition was initiated in the Romano-British period.

Earlier occupation of the area was focused on subtle topographical elevations within an otherwise low-lying and flat landscape, which had evolved and regressed in response to climatic and geological circumstances.

A range of archaeologically significant sites has been identified within the study area. The slight ridge at Crowland contains Bronze Age barrows, and further prehistoric sites may exist to the south, closer to Peterborough.

Iron Age salt production in the fenland was extensive, and this industry continued well into the Roman period. Romano-British finds scatters, recovered from several locations, attest to the possibility that settlement remains could fall within the survey corridor. Increasing settlement within the silt fenland may have been possible following the construction of the Car Dyke, an extensive waterway that probably functioned both as a catchment drain, and an inland waterway.

Land reclamation and subsequent agricultural improvements continued throughout the medieval and early post-medieval periods, and increasing land availability was matched by increased permanent settlement, including the monastic holdings, many of which were later abandoned as the coastline receded.

5.0 Survey Areas: Sections A-E, H (Figs.2-41)

The survey was undertaken along a 40m wide corridor, on land directly affected by the proposed development.

Surveys were not required along **Sections F** and **G** and the northern 200m of field 163 (**Section A**). A number of fields were not surveyed due to crop height or refusal of access.

Certain fields within the 1km study corridor were allocated plot numbers; commencing at **1** at the southern end of the route (**Section H**) rising to **166** at the northern end of **Section A**. Consequently, the results are presented and discussed sequentially from south to north.

Area surveyed: 44.31hectares (gradiometry)
1.6 hectares (resistivity).

Section H (Figs. 3, 8-11): Car Dyke-TF 52055 30245 to TF 52124 30336-c.1200m.

This section commences at the A47 and terminates 100m to the north of the Car Dyke.

Known archaeological sites within the study corridor include prehistoric and Romano-British features and artefacts, the most significant being Car Dyke, which, in this location, is a Scheduled Ancient Monument.

Area surveyed: 4.64 hectares.

Section E (Figs. 4, 12,13): Crowland-TF 52328 30851 to TF 52380 30879-c.600m.

This section extends northwards from the Cambridgeshire county border to meet the current A1073 at Crowland. The village, which lies on a slightly higher gravel ridge, has been a focus for occupation since prehistoric times.

Despite the close proximity of the village, the only known archaeological site is a post-medieval enclosure, alongside the A1173.

Area surveyed: 2.24 hectares.

Section D (Figs. 4, 12-19): Crowland to St. James Bridge-TF 52380 30879 to TF 52640 31130- c.3900m.

The survey area is a linear strip between the A1073 at Crowland and St. James Bridge, where the route crosses the B1166.

A number of archaeological sites have been identified within this section, including a Bronze Age barrow and cremation at the northern edge of Crowland. The route crosses a medieval earth bank, which runs parallel to the B1040 (Greenbank Drove).

To the east of Crowland, the survey runs close to a series of undated soil marks.

Two fields were unavailable for survey.

Area surveyed: 8.78 hectares.

Section C (Figs. 5, 20-27): St. James Bridge to Brotherhouse Bar -TF 52640 31130 to TF 52658 31435- c.3900m.

This section runs north from the B1166 to the point where the route crosses the drain to the south-east of Brotherhouse Bar at Queen's Bank. The latter may mark the site of a medieval earth bank.

Other remains include St. James Brickworks (at the junction of the A1073 and B1166), and a decoy pond at Decoy Farm.

Four fields were unavailable for survey.

Area surveyed: 9.24 hectares.

Section B (Figs. 6, 28-33): Brotherhouse Bar to Cowbit -TF 52658 31435 to TF 52685 31805-c.3900m.

The route runs alongside a drain, crossing a disused railway line east of Cowbit, and continues to the B1357.

This section passes close to the eastern side of Cowbit, where a concentration of relatively significant archaeological remains is known. They include a number of Iron Age and Romano-British salt works and artefact scatters.

Goll Grange, established in the C14th by Spalding Priory, lies within the survey corridor (TF 2690 1670). Given the potential for stone building remains, a resistivity survey was undertaken 200m to the north and south of this feature.

Three to four fields were unavailable for survey.

Area surveyed: 8.45 hectares (gradiometry)
1.6 hectares (resistivity).

Section A (Figs. 7, 34-41): Cowbit to A16 - TF 52685 31805 to TF 52420 31990 - c.3300m.

From Cowbit, the route turns north-westwards, re-crosses the disused railway, and continues c.500m beyond the A16 to meet the B1173.

The potential for archaeological activity continues into this section, which contains a number of Romano-British settlement and salt production sites, as well as a series of undated crop marks and traces of medieval occupation.

To the south of the A16, the route passes through the site of a borrow pit (used during the construction of the A16). This area was investigated prior to mineral extraction.

Area surveyed: 10.96 hectares.

6.0 Methodology

6.0.1 Gradiometry

Magnetic variation that is detectable within soils can often determine the nature and extent of past human activity. At British latitudes, the earth's magnetic field is approximately 50,000 nanoteslas (The nanotesla is the SI unit of magnetic flux, used in gradiometry to measure magnetic variation in relation to the Earth's magnetic field). Against this background, most archaeological features produce an enhancement of around 5-30 nanoteslas (nT). The strength of magnetic variation depends largely on the composition of the geology. For example, limestone and chalk exhibits low magnetic susceptibility, and contrasts well against topsoils: conversely, strongly magnetic igneous rocks can mask subtle anomalies completely.

For the most part, topsoils tend to be more responsive to magnetic remote sensing than the geologies over which they lie. Ferrous oxides occur naturally in many drift deposits, particularly those derived from, or containing elements of, igneous rocks. Organic decomposition within topsoils can supplement the level of ferrous compounds, a process amplified by agricultural activities.

The topsoil-like fills of ditches and pits tend to increase soil depths, and hence magnetic strengths, relative to surrounding soils. The converse also applies.

Ferromagnetic substances such as iron induce a very high response to magnetic surveys, and are thus easier to identify. Perhaps of more significance to the archaeological prospector are the weaker ferrous oxides: the randomly orientated magnetic fields of these materials produce minimal magnetic variation in their natural state. Geology/soil type can determine this variance (see above). Specifically, clay soils are ferrous oxide rich, hence their characteristic red colouration. Firing increases its versatility, but also enhances the magnetic properties of its ferrous content. For kilns, this may be in the order of 1000-5000 nT. Similar processes occur during the formation of igneous rocks (see above).

Invariably, most surveys detect discrete anomalies; in groups or randomly scattered across a site. In the absence of intrusive investigation, the nature and origin of these anomalies is often difficult to establish. Strongly magnetic dipolar anomalies usually reflect ferrous materials, such as ploughshares and horseshoes. Weaker examples may indicate ceramic materials such as brick and tile. The strength of the magnetic variation derives from permutations of the size and depth of the feature/object and the magnetic susceptibility of the surrounding soil. Pit-like anomalies, usually positive, can be identical to naturally occurring depressions, and the potential of these can only be estimated when they are examined in context with other factors, such as the proximity of definite or suspected archaeological remains.

The use of magnetic surveys to locate sub-surface ceramic materials and areas of burning, as well as magnetically weaker features, is well established, particularly on large green field sites. The detection of magnetic anomalies requires the use of highly sensitive instruments, in this instance the Geoscan FM 36 Fluxgate Gradiometer. This must be accurately calibrated to the mean magnetic value of each survey area. Two sensors, mounted vertically apart, measure slight local deformations of the earth's magnetic field. Cumulative readings can be stored, processed and displayed as graphic images.

6.0.2 Resistivity

This technique is based on the relative inability of materials to conduct an electrical current. Within soils, moisture is the principal conductive medium, and the relative water retentiveness of sub-surface features and surrounding soils can be established by passing a current through the earth and recording variations of electrical resistance.

This is a particularly useful method for detecting stone building remains, which are generally less moisture retentive than the surrounding soils.

In practice, the measurement of electrical resistance utilises two pairs of probes. One pair passes a current; the other measures voltage change. Although the probes can be configured to measure various characteristics of soil resistivity, for archaeological purposes the Twin Probe array is usually sufficient; a relatively quick and simple means of recording lateral variations of earth resistance.

For this survey, a Geoscan RM 15 Advanced instrument was employed.

6.0.3 The survey

With reference to the current site, the surveys comprised:

a) a 40m wide detailed gradiometer survey, based on 2 samples/m along 1m traverses in the 0.1 nT range,

b) a 40m wide resistivity survey, based on 1 sample/m along 1m traverses.

All survey areas where laid out as 20m sq grids, which (boundaries permitting) were centred along the proposed route.

Data from the gradiometer survey was processed using *Geoplot* (*v. 3.0*). It was desloped (a means of compensating for sensor drift during the survey) and clipped to reduce the distorting effects of extremely high or low readings caused by 'ferrous litter'. The results are plotted as greyscale and trace images.

The same programme was used to process the resistance data. This was de-striped and clipped, and was then presented as a series of greyscale images.

The surveys were carried out in April and May 2002 by David Bunn and Alex Osinsky, with additional help from Peter Heykoop and Jim Rylatt.

7.0 **Results** (for illustrations refer to volume II: Figs.1-74)

The results are presented as graphic images at a scale of 1:1250 (Figs. 42-74), commencing at Field 3 (Section H) and terminating at Field 166 (Section A). These comprise:

a) Trace plots of the unclipped data, at a resolution of 20 nT/cm

b) Greyscale images of the unclipped data, with the strongest anomalies depicted in colour

c) Greyscale images of the clipped data

d) Interpretive plots

It should be noted that the graphic resolution of extremely diffuse anomalies can be reduced when images are presented as printed images at larger scales.

References in the text to known archaeological sites, including former field boundaries, are based on information and maps provided by Babtie Group (Figs. 3-7).

SECTION H

Field 3 (Figs. 42, 8, 9)

The survey detected a modern service (**1**) that extends along the southern boundary of the field.

The balance of the field was magnetically quiet and the survey did not identify any obvious archaeological remains.

Field 4 (Figs. 43, 8, 9)

Magnetically similar characteristics to field 3, although a random scatter of relatively strong discrete anomalies were detected (Fig.43: trace plot).

Several north-south aligned, linear anomalies (example: **1**, red) were detected in the northern part of the field. Their orientation respects current land boundaries and it likely that they represent land drains.

Field 7 (Figs. 44, 8, 9)

Similar to those described above; a number of parallel linear anomalies were detected in field 7, and these are likely to reflect modern sub-surface land drains (example: **1**, red). Others on a slightly different alignment, may be clearer examples of natural reticulation (**2**).

A localised area of enhanced magnetic variation (**3**) may reflect ceramic debris in the subsoil.

Field 9 (Figs. 44, 10, 11)

For the most part, magnetically quiet, with the exception of a number of discrete anomalies and an area of variation that was detected close to the southern boundary (**1**).

Field 11 (Figs. 45, 10, 11)

To the north of the Car Dyke, the route passes close to a number of recorded find spots. These include Romano-British ceramic building materials and a complete Romano-British vessel. It is also possible that a kiln was uncovered during works adjacent to Whitepost Road (P. Williamson, *pers. comm.*). With this in mind, a number of anomalies detected in field 11 may be of significance.

Anomaly group **1** appears as a predominately positive area of magnetic variation, which possibly reflects the remains of a kiln or buried ceramic materials. This appears to lie at the intersection of several magnetically weak linear anomalies (example **2**, red) that form a network of regularly spaced anomalies, and probably represent modern land drains.

A series of diffuse curvilinear anomalies were detected (example **3**, yellow). The westernmost examples respect the current boundary and the alignment of the Car Dyke. Others do not appear to relate to modern / existing features, and could conceivably reflect sub-surface archaeological remains of a non-diagnostic form.

SECTION E

Field 50A (Figs. 45, 12, 13)

The route passes through a belt of peat, which could (potentially) mask earlier archaeological remains.

A series of linear anomalies were detected, most of which probably represent ceramic land drains (example **1**, red) and a former open drain (**2**). The strong magnetic signature of the latter probably relates to a rubble backfill.

Weaker anomalies included extremely diffuse linears (**3**, **4**) and other zones of unresolved magnetic variation (**5**, **6**). The archaeological significance of these zones is uncertain, and it is possible that they represent natural formations.

Field 50B/51 (Figs. 46, 12, 13)

Three linear anomalies (**1**) correspond to former field boundaries; others (example **2**) probably reflect similar features and possible cultivation marks (example **3**).

A series of regularly spaced and parallel linears (example **4**, red) in the southern half of the survey area are probably modern land drains.

Anomalies in the central part of the survey (**6**, circled) bear similarities with those in the previous field; an area of strong variation within this group (**7**) could increase their archaeological potential.

A discrete cluster of positive anomalies (**8**) was detected to the immediate south of the A1073. The proximity of the road and a field entrance raises the possibility that these features represent sub-surface rubble spreads.

SECTION D

Fields 55, 56, 57 (Figs. 47, 12, 13)

The survey traversed four former or existing field boundaries (example **1**, orange) and a series of probable dylings (example **2**, green).

The alignment of diffuse linear anomaly **3** mirrors that of the road, and is likely to represent an undated flanking ditch. It appears to cut (or be cut by) elements of **2**, indicating that **2** and **3** represent separate phases of activity.

Anomaly **4** marks the location of an electricity pole.

Field 62 (Figs. 47, 14, 15)

The survey identified a series of linear and curvilinear anomalies. The slightly 'S-shape' nature of the north to south-aligned examples (**1**) indicates that these may be traces of ridge and furrow ploughing, with corresponding headlands (**2**).

Linear anomaly **3** appears to cut, or be cut by, elements of **1**. This suggests that these features are not directly related, and belong to different phases of activity.

The northern end of the field, which contained an inaccessible cover crop, was not surveyed.

Field 63 (Figs. 48, 14, 15)

Anomaly **1** (orange) marks the location of a backfilled drain (fill probably includes rubble and ferrous debris). A number of other linear anomalies (**2-4**) appear to form components of a previous field system, which respects existing boundaries. There is a very tentative access (circled).

Elsewhere, there are a number of ephemeral anomalies (examples shown in yellow) that could just be archaeological, but are more likely to be of natural origin (eg relict channels).

Field 64 (Figs. 48, 14, 15)

The 'mottled' grey scale in field 64 probably reflects natural features, such as iron pan formations or pockets of peat.

Potentially significant linear and curvilinear anomalies (**1-3**) were detected close to Green Bank, which is a medieval earthwork (see Section 4).

Field 67 (Figs. 48, 14, 15)

An abrupt rise in the ground level occurs as the route crosses Green Bank. Two clearly resolved linear anomalies (**1**) almost certainly represent traces of a trackway that is on the same alignment as the medieval/post-medieval bank. Diffuse linear anomaly **2**, detected to the north of these, respects this feature.

Fields 68-74 (Figs. 49, 16, 17)

The survey detected a possible field boundary (**1**) and a series of weaker parallel linear anomalies (example **2**, green). The latter may be dylings or possibly land drains.

Areas of weak magnetic variation (circled) probably resolve as natural features.

Fields 71, 72 (Figs. 50, 16, 17)

A series of parallel linear anomalies (**1**) probably represent relatively modern ceramic land drains.

Two closely spaced linear anomalies (**2**) extend along the northern edge of field 71. These probably reflect modern agricultural activities (ie ploughing).

The survey did not detect diagnostic anomalies in field 72, and an underlying mottling of the greyscale image is almost certainly natural.

Field 73 (Figs. 51, 18, 19)

Beyond The Chase, the route passes close to a series of previously recorded soilmarks, although the results do not provide any clear evidence that the features that these marks represent extend into the survey area. Weak magnetic variation in the southern part of the field may incorporate potential archaeological anomalies, for example **1**, which shows as a diffuse penannular feature. This interpretation is extremely tentative, however, and it is equally likely that natural processes have produced this anomaly, and a wider zone of similar activity.

Discrete anomaly **2** is probably archaeological, although its significance is uncertain. It could be a pit.

Linear anomaly **3** is at the interface of two grids, and may be a survey error. However, it corresponds with an area of increased crop height and could reflect a modern service, such as a water pipe.

Linear **4** probably relates to the drain that forms the northern boundary of the field.

A line of strong magnetic variation at the south end of the field (**5**) reflects the close proximity of a road (The Chase).

Fields 76, 78 (Figs. 52, 18, 19)

A series of regularly spaced linear anomalies (example **1**, green) possibly resolve as former land divisions, such as dylings, although they could represent widely spaced land drains of recent origin. In Field 78 similarly aligned anomalies (**2**) were detected to north of a track (**3**).

A well-defined 'L-shaped' anomaly (**4**) shares spatial characteristics with existing land boundaries and anomalies **1-3** (?former field boundary).

Anomaly **5** could represent a former field boundary that pre-dates the prevailing orientation, and extends into field 79.

Field 79 (Figs. 53, 18, 19)

Excluding linear anomaly (**1**) that is described above and a second linear (**2**) at the northern end of the field, the survey area in field 79 appears to be magnetically quiet. Anomaly **2** possibly reflects a recent cultivation mark.

The remaining area in Section D was not available for survey.

SECTION C

Field 88 (Figs. 53, 20, 21)

A network of linear anomalies (example **1**, green) extends across the survey area. These appear to represent elements of a former field system, such as dylings, although the possibility that these features are a reflection of widely-spaced ceramic land drains with relatively strong magnetic signatures should not be ruled out, given their regularity.

Two diffuse linear anomalies (**2**) were detected in the southern part of the survey area. It is possible that these relate to an area of weak magnetic variation (**3**), although the full extent of the latter was not established.

Field 91 (Figs. 54, 22, 23)

The survey was resumed to the north of Whipchicken Road, where the route skirts alongside an area of woodland on a slight north-facing slope.

A number of anomalies (highlighted) appear to resolve as potentially significant features, although some of this may be the result of natural processes. However, there is a good possibility that those shown as yellow reflect archaeological remains. These include the corner of a possible enclosure (**1**), which was recorded in the southwest edge of the survey area on higher ground.

The survey also identified a strong localised anomaly close to the northern edge of the field (**2**). The archaeological potential of this is strengthened by the close proximity of the above features.

Field 92 (Figs. 55, 22, 23)

Anomalies of potential archaeological significance appear to continue into this field. Some of these can be confidently identified as archaeological, for example linear anomaly **1**, which probably reflects a former land division. Many of the other linear and curvilinear anomalies (major examples shown as blue), although resembling archaeological features, could also be natural. Their morphological characteristics suggest that they could represent meandering paleochannels; at this location, the route crosses former salt marshes, where the magnetic properties of the geology can 'mimic' archaeological activities. The landscape in section C, from this point onwards, is characterised by gentle undulations; possibly providing further evidence of semi-extant roddons.

Two straight linear anomalies (**3**, red) possibly represent modern land drains.

Discrete anomaly **4**, has pit-like characteristics.

Field 93 (Figs. 56, 22, 23)

Magnetically similar to the previous field: certain anomalies (shown as blue) contrast well against a 'quiet' background, particularly in the northern part of the field. The archaeological significance of these features is doubtful, and it seems likely that they reflect elements of relict channels.

The strong magnetic signature (shown as red) along the northern edge of the survey area marks the location of a track.

Field 94 (Figs. 57, 24, 25)

At least one linear anomaly (probably natural) that was detected in field 93 extends into this area.

A series of broadly parallel anomalies (**1**) extend across the mid-section of the survey area, possibly resolving as traces of ridge and furrow.

A rectangular anomaly (**2**), detected to the north of **1**, appears to reflect a small regular ditched enclosure.

Linear anomalies **3** and **4** correspond with former field boundaries.

Strong magnetic variation occurs at the north edge of the field, where the route crosses a road, **5**.

Field 94A (Figs. 58, 24, 25)

The survey detected several linear/L-shaped anomalies (shown as yellow), which could be interpreted as being archaeological (e.g. land divisions), although a natural origin is again possible within this geological framework, and the true nature of such anomalies can only be resolved by further investigation.

Field 95 (Figs. 58, 26, 27)

A well-defined linear anomaly (**1**) corresponds with the known location of a former field boundary. To the north of this, a series of linear anomalies (yellow) appear to respect its alignment, with elements of anomaly groups **2** and **3** possibly resolving as archaeological features. Again, this interpretation is tentatively offered, given that much of the magnetic variation in this field probably reflects natural soil processes. This scenario continues in the northern half of the field, where other linear anomalies of possible archaeological origin (example **4**) were detected.

A localised area of strong variation (**5**) was noted at the north-east corner of the survey, and this corresponds with a sluice gate that feeds into the drain at the northern end of the field.

The remaining fields in Section C contained maturing oilseed rape crops and were not therefore surveyed.

SECTION B

Fields 101, 102 (Figs. 59, 28, 29)

The greyscale images graphically illustrate the strong magnetic variability that is associated with the alluvial sequence that predominates on this section of the route, an area where the older marine alluvium of the Barroway Drove Beds dips below the younger Terrington Beds.

The deposition of iron-rich sediments in salt-water marshes may have produced the complex network of anomalies, some of which could be masking archaeological features. It is possible that some of these features relate to residual peat deposits, lying in lenses within surrounding soils and alluvium. This phenomenon is apparent in both fields and occurs frequently along the remainder of the route.

In field 101, two groups of anomalies (**1**, **2**) probably reflect miscellaneous debris that has been deposited close to boundaries.

Fields 103-108 (Figs. 60, 28, 29)

Modern services are responsible for the high magnetic variation displayed by linear anomalies (**1** and **2**) in fields 104, 105 and 108.

Linear anomalies (example **3**, green) in fields 106 and 107 probably represent former land divisions, such as dylings.
An area of relatively strong variation (**4**) was detected at the southern edge of field 107. The archaeological potential of this feature is uncertain, although it possibly reflects burnt/fired materials, such as brick and tile.

The mottled nature of the remaining anomalies probably reflects natural subsoil variation, as encountered in fields 101 and 102.

Fields 110, 111 (Figs. 61, 30, 31)

Many anomalies (some depicted in yellow) appear to superficially resolve as groups of ditches. However, as with Section C, the preponderance of naturally induced magnetic variation has necessitated the need for cautious interpretation. The true nature of some of these features can only be established by further investigation, for example augering or trial excavation.

Anomaly **1**, in the south-east corner of field 110, may be related to the service in field 108.

The resistance survey did not yield any conclusive evidence of building remains in field 111. Areas of higher resistance probably reflect the lower moisture levels of traffic-compacted soils and variable crop cover. It should be noted that resistance surveys undertaken in this field and the north end of field 112 were carried out following several days of heavy rain. This is reflected by the relatively poor response.

Field 112 (Figs. 62, 30, 31)

The resistivity survey, centred on Gol Grange (TF 2690 1670), was carried out on the whole of field 112. The remains of the Grange lie within a raised area in the northern part of the field. Slightly higher electrical resistance (circled) was identified across this mound, and so probably represents the lower moisture content of comparatively well drained soils. A slightly raised area in the northern half of the field displayed similar electrical properties (also circled).

The data was clipped and de-striped, which enhanced potentially significant anomalies. A c. 4mx 8m rectangular anomaly (**1**) was detected in the centre of the larger mound and it seems likely that this represents possible stone building remains.

Areas of higher resistance (**2, 4**) were recorded to the north of **1**. These may be significant; although it is possible that anomaly group **2** reflect grid discontinuities and the remnants of striping. Elements of the latter reflect tractor tramlines (**3**) in the wheat crop (the clearest were recorded along the southern edge of the field).

A number of short linear anomalies (example: **5**) were identified within an area of high resistance, on a slight mound. These possibly resolve as ridge and furrow.

High resistance in the north-east corner of the field (**6**) corresponds with a surface scatter of brick and tile. These artefacts were also detected by the gradiometer survey (**7**). The ceramic scatter appears to be the only feature that was detected by <u>both</u> survey techniques.

The magnetic survey detected a series of linear anomalies (example **8**, yellow). The close proximity of Gol Grange and a series of cropmarks (Fig.6) would suggest an archaeological origin for some of these; however, much of the magnetic variability in this field resembles that encountered in previous areas, where natural processes are largely responsible. Therefore, the separation of natural and archaeological anomalies has been problematic.

Field 113/114 (Figs. 63, 30, 31)

For the most part, the magnetic variation displayed is probably the result of natural processes. A group of regularly aligned anomalies (shown as yellow) appear to resolve as potential archaeological features, but this must again be treated with some caution.

Field 116 (Figs. 64, 32, 33)

The route traverses a disused railway at this location, close to anomaly group **1**.

Random magnetic variation in the southern half of field 116 is probably natural.

Linear anomalies **2** and **3** correspond to former field boundaries, and these features appear to contain miscellaneous ceramic and ferrous debris.

Linear anomaly **4** appears to reflect a previously unrecorded boundary feature, probably a ditch.

Fields117-120 (Figs. 65, 32, 33)

The remaining area in Section B comprises a number of small fields, some relatively long and narrow. Several linear anomalies (example **1**, green) within these strips respect current boundaries, and possibly reflect dylings. Examples of the latter have been identified close by.

A number of other linears (shown as yellow) were detected. The clearest of these, **(2)** are located in field 119. The general potential for archaeological remains is high in this area; there are known Romano-British settlement remains in field 117 for example, and an Iron Age salt works has been recorded close to the survey area in field 119. Anomaly **3** could conceivably represent the eastern extent of this feature.

The potential of anomaly **4** in field 118 is raised by its possible relationship with the linear that was identified at the north end of field 116 (see above).

Faint, narrow linear anomalies were detected in field 120. The southern part of 120 and the whole of field 121 were not available for survey.

SECTION A

Beyond the B1357, the route passes through an area containing cropmarks and a Romano-British salt making site. It would appear likely that elements of these, and/or related features, lie within the 40m survey corridor.

Field 124 (Figs. 65, 34, 35)

There is little in field 124 that can be resolved in terms of morphologically diagnostic archaeological remains. A group of discrete anomalies (circled) in the south-east corner of the survey block may represent sub-surface ceramic or burnt remains.

Fields 125, 126 (Figs. 66, 34, 35)

Random magnetic mottling seen in Fig. 66 cannot be resolved as archaeological features, particularly in the southern half of field 125. Therefore, archaeological features cannot be isolated with confidence in this area. However, there is a concentration of known cropmarks in both fields, some of which are traversed by the proposed corridor, and this alone suggests that some of the anomalies result from past human activities.

Diffuse linear **1** may correspond to one recorded cropmark, but this is tentative.

Anomaly **2** could just be archaeological, although this also is not clear. A discrete anomaly to the west, **3** may also be archaeological (see trace plot).

Anomaly **4** reflects the magnetic effects of an electricity pole.

A possible linear (**5**) at the north end of field 126 could be part of a series of linear anomalies detected in fields 126 and 127 (shown in green).

Fields 127, 128, 129 (Figs. 67, 34, 35)

The network of linear anomalies in fields 125 and 126 continues into field 127 (**1**, **2**). These anomalies appear to reflect at least two phases of activity. One group (**1**, shown in green) respects the western boundary of field 127, suggesting that group **1** postdates group **2**, which does not align with existing boundaries. The regular alignment of these anomalies suggests a possible agrarian origin, for example dylings or ridge and furrow.

Strong magnetic variation along the roadside boundaries (**3**) probably reflects modern services or miscellaneous debris.

Field 129 contains a concentration of recorded cropmarks, although most of these occur to the west of the survey area. The eastern elements of some of these may have been detected, and anomaly group **4** is interesting in that it comprises a series of negative linears, possibly reflecting stone features. Therefore, the archaeological potential of these anomalies should not be undervalued, given that one element of **4** appears to resolve as a sub-rectangular feature. The close proximity of discrete anomaly **5** (possibly an area of burning) reinforces this potential.

A curvilinear positive anomaly, **6**, is possibly archaeological.

Field 130 (Figs. 68, 36, 37)

The south-eastern corner of the survey appears to include traces of a former ditch, **1** (Fig.36). Linear **2** is similar, though less clear.

A number of other diffuse linear anomalies were identified (shown as green). The alignment of these features suggests a possible association with **1** and **2**.

Linear anomaly **3** may relate to the southern element of a cropmark complex (see Fig. 7, Field 130).

The mottled and apparently random magnetic variation towards the western end of the field corresponds with a slight change in soil type (S.S.L.R.C, 1989). This continues into fields 131, 132 and the eastern side of 134.

Fields 131, 132 (Figs. 69, 36, 37)

Strong variation along the eastern edge of field 131 almost certainly reflects the remains of the disused railway line (**1**). Other anomalies in both fields do not resolve as clear archaeological features, and a natural origin is suggested.

Field 134 (Figs. 70, 36, 37)

Linear anomaly **1** clearly separates two areas of contrasting magnetic values. This may reflect a change in soil type, possibly linked to fluvial action. The magnetically quieter western half may indicate the remains of a paleochannel or series of palaeochannels and associated iron pan formations. If this is so, then linear **1** could be natural. This interpretation is offered tentatively, given that two well-defined parallel linear anomalies (**2**), of possible archaeological significance, were detected at the western end of the survey area and match the alignment of **1**.

Faint linear anomalies (shown in green) have been detected between **1** and **2** (linear **3** almost certainly marks an earlier continuation of an existing ditch, as depicted on figure 37). Others are possible to the east of **1**, possibly reflecting earlier land divisions.

Field 135 (Figs. 71, 38, 39)

Note: two strip fields, each c. 20m wide, situated between fields 134 and 135, were not allocated field numbers, and are included in the description and image for 135.

The short linear anomalies in field 134 continue into 135 (**1**). A known field boundary was detected in this area (**2**).

Field 136 (Figs. 72, 38, 39)

Linear anomaly **1** represents a recently backfilled drain (probably containing miscellaneous debris).

Other, parallel/perpendicular, linear anomalies (green) probably reflect similarly redundant former land divisions. These, and some of those detected in field 134, may be components of a series of dylings. The narrow linear form of existing fields reinforces this interpretation.

Fields 161, 163 (Figs. 72, 73, 38-41)

Beyond a road crossing, two diffuse linear anomalies (**1**) in field 161 possibly reflect a change in the geology and/or soils. This complements the abrupt transition encountered in field 134.

The magnetic variation to the west of **1** continues into field 163. These anomalies are similar to many encountered in Section B and probably relate to natural features.

An area of strong magnetic disturbance (circled) at the western end of the survey in field 163 lies within the broad confines of a borrow pit (used during the construction of the A16 in 1994/5). These anomalies may reflect debris contained within the backfill.

The remainder of the route, extending up to the A16, was not surveyed.

Fields 164, 165, 166 (Figs. 74, 40, 41)

A nebulous array of thin linear anomalies (**1**) was detected in field 164. These do not resolve as clear archaeological features.

A distinct zone of strong disturbance (**2**) at the western end of field 165 (and another, **3**, at the eastern end of field 166) lies close to an industrial development. Discrete anomaly **4** (field 166) probably represents debris that has accumulated alongside the A1173.

The survey recorded a series of magnetically weak, parallel, linear anomalies (shown as blue). These probably reflect natural features, such as relict channels.

8.0 Conclusions

The survey has identified a range of probable and possible archaeological anomalies. Many of these relate to agricultural activities, and include former field boundaries and medieval dylings. Examples of the latter were detected close to, or within, small narrow fields at Crowland and Cowbit.

A number of relatively strong discrete anomalies were also recorded in several locations. Given the past significance of this area for coastal salt and brick/tile production, some of these features may well be related to aspects of these industries. Relevant anomalies detected in fields 119 and 125 lie close to known Iron Age and Romano-British salt making sites at Cowbit. The example in field 107 occurs within a series of medieval dylings. Others were detected in the vicinity of Crowland. The example in Section H (field 11) was detected on higher ground, within 100m of the Car Dyke.

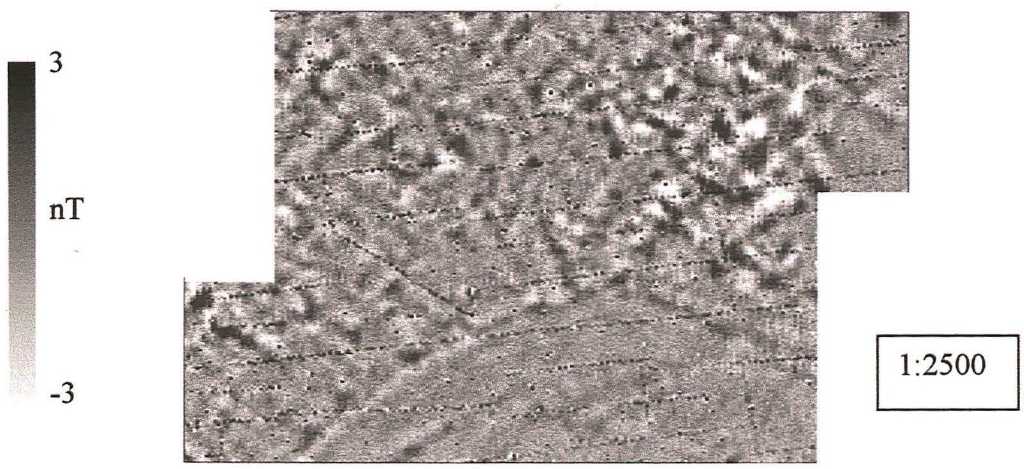
A possible medieval/post-medieval track has been identified to the east of Crowland, and it is tentatively suggested that settlement remains may lie in field 129 (Section A).

For much of the survey, the preponderance of naturally produced magnetic variation has compromised, and to some extent hindered, results: the magnetic signatures of relict palaeochannels, salt marshes and/or peat deposits may be masking or 'mimicking' archaeological features, although verification is not possible without the application of further archaeological techniques. Consequently, the interpretation of certain anomalies has been offered with caution, particularly in Sections A to D.

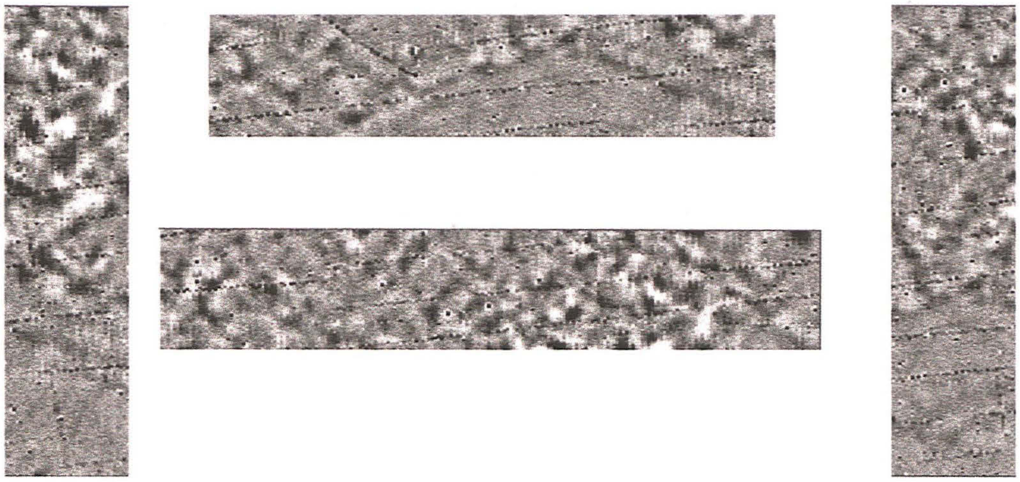
Taken in isolation, certain anomalies in the central parts of Section C appear to resolve as traces of ridge and furrow ploughing and elements of enclosures. Of these, it seems likely that anomaly **1,** detected in field 91 (Fig. 54), represents the north-east corner of an enclosure. The southernmost part of field 91 lies on slightly elevated ground, which may have existed as a slight island or ridge within an otherwise wetland landscape. This may have been a focus for past human occupation, aspects of which appear to have been detected by the survey.

To a large extent, anomalies to the north of field 91 are problematic: some certainly reflect former field boundaries (see fields 94/95), which were removed in relatively recent times. Others appear to resolve as potentially significant archaeological anomalies. However, on this type of geology, the magnetic contrast between archaeological and natural anomalies can be slight non-existent.

A magnetic survey undertaken close to Boston in 2000 (Rylatt and Bunn, 2000) identified a range of anomalies that share similar properties to the seemingly natural anomalies encountered during the current survey (greyscale reproduced below).



The interpretation of these features as natural phenomena was relatively straightforward; the size of the survey area enabled a wider overview. When presented as 40m sections (below), the situation mirrors aspects of the current site.



Their interpretation as natural features was confirmed during subsequent excavation. The mottled areas, including linear anomalies, in the upper part of the image resolved as iron-rich peat deposits and silt-filled depressions; the relatively quiet area reflected a migratory relict channel.

The relative absence of settlement remains and artefact scatters in Section C suggests that this area has been less densely occupied than other parts of the route, or that archaeological deposits lie masked beneath deposits of alluvium. The upper alluvial sequence (Terrington Beds) is relatively recent; in places later than 1000 years BP.

The occurrence of natural features continues into Section B, particularly on land to the south of field 116, and beyond the B1357, into Section A. Archaeological remains were detected within section B, specifically a series of suspected dylings in field 107, and probable building remains on the elevated site of Gol Grange in field 112. Anomalies associated with the latter were detected by resistivity; an area where gradiometry was less responsive. For the most part, stone structures do not respond well to magnetic survey, although associated features, such as hearths and ditches, usually do. It is possible that some ditches were detected in this area, but these remain virtually indistinguishable from natural features.

9.0 Acknowledgements

Pre-Construct Geophysics would like to thank Babtie Group for this commission. We would also like to extend our thanks to the many landowners and occupiers for their co-operation during the survey.

10.0 References

Babtie Group — 2001 *A1073 Peterborough to Spalding Improvement Scheme, Archaeological Evaluation Works: Specification for Geophysical Survey*. Unpublished.

B.G.S. — 1984 *Peterborough, England and Wales Sheet* ***158***. Solid and Drift Geology. 1:50,000 Series. Keyworth, British Geological Survey.

B.G.S. 1992 *Spalding, England and Wales Sheet **144***. Solid and Drift Geology. 1:50,000 Series. Keyworth, British Geological Survey.

Clark, A. J. 1990 *Seeing Beneath the Soil*. London, Batsford.

David, A. 1995 *Geophysical Survey in Archaeological Field Evaluation*. London, English Heritage: Research & Professional Guidelines No.**1**.

Gaffney, C., Gater, J. & Ovendon, S. 1991 *The Use of Geophysical Techniques in Archaeological Field Evaluation*. London, English Heritage: Technical Paper No. **9.**

Rylatt, J. & Bunn, D.B. 2000 *Fluxgate Gradiometer Survey: Land off Great Fen Road, Boston, Lincolnshire*. Pre-Construct Geophysics. Unpublished Report.

S.S.L.R.C. 1983 *Soils of England and Wales, Sheet 4 Eastern England.* Harpenden, Soil Survey and Land Research Centre

S.S.L.R.C. 1989 *Soils of the Boston and Spalding District.* Harpenden, Soil Survey and Land Research Centre