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LAND AT QUARRINGTON GLEBE, QUARRINGTON, LINCOLNSHIRE

Gradiometer Survey

(Survey Ref : 0950996/QUL/LAS)

Site Code QG 96 Accession No. 108.96

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Produced by
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under the direction of
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Commissioned by
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SUMMARY

A geophysical evaluation programme comprising gradiometer survey was carried out on land (1 ha) at Quarrington Glebe in the village of Quarrington, near Sleaford, Lincolnshire in advance of proposed housing development (centred on 505500 344660).

The survey was based upon the principle that past human activity and its associated debris usually creates slight but persistent changes in the local magnetic environment which can be sensed from the surface (using magnetometry).

In the present case, there is very little magnetic evidence for features of archaeological potential, with the exception of a probable 'cut' feature, which is partially obscured by magnetic inference caused by a modern ferrous water pipe, and ephemeral traces of hollows or intrusions concentrated towards the northern part of the survey area.

1. INTRODUCTION

1.1 Geophysical survey was commissioned by Lindsey Archaeological Services on 1 hectare of land at Quarrington Glebe (OS Field No. 4374, adjacent to Northfield Road (east side), on the northern outskirts of the village of Quarrington, c. 1.5 km southwest of Sleaford, Lincolnshire (centred on 505500 344660) in advance of housing development. The location is shown on Fig. 1. The fieldwork was carried out in September 1996.

1.2 The survey area comprises an area of arable farmland, which was prepared seedbed at the time of survey.

1.3 Although no sites or finds of archaeological significance are known from the survey area itself, Early - Middle Anglo Saxon remains have been discovered within the adjacent fields to the southeast, less than 200 m from the survey area, in proximity to the Manor House, although no focus of an associated settlement has yet been determined (pers. comm. N. Field).

1.4 The present magnetometer (gradiometer) survey aimed to identify activity areas and characterise 'cut' features and structural remains of later prehistoric or subsequent periods. An explanation of the techniques used, and the rationale behind their selection, is included in an Appendix to the present report.

2. MAGNETIC SURVEY DESIGN

2.1 An area of one hectare within the southeastern corner of the field of the proposed housing development lying closest to the known Anglo-Saxon activity had been designated for gradiometer survey, and examined by detailed gridded gradiometer survey using a Geoscan Research FM 36 Fluxgate Gradiometer (sampling 4 readings per metre at 1 metre traverse intervals in the 0.1 nT range). The nanotesla (nT) is the standard unit of magnetic flux (expressed as the current density), here used to indicate positive and negative deviations from the Earth's normal magnetic field.

2.2 The survey grids were set along the straight fenceline dividing Fields 4374 and 6481 (although the latter is shown as a field on the current OS sheet, it is now built-over), and offset a distance of 5m west of the fence which divides the survey field from the footpath in order to reduce the magnetic interference from the wire fence at this location (Fig. 2). The area in proximity to electricity services at the extreme southern end of the survey block were not included to avoid gross magnetic distortion from an underground cable.

2.3 Field data were stored to 3.5-inch disks, and processed using Geoscan Research Geoplot and Oxford Archaeotechnics software.

2.4 In order to reduce the interference from a ferrous water pipe which crosses the north and east side of the survey grid, the three 30 x 30 m survey grids containing this feature (producing 'peaks' exceeding +300 nT) were clipped during data processing at -5 and + 5 nT (a value which represents 3 standard deviations for the majority of the site) before incorporation in the composite plot. This has allowed both the grey scale and stacked trace plots to display the full dynamic range across the remainder of the survey area.

2.5 Magnetometer data have been presented as grey scale and raw data stacked trace plots (Figs. 3 & 5); a summary and interpretation of results is shown on Fig. 4.

3. SURVEY RESULTS

3.1 Gradiometer survey covered nine complete and one partial 30 x 30 m survey grids (0.9 ha); a small area within the extreme southeast angle had be excluded from survey owing to the presence of an electricity pole, transformer and underground electricity cable.

3.2 The majority of the anomalies recorded were extremely weak, in the range -1 to +1 nT.

3.3 The northeastern side of the survey area is crossed (northwest-southeast) by a ferrous water pipe.

3.4 The survey located few features of obvious archaeological potential. The majority of anomalies appear to be of agricultural origin.

3.5 In addition to the general north-south striations, which include both modern agricultural marks and perhaps furrow bases from former (Medieval or post Medieval) ridge and furrow cultivation, there are suggestions of further grouped ?agricultural linears on a northwest-southeast trend (Fig. 4).

3.6 An apparent 'cut' feature is visible close to the northern boundary of the survey area, partly obscured by the negative 'wash-out' from the ferrous water pipe. This feature measures some 4 m in diameter, appears to have a projection on its west side.

3.7 A few extremely tenuous weak positive anomalies which may represent shallow features are visible within the northern part of the survey area. They are not necessarily of anthropogenic origin.

3.8 There is a general litter of ferrous debris apparent over the survey area, which tend to form regular groupings on both northwest-southeast and northeast-southwest trends; the former tend is particularly apparent on the stacked trace plot (Fig. 5), where the major ferrous scatter is on a similar alignment to the weak lineations indicated on Fig. 4.

4. CONCLUSIONS

4.1 The majority of the extremely weak anomalies revealed by detailed gradiometry do not appear to relate to any focus of underlying archaeological activity, with the exception of one apparently 'cut' feature and an area of possible intrusions which have been recorded close to the northern boundary of the survey. The image of the stronger cut feature is partly 'swamped' by a modern ferrous pipeline. Otherwise the gradiometer plot is unremarkable. The rectilinear distribution of ferrous material is unusual, although it generally reflects the alignment of grouped weak linears which tend to be almost invariably of agricultural origin .

REFERENCES

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GALE, S.J. & HOARE, P.G. 1991. *Quaternary Sediments: petrographic methods for the study of unlithified rocks.* Belhaven Press: London (see Section 4.7, pp.201-229, "The magnetic susceptibility of regolith materials").

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THOMPSON, R. & OLDFIELD, F. 1986. *Environmental Magnetism.* Allen & Unwin: London.

Topsoil magnetic susceptibility mapping and magnetometer survey by Oxford Archaeotechnics Limited under the direction of A.E. Johnson *BA(Hons)*, with D. Chambers *BA(Hons)*.

APPENDIX - MAGNETIC TECHNIQUES: GENERAL PRINCIPLES

A1.1 It is possible to define areas of human activity (particularly soils spread from occupation sites and the fills of cut features such as pits or ditches) by means of *magnetic survey* (Clark 1990; Scollar et al. 1990). The results will vary, according to the local geology and soils (Thompson & Oldfield 1986; Gale & Hoare 1991), as modified by past and present agricultural practices. Under favourable conditions, areas of suspected archaeological activity can be accurately located and targeted for further investigative work (if required) without the necessity for extensive random exploratory trenching. Magnetic survey has the added advantages of enabling large areas to be assessed relatively quickly, and is non-destructive.

A1.2 Topsoil is normally more magnetic than the subsoil or bedrock from which it is derived. Human activity further locally enhances the magnetic properties of soils, and amplifies the contrast with the geological background. The main enhancement effect is the increase of *magnetic susceptibility*, by fire and, to a lesser extent, by the bacterial activity associated with rubbish decomposition; the introduction of materials such as fired clay and ceramics - and, of course, iron and many industrial residues - may also be important in some cases. Other agencies include the addition and redistribution of naturally magnetic rock such as basalt or ironstone, either locally derived or imported.

A1.3 The tendency of most human activity is to increase soil magnetic susceptibility locally. In some cases, however, features such as traces of former mounds or banks, or imported soil/subsoil or non-magnetic bedrock (such as most limestones), will show as zones of lower susceptibility in comparison with the surrounding topsoil.

A1.4 Archaeologically magnetically enhanced soils are therefore a response of the parent geological material to a series of events which make up the total domestic, agricultural and industrial history of a site, usually over a prolonged period. Climatic factors may subsequently further modify the susceptibility of soils but, in the absence of strong chemical alteration (e.g. during the process of podzolisation or extreme reduction), magnetic characteristics may persist over millions of years.

A1.5 Both the magnetic contrast between archaeological features and the subsoil into which they are dug, and the magnetic susceptibility of topsoil spreads associated with occupation horizons, can be measured in the field.

A1.6 There are several highly sensitive instruments available which can be used to measure these magnetic variations. Some are capable, under favourable conditions, of producing extraordinarily detailed plots of subsurface features. The detection of these features is usually by means of a *magnetometer* (normally a fluxgate gradiometer). These are defined as passive instruments which respond to the magnetic anomalies produced by buried features in the presence of the Earth's magnetic field. The gradiometer uses two sensors mounted vertically, often 50 cm apart. The bottom sensor is carried some 30 cm above the ground, and registers local magnetic anomalies with respect to the top sensor. As both sensors are affected equally by gross magnetic effects these are cancelled out. In order to produce good results, the magnetic susceptibility contrast between features and their surroundings must be reasonably high, thereby creating good local anomalies; a generally raised background, even if due to human occupation within a settlement context, will sometimes preclude meaningful magnetometer results. The sensitive nature of magnetometers makes them suitable for detailed work, logging measurements at a closely spaced (less than 1 metre) sample interval, particularly in areas where an archaeological site is already suspected. Magnetometers may also be used for rapid 'prospecting' ('scanning') of larger areas (where the operator directly monitors the changing magnetic field and pinpoints specific anomalies).

A1.7 *Magnetic susceptibility measuring systems*, whilst responding to basically the same magnetic component in the soil, are 'active' instruments which subject the sample area being measured (according to the size of the sensor used) to a low intensity alternating magnetic field. Magnetically susceptible material within the influence of this field can be measured by means of changes which are induced in oscillator frequency. For general work, measuring topsoil susceptibility *in situ*, a sensor loop of around 20 cm diameter is convenient, and responds to the concentration of magnetic (especially ferrimagnetic) minerals mostly in the top 10 cm of the soil. Magnetically enhanced horizons which have been reached by the plough, and even those from which material has been transported by soil biological activity, can thus be recognised.

A1.8 Whilst only rarely encountering anomalies as graphically defined as those detected by magnetometers, magnetic susceptibility systems are ideal for detecting magnetic spreads and thin archaeological horizons not seen by magnetometers. Using a 10 m interval grid, large areas of landscape can be covered relatively quickly. The resulting plot can frequently determine the general pattern of activity and define the nuclei of any occupation or industrial areas. As the intervals between susceptibility readings generally exceed the parameters of most individual archaeological features (but not of the general spread of enhancement around features), the resulting plots should be used as a guide to areas of archaeological potential and to suggest the general form of major activity areas; further refinement is possible using a finer mesh grid or, more usually, by detailing underlying features using a gradiometer.

A1.9 Magnetic survey is not successful on all geological and pedological substrates. As a rule of thumb, in the lowland zone of Britain, the more sandy/stony a deposit, the less magnetic material is likely to be present, so that a greater magnetic contrast in soil materials will be needed to locate archaeological features; in practice, this means that only stronger magnetic anomalies (e.g. larger accumulations of burnt material) will be visible, with weaker signals (e.g. from the fillings of simple agricultural ditches) disappearing into the background. Similar problems can arise when the natural background itself is very high or very variable (e.g. in the presence of sediments partially derived from magnetic volcanic rocks).

A1.10 The precise physical and chemical processes of changing soil magnetism are extremely complex and subject to innumerable variations. In general terms, however, there is no doubt that magnetic enhancement of soils by human activity provides valuable archaeological information.

A1.11 As well as locating specific sites, topsoil magnetic susceptibility survey frequently provides information relating to former landuse. Variations in the soils and subsoils, both natural and those enhanced by anthropogenic agencies, when modified by agriculture, give rise to distinctive patterns of topsoil susceptibility. The containment of these spreads by either natural or man-made features (streams, hedgerows, etc.) gives rise to a characteristic chequerboard or strip pattern of varying enhancement, often showing the location of former field systems, which persist even after the physical barriers have been removed. These patterns are often further amplified in fields containing underlying archaeological features within reach of the plough. More subtle landuse boundaries and indications of former cultivation regimes are often suggested by topsoil magnetic susceptibility plots.

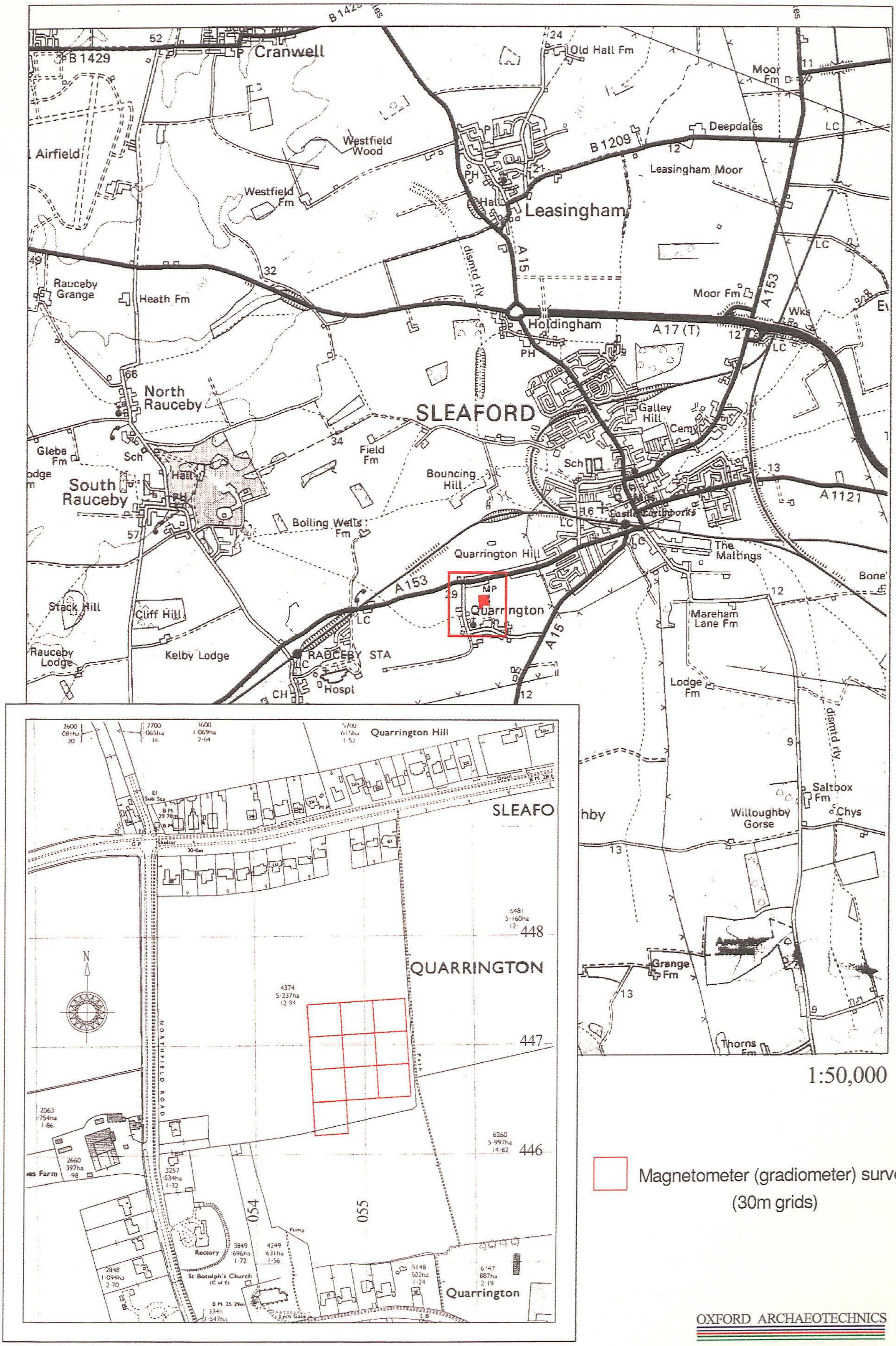
A1.12 Where a general spread of magnetically enhanced soils contained within a long-established boundary becomes admixed over a long period by constant ploughing, it can be diffused to such a point that the original source is masked altogether. Magnetically enhanced material may also be moved or masked by natural agencies such as colluviation or alluviation. Generally, it appears that the longer a parcel of land has been under arable cultivation, the greater is the tendency for topsoil susceptibility to increase; at the same time there is increasing homogeneity of the magnetic signal within the soils owing to continuous agricultural mixing of the material. Some patterns of soil enhancement derived from underlying archaeological features are, however, apparently capable of resisting agricultural dispersal for thousands of years (Clark 1990).

FIGURE CAPTIONS

Figure 1.	Location maps. Scale 1:50,000 and 1:5,000. Based upon OS 1:50,000 Map 130, and OS 1:2500 Sheets TF 0544 & 0545, reduced to 1:5000 scale.
Figure 2.	Location of survey area and overview (Geoscan Research Geoplot Licence No. GPB 885-6). Based upon OS 1:2500 Sheets TF 0544 & 0545. Scale 1:2500.
Figure 3.	Gradiometer survey: grey shade plot(Geoscan Research Geoplot Licence No. GPB 885-6). Scale 1:1000.
Figure 4.	Gradiometer survey: grey shade plot and interpretation (Geoscan Research Geoplot Licence No. GPB 885-6). Scale 1:1000.
Figure 5.	Gradiometer survey: stacked trace plots: raw data (Geoscan Research Geoplot Licence No. GPB 885-6). Scale 1:1000.

Land at Quarrington Glebe, Quarrington, Lincolnshire

Magnetometer (gradiometer) survey: Location



1:50,000

Magnetometer (gradiometer) survey (30m grids)

1:5,000

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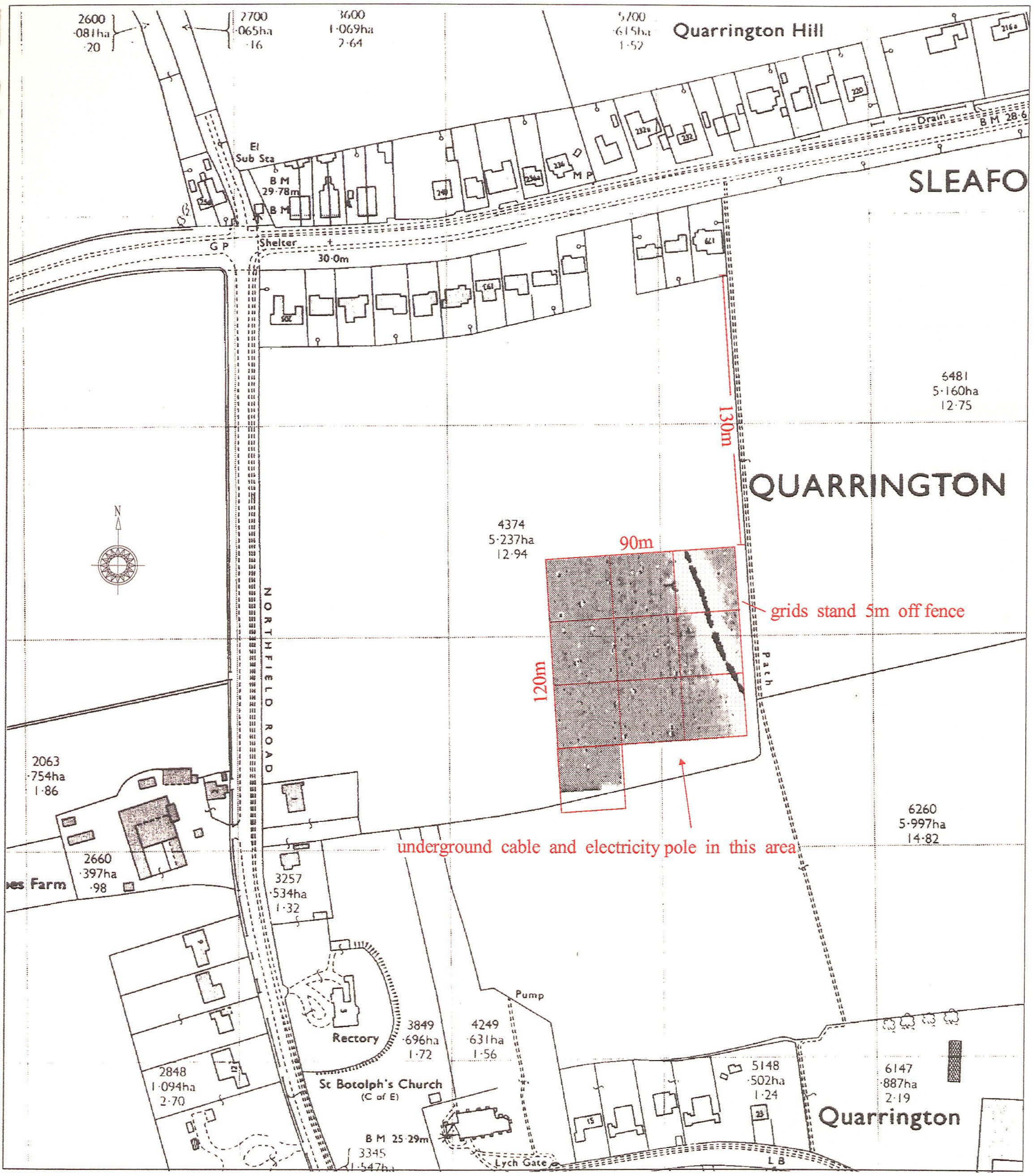
FIG. 1

Land at Quarrington Glebe, Quarrington, Lincolnshire

Magnetometer (gradiometer) survey: survey grids



1:2500

-2 -1.5 -1 -.5 0 .5 1 1.5 2 nT

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FIG. 2

Land at Quarrington Glebe, Quarrington, Lincolnshire

Magnetometer (gradiometer) survey: Grey shade plot

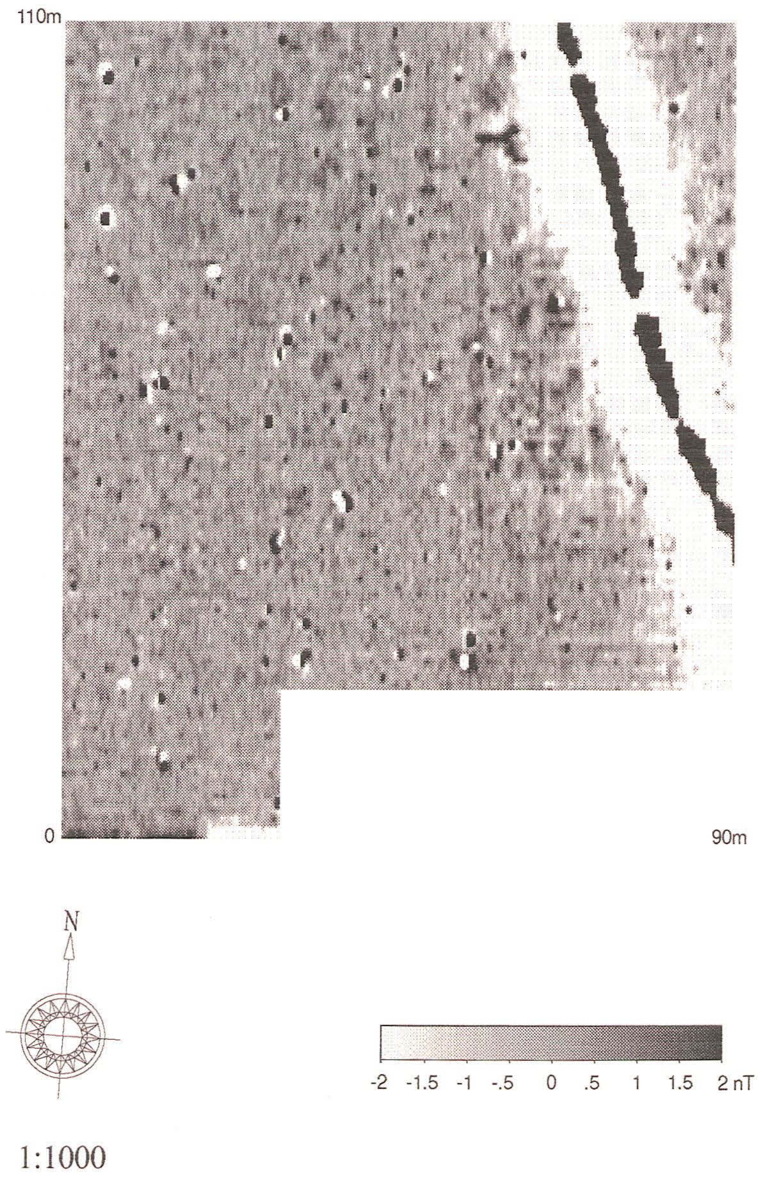

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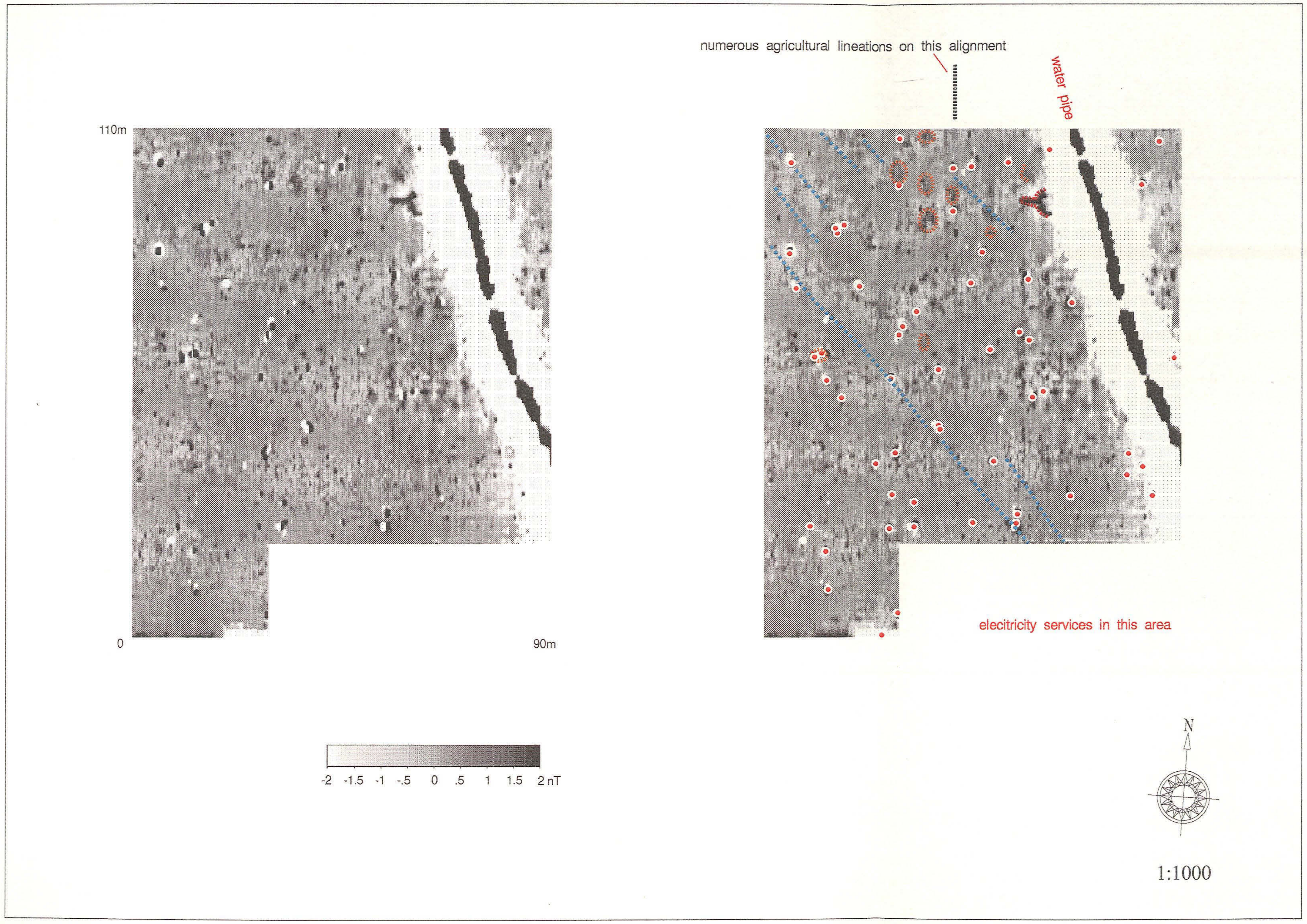
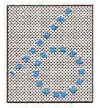
FIG. 3



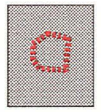
Land at Quarrington Glebe, Quarrington, Lincolnshire

Gradiometer Survey, Grey Shade Plot

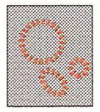
Interpretation



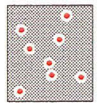
Weak linear and curvilinear features, including agricultural striations



Pits, other cut features



Possible pits / hollows or shallow intrusions



Ferrous material

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FIG. 4

Land at Quarrington Glebe, Quarrington, Lincolnshire

Magnetometer (gradiometer) survey: Stacked trace plot: raw data

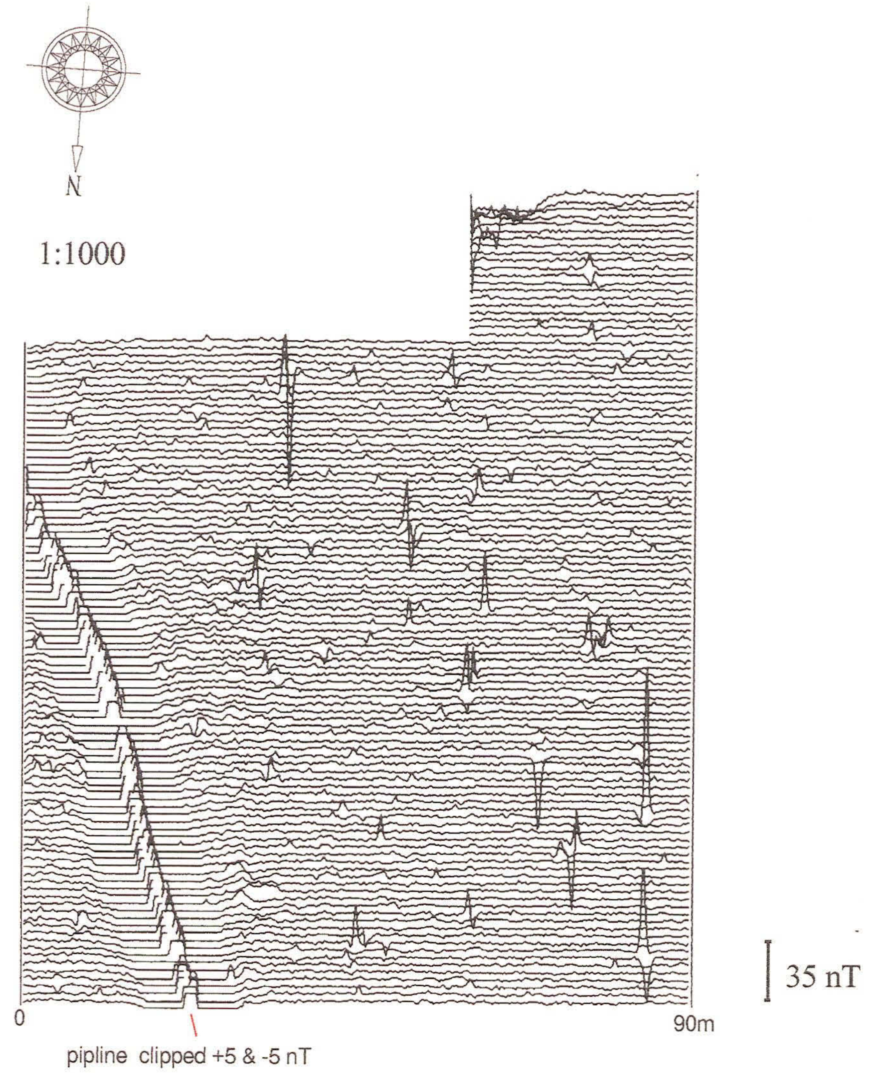

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FIG. 5

Specialist Archaeological Field Evaluation

INTERNAL QUALITY CHECK

Survey Reference	0950996/QUL/LAS		
Primary Author	[signature]	Date	8/10/96
Checked By	APJ	Date	8.10.96
Checked By		Date	
Further Corrections		Date	

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